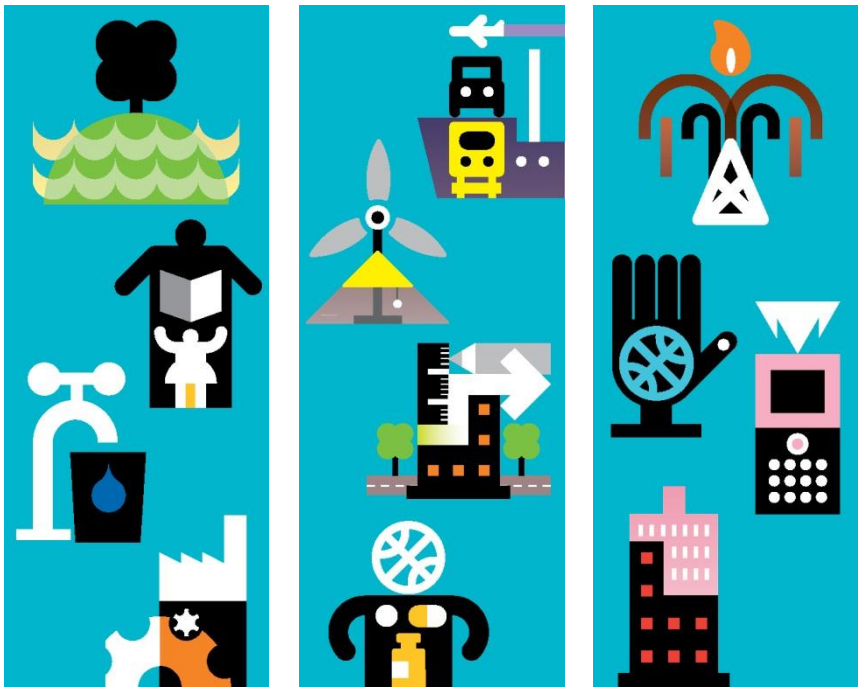

Ugu Environmental Management Framework

Geological Specialist Report

October 2013

Ugu District Municipality

Ugu District Municipality

agriculture & environmental affairs
Department Agriculture & Environmental Affairs
PROVINCE OF KWAZULU-NATAL

Mott MacDonald

Ugu Environmental Management Framework

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Ugu District Municipality

28 Connor Street, Port Shepstone, 4240

Mott MacDonald, Mott MacDonald House, 359 Rivonia Boulevard, Rivonia, Johannesburg 2128, South Africa.
Postal address: PO Box 787511, Sandton 2146, South Africa
T +27 (0) 11 519 0000 **F** +27 (0) 87 310 5199 **W** www.mottmac.com

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11.	October 2013	M. Khan	A. Butlin	S. Koch	Final Geological Report	

Contents

1 Project Introduction and Methodology

The solid geology of the vast majority of the Ugu District Municipality is underlain by competent rock types such as Gneiss, Arenite, Dolerite, Marble and Tillite. There are small areas where problematic rocks such as Shale and Mudstone are present. These rock types are concentrated mainly on the Northern Boundary of the Ugu District Municipality close to Kokstad.

Specialist information has been obtained from:

- Geology Data Source: Enpat, KZN;
- Soil Depth Data Source: KZN Provincial Growth;
- Engineering Geology of Southern Africa, Volume's 1,2,3 and 4 by A.B.A. Brink;
- Kwazulu-Natal Coastal Vulnerability Assessment: Department of Agriculture, Environmental affairs & Rural Development; and
- Landslide classification, characterization and susceptibility modelling in KwaZulu-Natal.

2 Geological Risk Areas for Development

Collapsible Soils – For any construction on collapsible soils, there is a risk of settlement of the structure, potentially extreme settlement and structural failure. This occurs when there is a change in moisture content of the soil, by poor drainage, and an increase in loading from the new structure. These soils may be found along the coast, predominantly over Gneiss and Arenite formations.

Heaving/ Shrinking Soils – For any construction on heaving soils, there is a risk of differential settlement of the structure, potentially leading to structural failure. This occurs when there is an increase in moisture content of the soil around the new structure, by poor drainage, and the moisture content in the middle of the structure remaining unchanged. This will also occur when the moisture content around the new structure dries out faster than the middle of the structure. These soils may be found typically over Mudstone, Shale and Dolerite formations.

Unstable Slopes – Slope failure in construction such as road cuttings or deep excavations can occur in thinly laminated weak rocks such as Shale, Mudstone and Berea formation. These conditions may also be experienced in Tillite, Gneiss, Arenite, Dolerite and Marble, especially if the rock is weathered and fractures are dipping towards the excavated face.

Historic Mining Risks – There are numerous mining activities, presently active and closed mines within the Ugu District Municipality. West of Harding there is a dormant nickel mine and a cluster of aluminium deposits that has not been exploited. North and North West of Port Shepstone there are active Limestone, Quartzite and building sand quarry's. Mines producing building sand are located at Mthwalume and Scottburgh with abandoned/dormant/intermittently producing mines near Ramsgate, St Michael's on Sea and Pennington. Inactive and abandoned gold and molybdenum mines are located near Umzinto and Kenterton. Carbon dioxide gas was produced at Bombela, but is currently inactive.

Any new construction activity close to existing mining or abandoned mines must investigate the underground stability within and around the new structure to predict the possibility of underground collapse as a result of cavities in the underground workings. Please refer to Figure 9.1, showing the Mineral Map of Kwazulu-Natal.

Seismic Risk – A major fault runs parallel to the coastline along the Ugu District Municipality. The risk of a major earthquake potentially occurring in the Ugu District Municipality is very low, but critical structures susceptible to earth tremors, such as dams, should only be built over the fault line after detailed analysis.

Aggressive Coastline - The Ugu District Municipality has a particularly aggressive coastline. Currently there are companies prospecting for oil off the Ugu coastline. Any future installation off the Ugu coastline will be vulnerable to damage due to the aggressive coastline. The susceptibility of the coastal geology to erosion by the sea is discussed further in a later section of this report.

Landslide Susceptibility – Landslides when they do occur are usually catastrophic and if in a developed area can cause large scale socio-economic losses. It is for this reason that it is vital to understand what causes landslides and to identify the area's most susceptible to their occurrence. The factors that increase the risk of landslides occurring are:

- Slope angle;

- Seismicity;
- Lithostratigraphy and rock type;
- Groundwater regime, including soil/rock permeability
- Discontinuities including igneous intrusions creating contact zones (particularly dolerite)
- Lineaments;
- Terrain morphology; and
- Aspect.

