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Department:
Transport
Province of KwaZulu-Natal

# PROVINCE OF KWAZULU-NATAL
# DEPARTMENT OF TRANSPORT

## TRANSPORT INFRASTRUCTURE AND REGIONAL SERVICES

## UNDERBERG REGION

## UPGRADE OF MAIN ROAD P419

## FROM KM 4.4 – KM 9.4 & KM 17.0 – KM 22.0

## PAVEMENT DESIGN REPORT

## DATE: JULY 2020

| **Issued to:** | **Prepared by:** |
|---|---|
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# DOCUMENT CONTROL SHEET

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|---|---|---|
| **TITLE:**<br><br>**PAVEMENT DESIGN REPORT** | THE UPGRADING OF MAIN ROAD P419 FROM KM 4.4 TO KM 9.4 AND KM 17 to KM 22 | |
| **ILIFA PROJECT NO:**<br><br>H19-001-00 | **DATE:**<br><br>2020-07-21 | **REPORT STATUS:**<br><br>DRAFT |

| **CARRIED OUT BY:** | **COMMISSIONED BY:** |
|---|---|
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**SYNOPSIS**:

The report covers the materials investigation, traffic evaluation and pavement design for the two sections of Main Road P419.

**KEY WORDS:**

P419, Traffic Study, Material Investigation, Pavement Design



**QUALITY VERIFICATION**

SACAS ISO 9001:2015

This report has been prepared under the controls established by a certified ISO 9001:2015 quality management system developed by Ilifa Africa Engineers (Pty) Ltd.

| **Verification** | **Capacity** | **Name** | **Signature** | **Date** |
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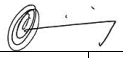
| **Authorized by** | CEO | J.J. Olivier |  | 2020-07-21 |

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# 1. INTRODUCTION

## 1.1. APPOINTMENT

Ilifa Africa Engineers (Pty) Ltd have been appointed for the Underberg Area Offices for a three-year period, in a letter dated 2 November 2017. Since Main Road P419 falls in the same Underberg area, the existing appointment was extended to include the upgrading of this road from gravel to blacktop. Order Number E0060865 was issued on 1 August 2019 by the Department.

Km 0.0 to km 4.4 and Km 22.0 to Km 24.0 have already been upgraded to blacktop by VNA Consulting during previous contracts.

The current appointment of Ilifa Africa entails the detail design, tender documentation, project implementation, full time supervision and close-out of the project. The sections of road that will be upgraded now is Km 4.4 to Km 9.4 and Km 17.0 to Km 22.0

## 1.2. PURPOSE OF REPORT

The report covers the materials investigation, traffic evaluation and pavement design for the two sections of road. The main purpose of the report is to provide enough details regarding the proposed pavement design for the KZN Department of Transport to issue a pavement Design Certificate (PDC).

## 1.3. SCOPE OF CONSTRUCTION WORK

The project comprises the construction of two sections of 5 kilometres each, Km 4.4 – Km 9.4 and Km 17.0 - Km 22.0. The scope of works include mass earth works, layer works, asphalt surfacing, concrete side drains, new pipe and box culverts as well as sidewalks, with road signs and road markings. The total proposed surfacing width is 7.0 m and consists of 2 x 3.5m lanes. A 1.5m wide sidewalk will be provided at the following areas:

- Left Hand Side (Increasing chainages):
    - Km 5.237 – km 6.041
    - Km 7.680 – km 9.753
    - Km 20.168 – km 22.120

- Right Hand Side (Increasing chainages):
    - Km 4.513 – km 5.258
    - Km 8.524 – km 8.285
    - Km 16.600 – km 21.120

The detail scope of the works includes the following:

- Establishment on site and clearing and grubbing
- Provision of traffic accommodation facilities
- Survey requirements
- Road layer works
  - Mass earthworks consisting of G10 material compacted to 93% MDD in layers of 150mm, where required
  - Rip and recompact the roadbed and compact the material to 93% MDD
  - 150mm G7 selected layer compacted to 95% MDD
  - 150mm C4 subbase compacted to 96% MDD
  - 150mm G2 crushed stone base compacted to 85% BRD
  - 30mm Medium Continuously Graded Asphalt
- Sidewalk layer works
  - Mass earthworks consisting of G10 material compacted to 93% MDD in layers of 150mm, where required
  - Rip and recompact the roadbed and compact the material to 93% MDD
  - 150mm G6 material compacted to 95% MDD
  - 125mm G5 material compacted to 97% MDD
  - 20mm Fine Graded Asphalt
- Road prism drainage
- Extension of existing culverts
- Construction of erosion protection measures (gabions, stone pitching, etc.)
- Installation of guardrails, where required
- Installation of new road signs
- New road markings and road studs
- Finishing and cleaning up of the road and road reserve
- Continuous quality control over materials and workmanship, and compliance with the Particular Specifications with regards to environmental management and occupational health and safety, during all the above construction activities.
- Removal of all site establishment facilities and constructional plant on completion of the Works

# 2. SITE LOCATION AND DESCRIPTION

## 2.1 SITE LOCALITY

**Table 2-1** indicates the summary for the road under consideration.

**TABLE 2-1: PROJECT SUMMARY**

| Project Name | Physical Address | District Municipality | Y- Co-ordinate | X- Co-ordinate |
|---|---|---|---|---|
| Upgrade of Main Road P419 From Km 4.4- Km 9.4 & Km 17.0 – Km 22.0 | Main Road P419 From Km 4.4- Km 9.4 & Km 17.0 – Km 22.0. Hlanganani | Harry Gwala District Municipality | 29° 45’47.3342"S | 29° 51'55.2224"E |

The locality map of Main Road P419 as well as the two sections of road under consideration is indicated in **Figure 2-1.**