The landslide susceptibility categorises the areas into three risk classes, namely: Low Susceptibility, Moderate Susceptibility and High Susceptibility. In the Ugu District Municipality, the area close to Kokstad has a High Susceptibility to landslides while the rest of the Ugu District away from the coastal belt has a hilly terrain and has a Moderate Susceptibility to landslides.

Coastal Vulnerability Assessment – The southern boundary from Port Edward to Scottburgh for the Ugu District Municipality is the Indian Ocean. This is a very important resource for the Ugu District Municipality as the majority of the population is concentrated along the coastline and most of the economic activities for the Municipality occur near the coastline. The disproportionate settlement at the coast has led to increased pressure on the coastal zone mainly through resource exploitation and coastal development.

This leads to natural coastal functioning being lost, leaving the coast vulnerable to the impacts of sea-level rise, coastal erosion, extreme weather, oceanic events and other coastal hazards (O'Connor et al., 2009).

Due to the risks posed by coastal erosion, sea-level rise and extreme events, the Kwazulu-Natal Coastal Vulnerability Index (CVI) was developed. The CVI assesses the relative physical coastal vulnerability based on a set of physical coastal parameters that serve as indicators of risk. The coast is categorised into three risk classes, namely: RISK (Yellow), MODERATE RISK (Orange) and HIGH RISK (Red).

- RISK (Yellow): Sites that score RISK are considered to be at lower risk than other areas to be impacted by damage due to favourable physical parameters such as vegetation, beach width, dune width, outcrop and distance to the 20m isobaths respectively. Any new developments must be set-back appropriately so as to maintain the natural functioning of the coast.
- MODERATE RISK (Orange): Sites that score MODERATE RISK are at higher risk that areas of RISK, and there is a greater likelihood of these sites being damaged as a result of coastal erosion or extreme weather events. It is recommended that the option of 'retreat and defence' be explored as existing infrastructure may be damaged. New developments must be set back sufficiently to ensure that they are not damaged.
- HIGH RISK (Red): Sites that score HIGH RISK are considered to be the most susceptible to the effects of erosion and are most likely to be impacted should sea-levels rise or extreme events occur. It is recommended that the option of retreat and defence be explored as existing infrastructure may be damaged. New developments in areas adjacent to sites with this risk category must be set back sufficiently to ensure that they are not damaged.

Please refer to Figures 9.2 to 9.9 showing the Coastal Vulnerability Assessment for the Ugu District Municipality.

3 Solid Geology Descriptions

Please refer to Figure 10, identifying the Solid Geology for the Ugu District Municipality.

Tillite: Tillite is found extensively within the Ugu District Municipality and is an excellent founding material. Tunnelling through unweathered Tillite rock is generally trouble free and crushed Tillite will provide an excellent construction material. When exposed in cuttings, Tillite will present numerous slope problems involving the sliding of large blocks of rock along clay intercalations at dip angles of 10 - 20°. This can be overcome by bolting or anchoring with or without mesh and shotcrete. Another option is to reduce the angle of the slope.

Mudstone: Mudstone may be encountered in a small area close to Kokstad. One of the most troublesome properties of this rock is its tendency to breakdown rapidly after exposure to the atmosphere in cuttings or during tunnelling. Residual soils formed from Mudstone will exhibit expansive characteristics. These soils will heave when wet and shrink when dry causing differential movements and cracking of structures. Mudstone may be used in a compacted fill or as a road sub-base layer together with a stabiliser. Lime is considered the most suitable chemical agent for stabilising Mudstone.

Shale: Shale will be encountered on the north western boundary from Harding to Kokstad and around Port Shepstone. Very similar to Mudstone, Shale will breakdown after exposure to the atmosphere in cutting or tunnelling. Residual soils formed from Shale will exhibit expansive characteristics. These soils will heave when wet and shrink when dry causing differential movements and cracking of structures. This material is not suitable for construction.

Dolerite: Dolerite may be encountered in small areas close to Kokstad. Unweathered Dolerite Rock is an excellent founding material and may be used as founding for major structures such as dams. It may also be crushed and used as a rock fill, concrete aggregate or as a selected layer in road/rail construction. The durability of the rock needs to be assessed before use as this could pose a problem during the service life of a structure. Dolerite decomposes chemically to form Montmorilinite, a highly expansive clay mineral. Residual soils derived from Dolerite will heave when wet and shrink when dry causing serious damage to structures.

Gneiss: Gneiss is found extensively within the Ugu District Municipality and is an excellent founding material. Crushed unweathered Gneiss will provide an excellent construction material. When exposed in cuttings, Gneiss in fairly stable and should not present slope stability problems. Gneiss will weather to form a sandy type of material that may exhibit a collapsible fabric.

Arenite: Arenite is found scattered within the Ugu District Municipality. Arenite is a sedimentary rock similar to Sandstone but is regarded as clean Sandstone because it is composed entirely from sand sized grains. Crushed Arenite is not suitable as a concrete aggregate because it causes serious deterioration of concrete, deflection of reinforced concrete members and surface cracking. Arenite will weather to form a sandy type of material that may exhibit a collapsible fabric.

Marble: Marble may be encountered in small areas around Port Shepstone. Unweathered Marble Rock is an excellent founding material. It may also be crushed and used as a rock fill, concrete aggregate or as a

selected layer in road/rail construction. When exposed in cuttings, Marble is fairly stable and should not present slope stability problems.

In addition to the solid geology mapping, another notable formation in the region (Berea) was identified by Brink (1981 to 1996).

Berea Formation: The Berea Formation with the calcarenites from which it was derived, occurs as a narrow belt along almost the entire coast of KwaZulu-Natal. This formation exhibits a collapsible fabric and excessive settlement is likely to occur when founding on this formation. This material is highly erodible by wind and water.

4 Soil Depth Description

Please refer to Figure 9.11, identifying the soil depth for the Ugu District Municipality.

The solid geology of the Ugu District Municipality is covered by varying thickness of residual and transported soils. Soil cover greater than 750 mm may be encountered in the area around Harding, along the coast from Margate to Scottburgh, and the northern boundary of the Ugu District Municipality. The vast majority of the Ugu municipality has soil cover depth (450 mm – 750 mm) above the solid geology. Soil cover less than 450 mm may be encountered along the coast behind the deep soil areas and above Umzinto extending towards the Ugu District Municipal boundary.

5 Geo-tourism

The Ugu District Municipality has some unique geological features within its boundary that have the potential for being further developed as a geo-tourism location. A list of identified sites includes the following:

- Uvongo waterfall along the coastline;
- Oribi Gorge;
- Wilson's cutting;
- Renken fault line;
- Hells Gate; and
- The Red Desert.