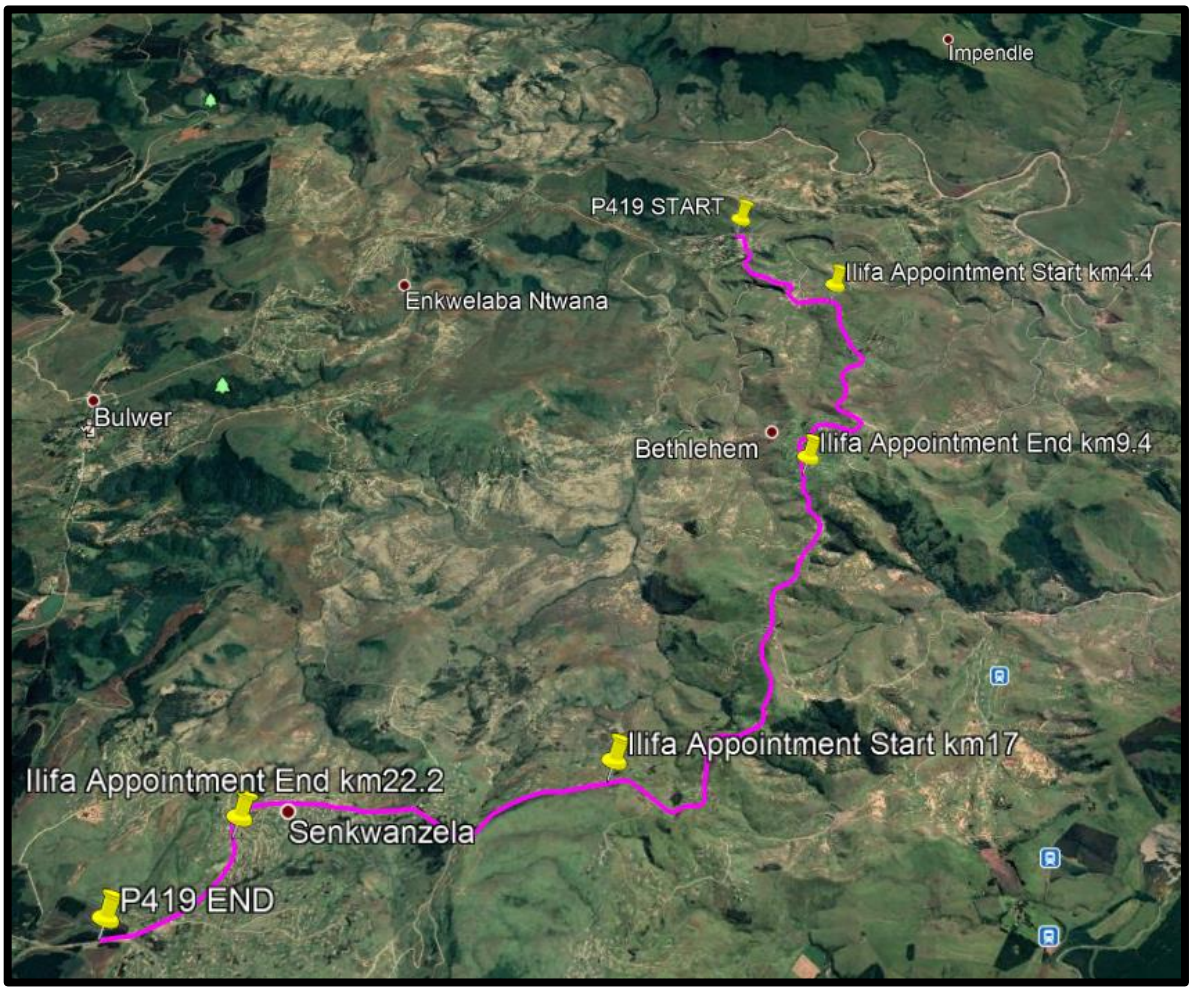



**FIGURE 2-1: LOCALITY PLAN**

## 2.2 GENERAL DESCRIPTION OF ROAD

Road P419 traverses hilly to mountainous terrain in a rural area of KwaZulu-Natal between the R617 (P7-3) and P612 (P23-1), linking Deepdale and Donnybrook. The total length of road P419 is approximately 24.0km.

There are numerous existing culverts crossing the road as well as a portal culvert and a partially completed bridge structure at km 3.5.

The portion of the existing gravel road to be upgraded has a nominal width of 7.5 metres and the overall length is approximately 10.0 km.

Ilifa Africa Engineers has been appointed for the following two sections:

- km 4.4 and continues to km 9.4,
- km 17.0 and continues to km 22.0

The following sections have been upgraded to blacktop under previous contracts:

- km 0.0 – km 4.4
- km 22.0 – km 24.0

## 2.3 CLIMATE

A summary of the climatic statistics is given in **Table 2-2.** Information obtained from www.timeanddate.com for Ixopo between 2005 and 2015, was used for the summary.

**TABLE 2-2: CLIMATIC STATISTICS**

| Property | Value |
|---|---|
| Average Annual Maximum Temperature | 24.8ºC |
| Average Annual Minimum Temperature | 9.6ºC |
| Highest Maximum Temperature | 28.0ºC |
| Lowest Minimum Temperature | 3.0ºC |
| Average Annual Rainfall | 589.6mm |
| Maximum Monthly Rainfall | 103.9mm |

This is a high summer rainfall area with an average annual rainfall of 589.6mm. Most rain occurs from October to April. The maximum average daily summer temperature is 26.6ºC and the minimum average daily winter temperature is 5.8ºC.

The average temperatures and precipitation are shown in **Figure 2-2.**

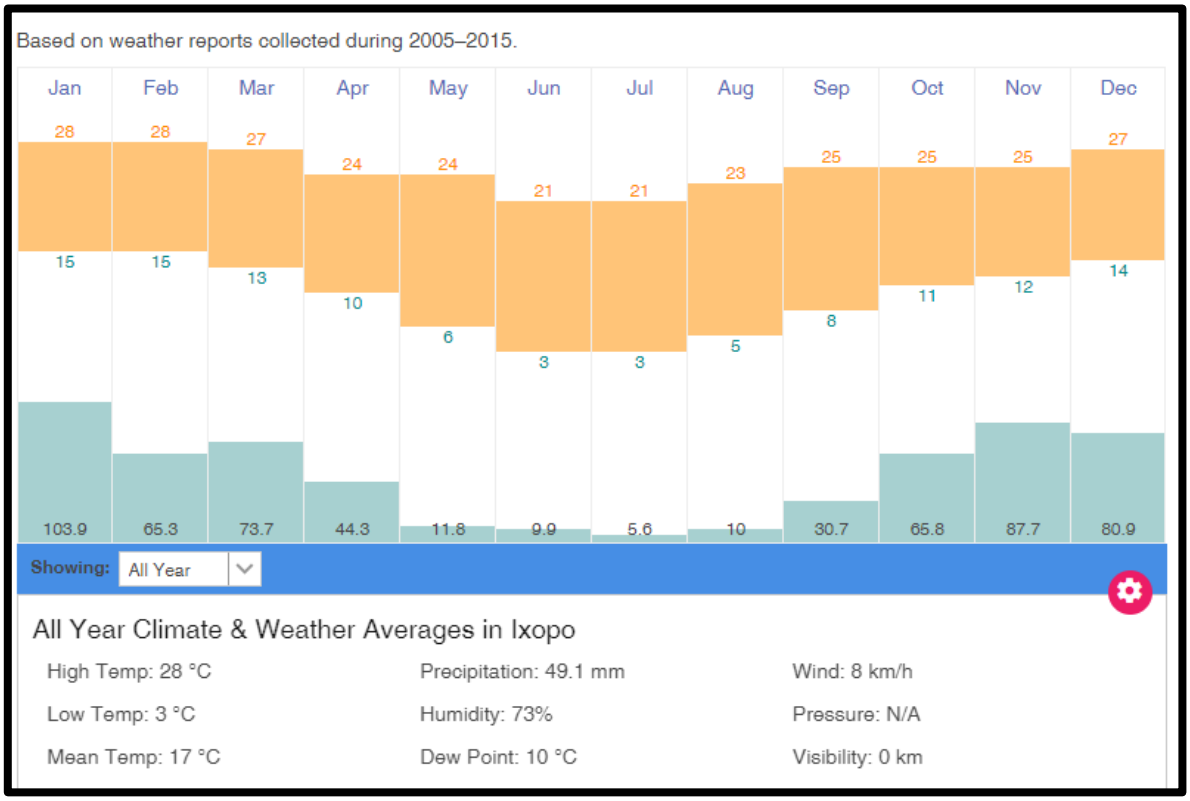



**FIGURE 2-2: AVERAGE TEMPERATURES AND PRECIPITATION**

# 3. EXISTING SERVICES

All known existing services are indicated on the layout drawings. It should be noted that there is an existing main power line that runs adjacent to Main Road P419 from Km 16.8 to about Km 19.4. Furthermore, there is a large water main line (owned by the Harry Gwala District Municipality) that runs parallel to the existing alignment of P419 from Km 18.9 to Km 22.5. Construction in these sections will require extreme caution.

It is also expected that unknown domestic services crossings, requiring relocation or protection, may be encountered along the route as the work proceeds. The Contractor shall make every effort to locate all these services prior to excavations commencing in that area. Such efforts shall include diligent enquiry and discussions with adjacent landowners, visual surface inspection and exploratory trenching investigation, as required.

# 4. MATERIALS INVESTIGATION

## 4.1 MATERIALS INVESTIGATION DONE BY VNA CONSULTING

During VNA Consulting's appointment a materials investigation was done by Soilco in July 2011. The materials information was obtained from VNA Consulting's "*Materials Investigation and Utilisation Report for the upgrade of the district road P419 (km0.6 – km10.6)*".

Information from the previous report has been used for the pavement design of the first section of main road P419 (Km 4.6 to Km 10.10). Ilifa Africa has no record of a Pavement Design Certificate (PDC) for the first section of road as done by VNA Consulting.

During the previous materials investigation, a total of twenty test pits were excavated at 500m intervals, alternating between left hand side and right-hand side of the proposed centre line. Twenty-one DCP tests were also done along the road as part of the materials investigation. A summary of the material properties of the original investigation done by Soilco is summarised in **Table 4-2.**

Two borrow pits were also identified during the previous materials investigation, and a total of 5 samples from the exposures, faces and excavation pits of these borrow pits were taken. A third potential borrow pit was later identified along road D2434 and tested.

The locations of the borrow pits can be seen in **Table 4-5 and Figure 4-4.**

## 4.2 MATERIALS INVESTIGATION DONE BY ILIFA AFRICA ENGINEERS

Subsequently to the previous materials investigation done by Soilco, Ilifa Africa appointed Geosure to conduct the materials investigation for the second road section between Km 16.3 and Km 21.75.

A total of eleven test pits were excavated at 500m intervals, alternating between left hand side and right-hand side of the proposed centre line. Ten DCP tests were also done along the road as part of the materials investigation.

A summary of the material properties done by Geosure is summarised in **Table 4-3**.