6 Future Development

Geological descriptions of soils and rocks are provided in this report at a general level. This includes typical characteristics observed and published in existing literature. However each site is unique, therefore for each new development a suitable geotechnical investigation must still be undertaken. It should also be noted that superficial deposits of rift or residual soils are unknown and will required detailed geotechnical investigation for any development.

7 Conclusion and Recommendations

Most of the Ugu District Municipality is underlain by good competent rock types but there are small areas where problematic rocks such as Shale and Mudstone are present. There are also sites of potential under-mining risk, unstable slopes and collapsible soils.

The Ugu District Municipality Southern Boundary is the Indian Ocean, a very sensitive coastal zone. Any development along this zone needs carefully consideration to protect and conserve this area.

As mentioned in section 2, geological risks do exist within the Ugu District Municipality and every attempt must be made to identify areas of risk before development occurs so that these areas are avoided where possible. If avoidance is not possible, risks need to be reduced or managed.

8 Reference

1. A.B.A. Brink (1996). Engineering Geology of Southern Africa. Volume 1. Fontein Books.

2. A.B.A. Brink (1981). Engineering Geology of Southern Africa. Volume 2. Building Publications.

3. A.B.A. Brink (1983). Engineering Geology of Southern Africa. Volume 3. Building Publications.

4. A.B.A. Brink (1985). Engineering Geology of Southern Africa. Volume 4. Building Publications.

5. Geology Data Source: Enpat, KZN

6. Soil Depth Data Source: KZN Provincial Growth

9 Appendices

Appendices for this Geology section of the report include the following:

Figure 9.1. Mineral Map of the KwaZulu-Natal Province

Figure 9.2. Coastal Vulnerability Index- Port Edward to South Broom

Figure 9.3. Coastal Vulnerability Index- South Broom and North

Figure 9.4. Coastal Vulnerability Index- South and North of Margate

Figure 9.5. Coastal Vulnerability Index- South and North of Port Shepstone

Figure 9.6. Coastal Vulnerability Index- North of Port Shepstone to Hibberdene

Figure 9.7. Coastal Vulnerability Index- Hibberdene to Elysium

Figure 9.8. Coastal Vulnerability Index- North of Elysium

Figure 9.9. Coastal Vulnerability Index- South and North of Scottburgh

Figure 9.10. Solid Geology of the Ugu District Municipality

Figure 9.11. Soil Depth of the Ugu District Municipality

Figure 9.1: Mineral Map of the KwaZulu-Natal Province

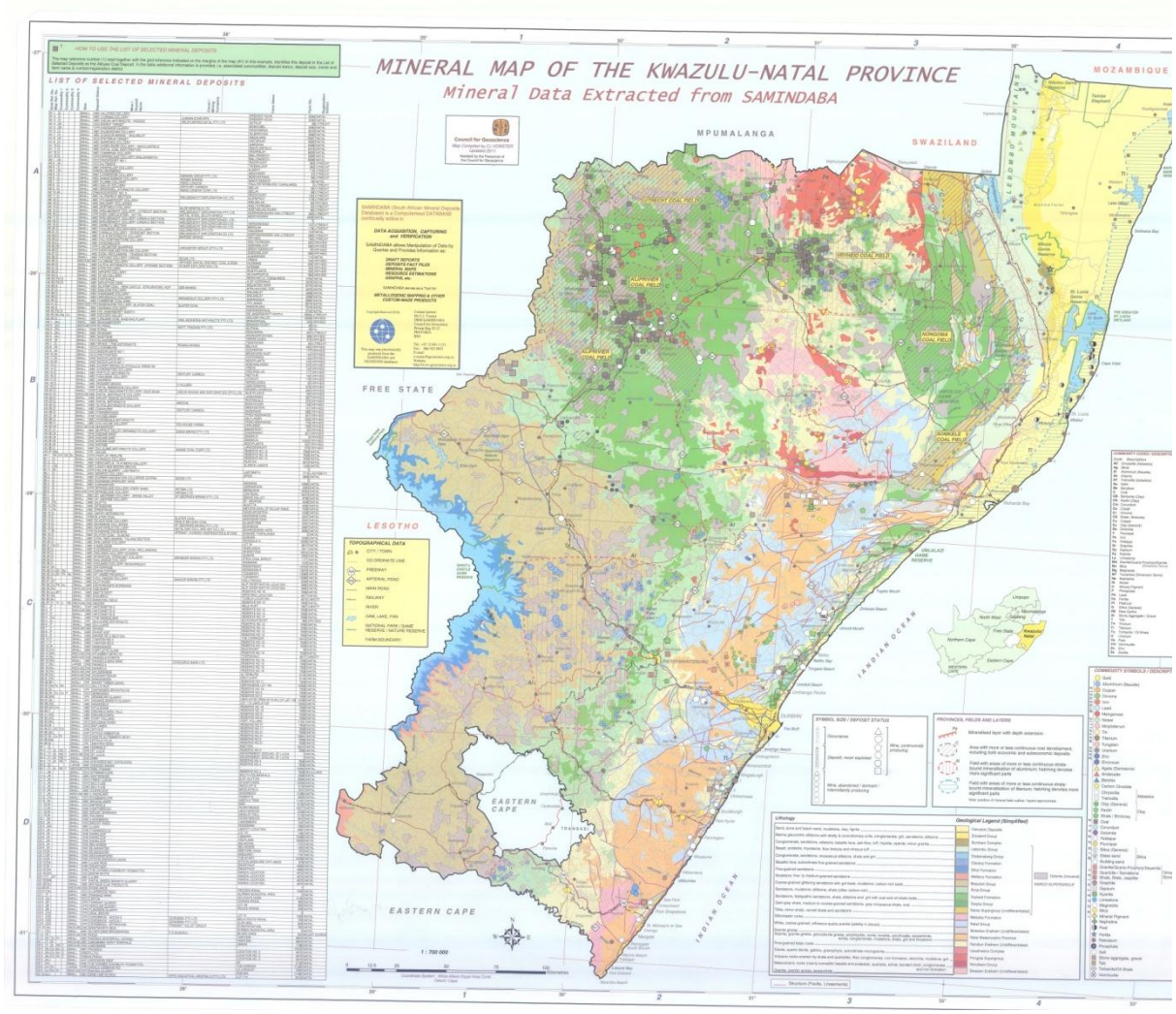
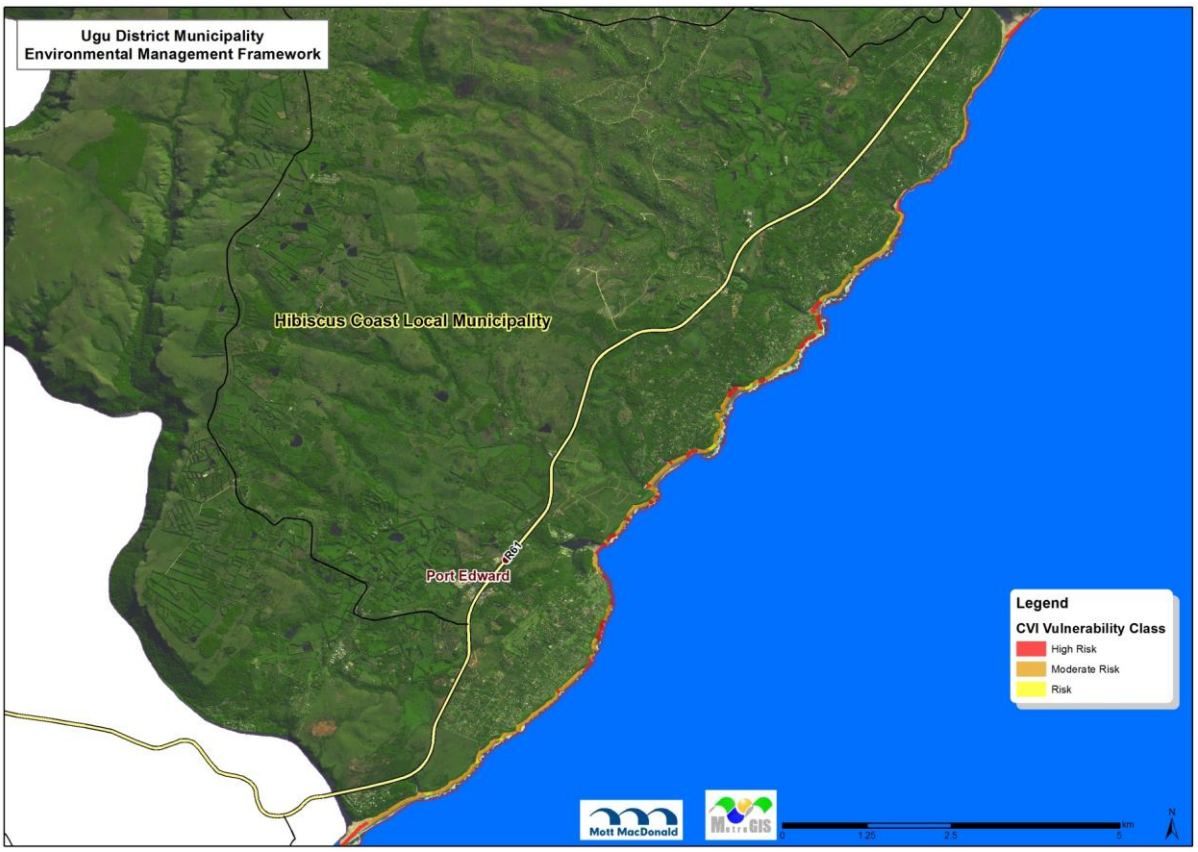
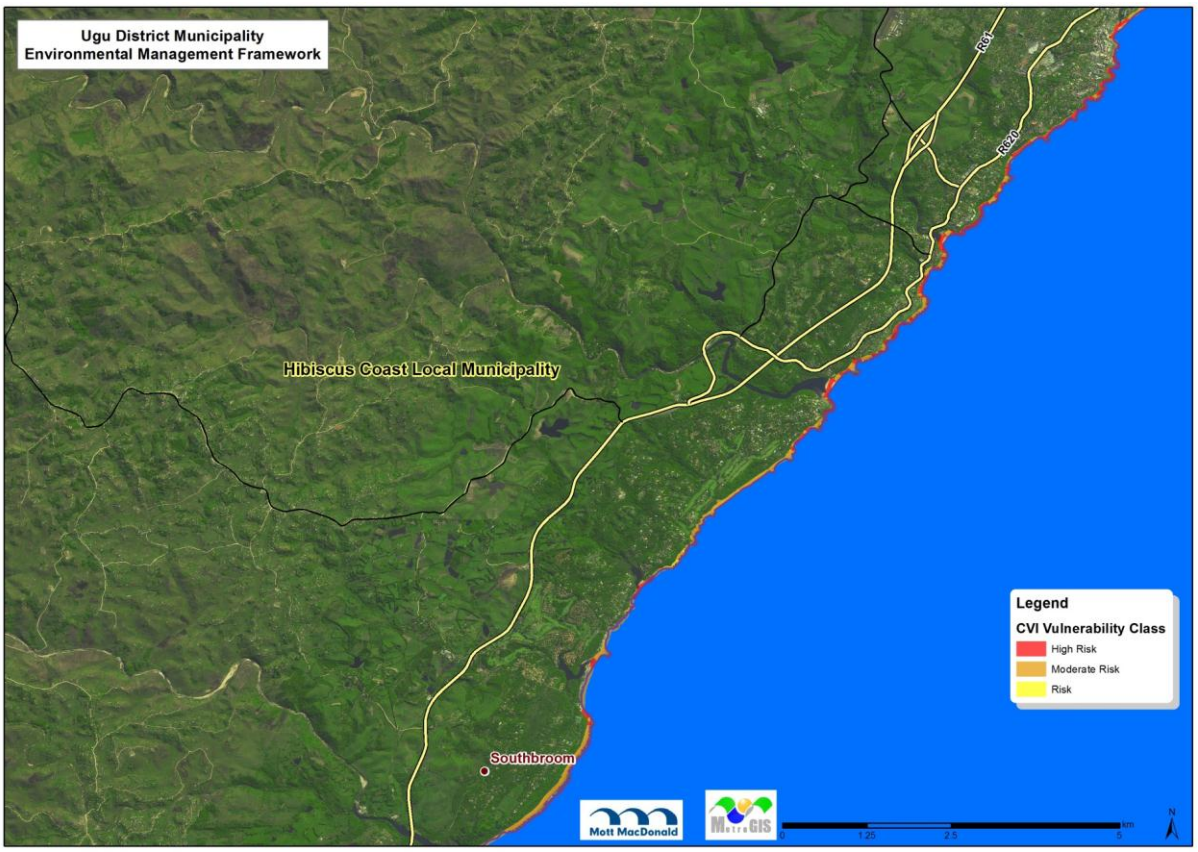


Figure 9.2: CVI- Port Edward to Southbroom



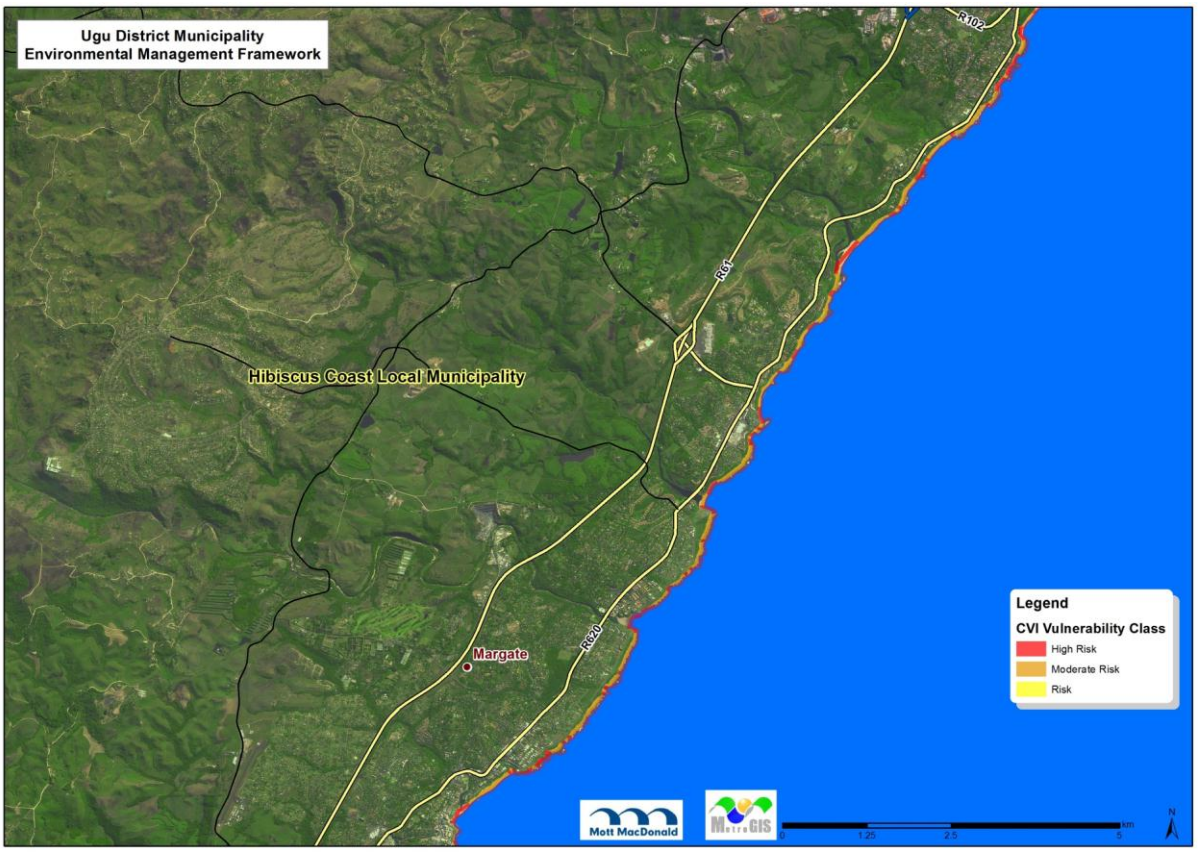
Source: MetroGIS, 2013

Figure 9.3: CVI- Southbroom and North



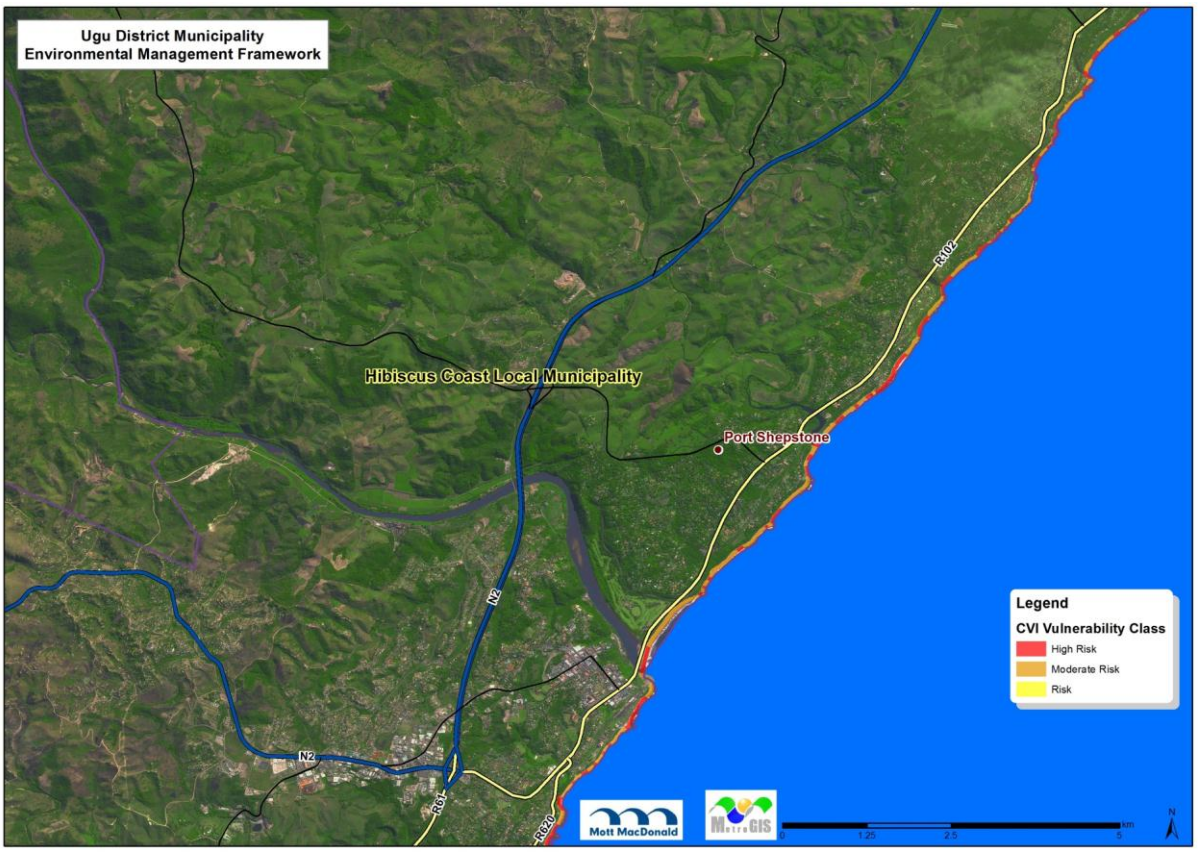
Source: MetroGIS, 2013

Figure 9.4: CVI- South and North of Margate