## 4.3 GENERAL GEOLOGY

In general, the following typical subsoil horizons can be found in areas underlain by mudstone:

- Dry to slightly moist, dark brown, firm, intact, slightly clayey sandy silt – Colluvium. The colluvial soils extend to an average depth of 0,7 metres below existing ground level.

- Slightly moist, deep pinkish red to red and yellowish brown, soft to firm, intact moderately clayey silt – Residual Mudstone. The residual soils extend to bedrock level at an average depth of 1,2 metres below existing ground level.

- Dark pink/reddish pink to yellow and yellowish brown, completely to highly weathered, very fine to fine grained, thinly laminated, highly fractured, extremely soft to very soft rock – Mudstone.

- In some instances, the residual soils are completely absent and colluvial soils (generally less than 0,5 metres thick) are underlain directly by mudstone bedrock.

The geology of the greater Underberg Area is characterised by mudstone and sandstone bedrock of the Adelaide Formation, which is in turn intruded extensively by younger Jurassic age dolerite.

**Figure 4-1** and **Figure 4-2** provide typical examples of the soil profile on Main Road P419.

**FIGURE 4-1: TYPICAL SUBSOIL PROFILE IN MUDSTONE AREAS**

**FIGURE 4-2: COLLUVIAL SOILS UNDERLAIN WITH BEDROCK**

## 4.4 TEST PITS DATA

The material test results for the materials investigation done by VNA Consulting are attached in **Annexure A** and the materials investigation done by Ilifa Africa are attached in **Annexure B.**

As indicated above, samples of the test pit layers were taken to determine the grading, Atterberg limits, CBR values and COLTO classification. A summary of the material properties done by Soilco is summarised in **Table 4-2.** A summary of the material properties done by Geosure is summarised in **Table 4-3**.