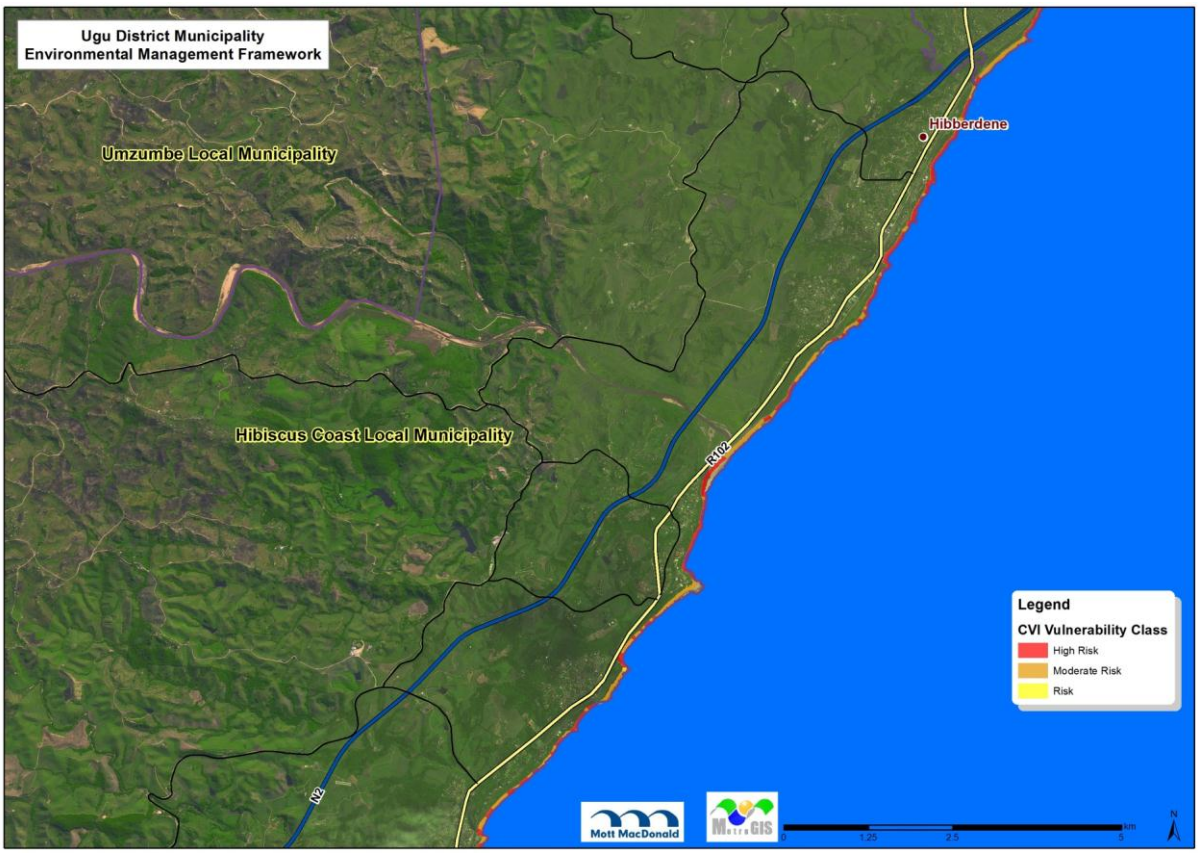
Source: MetroGIS, 2013

Figure 9.5: CVI- South and North of Port Shepstone



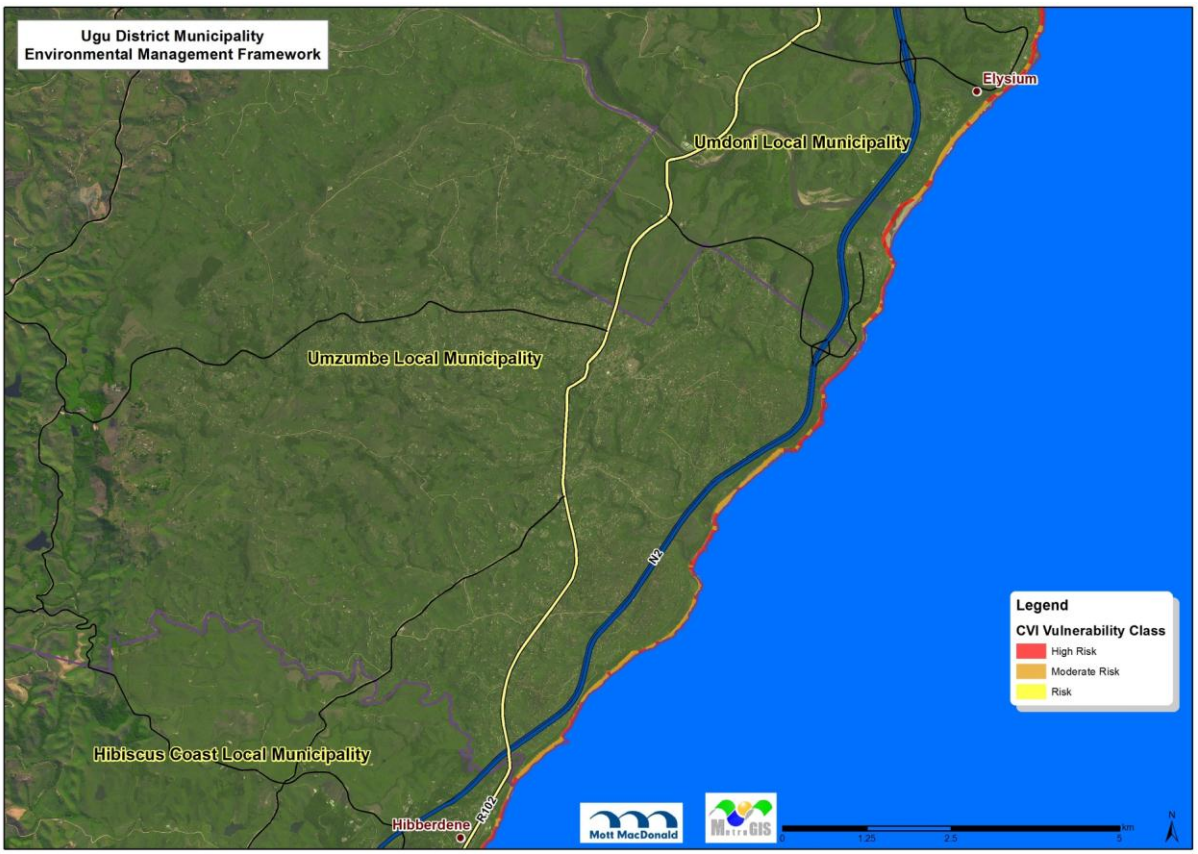
Source: MetroGIS, 2013

Figure 9.6: CVI- North of Port Shepstone to Hibberdene



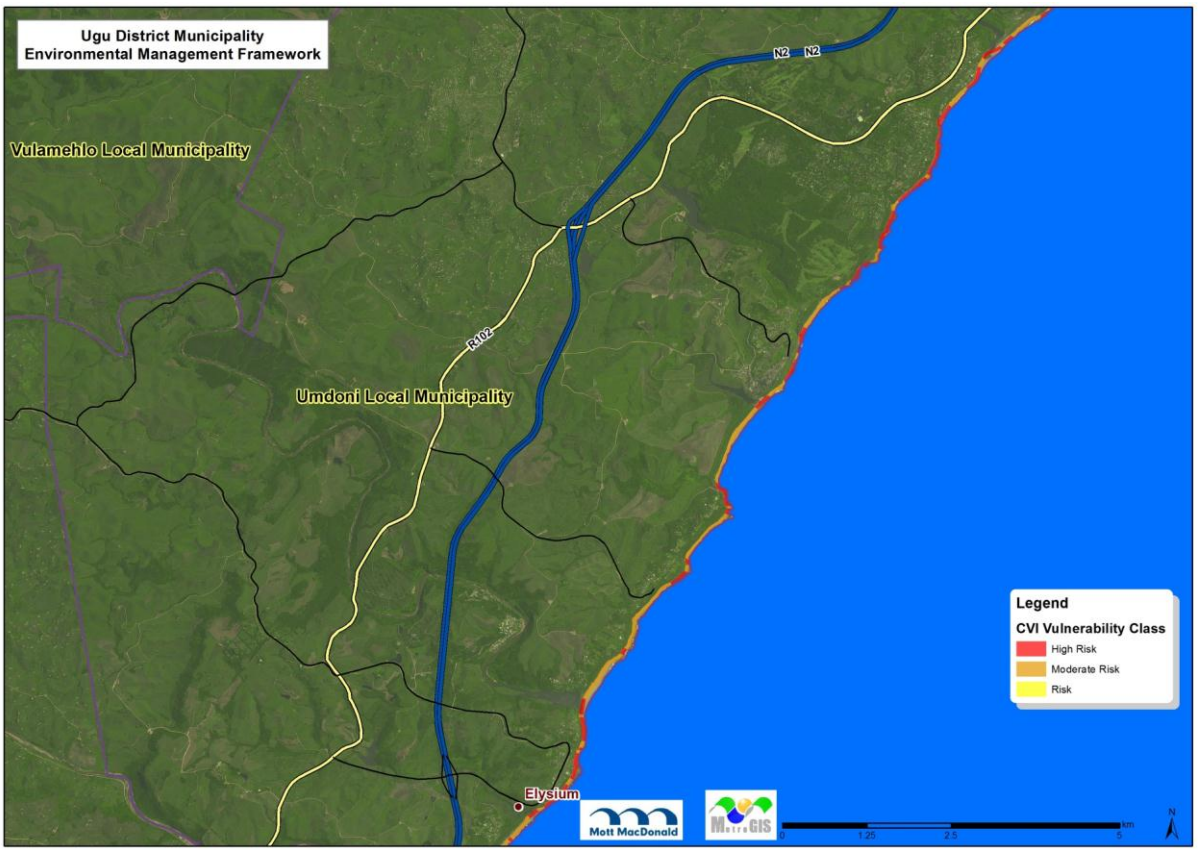
Source: MetroGIS, 2013

Figure 9.7: CVI- Hibberdene to Elysium



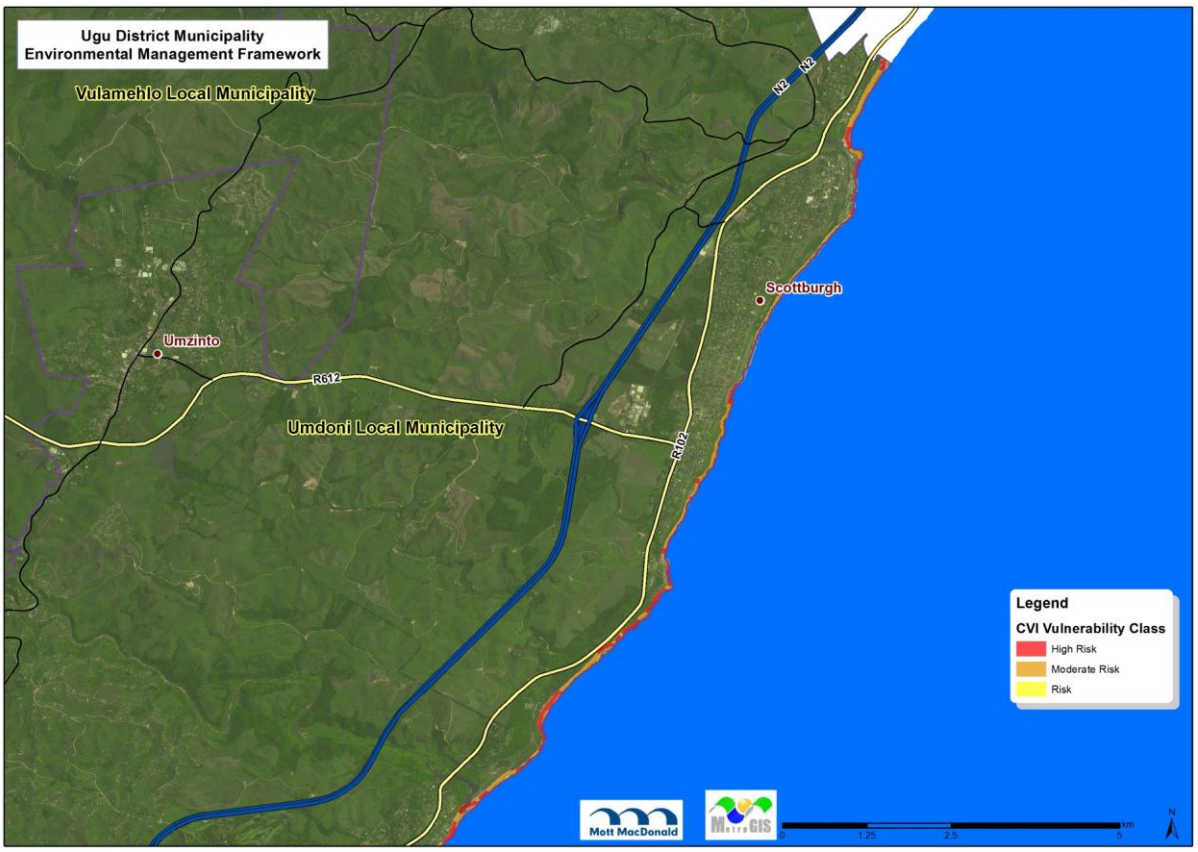
Source: MetroGIS, 2013

Figure 9.8: CVI- North of Elysium



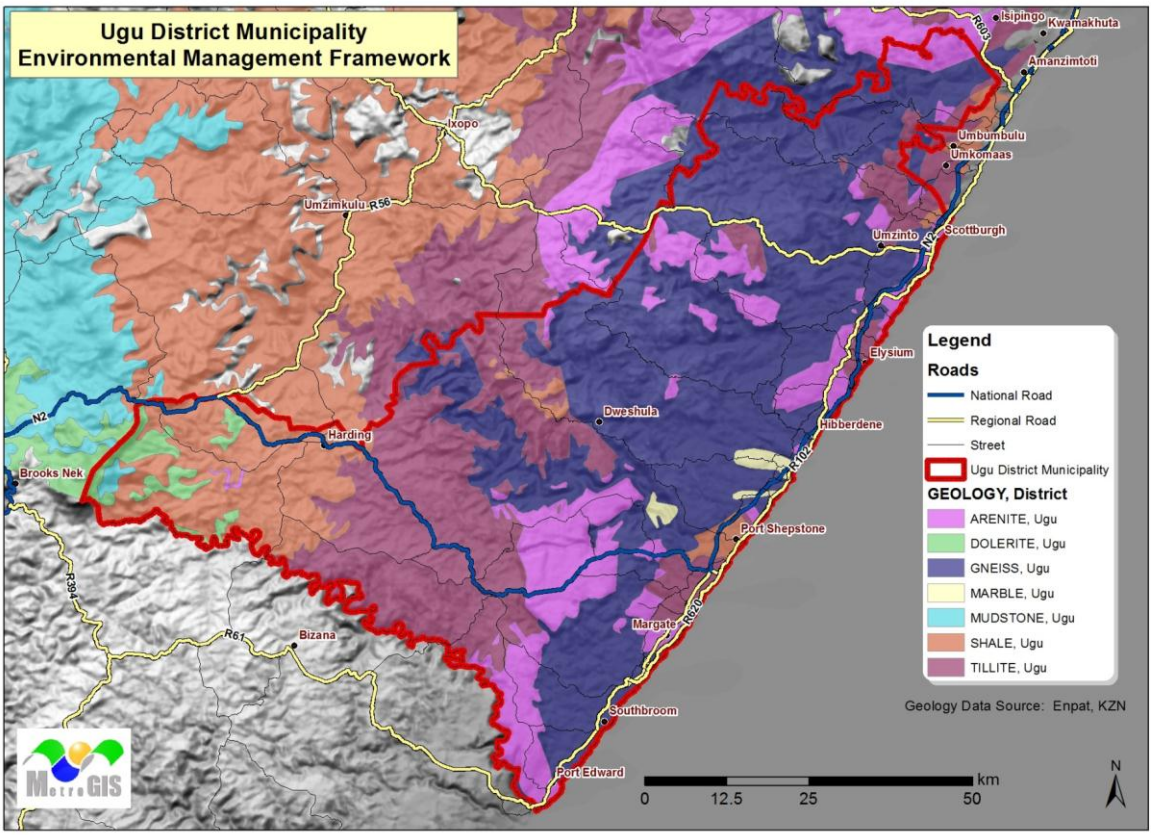
Source: MetroGIS, 2013

Figure 9.9: CVI- South and North of Scottburgh



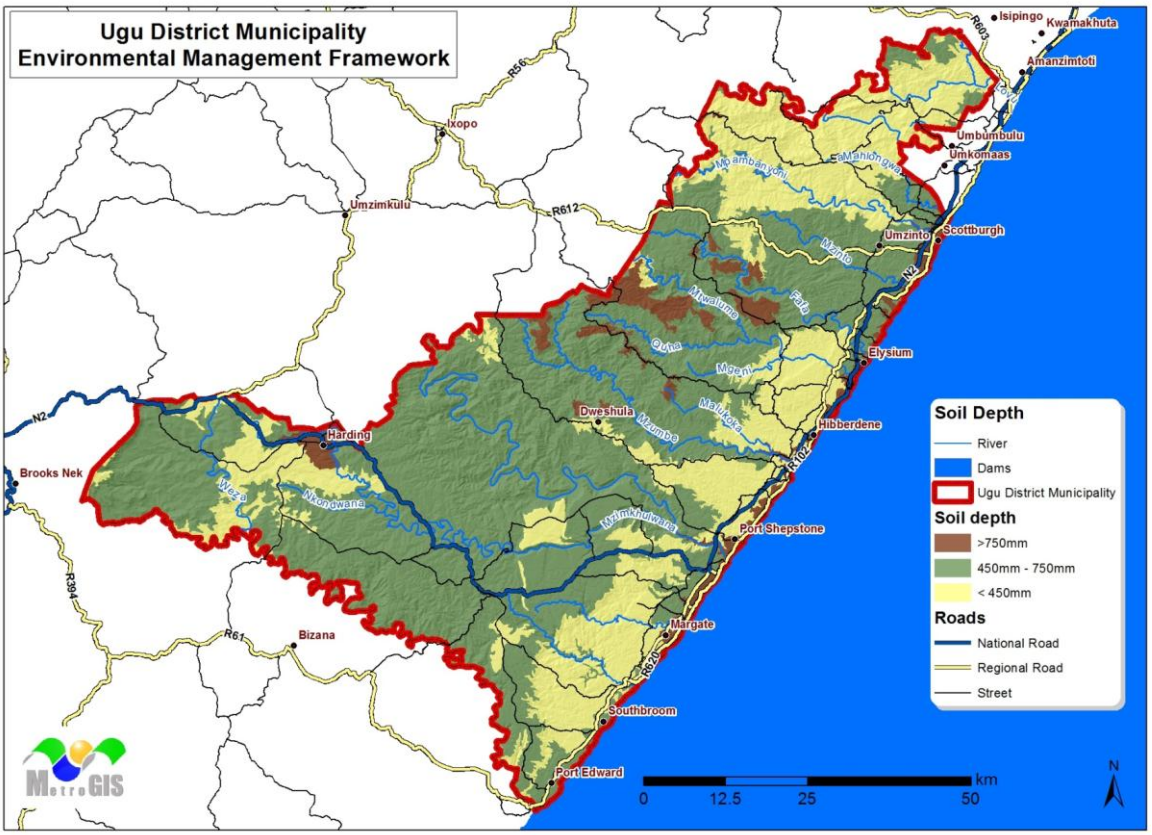
Source: MetroGIS, 2013

Figure 9.10: Solid Geology of the Ugu District Municipality



Source: *ENPAT KZN.*

Figure 9.11: Soil Depth of the Ugu District Municipality



Source: KZN Provincial Growth