**TABLE 4-2: TEST PITS SUMMARISED RESULTS VNA MATERIALS INVESTIGATION (KM 4.6 TO KM 10.1)**

| SAMPLE DATA | | | | | | | | | | | | | | SUMMARY OF TEST RESULTS | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | SIEVE ANALYSIS (% PASSING) | | | | | | | | | | | ANALYSIS | | | | | | | | CBR | | | | | |
| DISTANCE (KM) | TEST PIT NUMBER | DEPTH | 75.0 | 63.0 | 59.0 | 37.6 | 26.5 | 19.0 | 13.2 | 4.75 | 2.0 | 0.425 | 0.075 | GM | LL | PI | LS | OMC | MDD | MC | SWELL | 100% | 98% | 95% | 93% | 90% | COLTO CLASSIFICATION |
| 4+600 LHS | TP9 | 0-500 | 78 | 78 | 78 | 78 | 77 | 71 | 64 | 49 | 42 | 33 | 21 | 2.4 | 24 | 8 | 4.1 | 9.2 | 2044 | 9.3 | 0.91 | 30 | 23 | 15 | 11 | 7 | G8 |
| | TP9 | 500-600 | | | | | | | | 100 | 99 | 92 | 83 | 0.26 | 47 | 11 | 6.0 | | | | | | | | | | NA |
| | TP9 | 600-900 | | | | | | 100 | 97 | 74 | 62 | 48 | 28 | 1.62 | 25 | 8 | 4.5 | 10.3 | 2006 | 10.2 | 0.97 | 29 | 24 | 17 | 14 | 11 | G8 |
| 5+100 RHS | TP10 | 0-350 | | 100 | 87 | 81 | 77 | 74 | 68 | 50 | 38 | 26 | 16 | 2.20 | 24 | 8 | 4.0 | 9.9 | 2070 | 9.9 | 0.16 | 98 | 78 | 55 | 39 | 21 | G5 |
| | TP10 | 350-1000 | | | | | | | | 100 | 99 | 62 | 31 | 1.07 | 30 | 7 | 3.5 | 14.0 | 1882 | 14.3 | 0.95 | 41 | 36 | 30 | 23 | 16 | G7 |
| 5+600 RHS | TP11 | 30-1000 | | | | | | | | 100 | 98 | 55 | 26 | 1.21 | 29 | 6 | 3.0 | 14.3 | 1842 | 14.3 | 0.87 | 36 | .32 | 26 | 21 | 15 | G8 |
| 6+100 RHS | TP12 | 0-500 | | | | | | 100 | 95 | 82 | 73 | 52 | 26 | 1.49 | 26 | 10 | 5.0 | 9.7 | 2036 | 9.7 | 0.91 | 40 | 30 | 20 | 14 | 9 | G8 |
| 6+600 LHS | TP13 | 0-200 | | | | | | 100 | 92 | 76 | 64 | 45 | 23 | 1.68 | 24 | 8 | 4.0 | 9.2 | 2083 | 9.2 | 0.28 | 58 | 50 | 39 | 26 | 14 | G6 |
| | TP13 | 200-1000 | | | | | | | 100 | 99 | 98 | 91 | 75 | 0.36 | 28 | 11 | 5.5 | 13.8 | 1810 | 13.7 | 2.52 | 18 | 11 | 6 | 3 | 2 | NA |
| 7+100 RHS | TP14 | 0-1000 | | | | | | | 100 | 98 | 92 | 85 | 78 | 0.46 | 42 | 20 | 10.0 | 17.9 | 1702 | 17.7 | 1.93 | 24 | 20 | 13 | 9 | 5 | G9 |
| 7+600 LHS | TP15 | 0-60 | | | 100 | 93 | 93 | 67 | 60 | 46 | 38 | 27 | 17 | 2.17 | 26 | 10 | 5.0 | | | | | | | | | | NA |
| | TP15 | 60-250 | | | | | | 100 | 99 | 97 | 94 | 88 | 77 | 0.41 | 34 | 15 | 7.5 | 100 | 99 | 97 | | | | | | | NA |
| | TP15 | 250-1000 | | | | | | | | 100 | 99 | 99 | 93 | 0.09 | 46 | 17 | 8.5 | 18.8 | 1691 | 18.6 | 5.15 | 7 | 6 | 4 | 4 | 4 | NA |
| 8+100 RHS | TP16 | 0-600 | | | | | | 100 | 98 | 79 | 68 | 53 | 35 | 1.44 | 24 | 8 | 4.0 | 9.2 | 2043 | 9.1 | 2.13 | 25 | 22 | 17 | 12 | 7 | G8 |
| | TP16 | 600-1000 | | | | | | 100 | 99 | 94 | 89 | 77 | 59 | 0.76 | 25 | 12 | 6.0 | 12.2 | 1901 | 12.2 | 161 | 20 | 13 | 7 | 5 | 3 | G10 |
| 8+600 LHS | TP17 | 0-800 | | | | | 100 | 98 | 91 | 49 | 32 | 15 | 8 | 2.45 | 25 | 10 | 5.0 | 9.6 | 1992 | 9.6 | 1.08 | 56 | 40 | 24 | 18 | 12 | G7 |
| 9+100 RHS | TP18 | 0-850 | 80 | 80 | 70 | 70 | 69 | 68 | 60 | 50 | 45 | 35 | 20 | 2.01 | 27 | 10 | 5.0 | 10.2 | 2063 | 10.2 | 0.84 | 48 | 37 | 25 | 17 | 9 | G7 |
| | TP18 | 850-900 | | | 100 | 95 | 91 | 87 | 81 | 66 | 59 | 47 | 39 | 1.56 | 27 | 11 | 5.5 | | | | | | | | | | NA |
| 9+600 LHS | TP19 | 0-300 | | | | | | 100 | 99 | 90 | 68 | 35 | 18 | 1.78 | 25 | 11 | 5.5 | 8.8 | 2121 | 8.7 | 0.23 | 28 | 25 | 16 | 11 | 7 | G8 |
| 10+100 RHS | TP20 | 0-300 | | | | | | | 100 | 98 | 93 | 93 | 88 | 0.21 | 49 | 21 | 10.5 | 19.4 | 1664 | 19.3 | 1.65 | 18 | 12 | 7 | 4 | 2 | NA |

**TABLE 4-3: TEST PITS SUMMARISED RESULTS ILIFA MATERIALS INVESTIGATION (KM 18.85 KM 21.75)**

| SAMPLE DATA | | | | | | | | | | | | | | | | | | | SUMMARY OF TEST RESULTS | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | SIEVE ANALYSIS (% PASSING) | | | | | | | | | | | | | | | | ANALYSIS | | | | | | | CBR | | | | | |
| DISTANCE (KM) | TEST PIT NUMBER | DEPTH | 75.0 | 63.0 | 53.0 | 50.0 | 37.5 | 28.0 | 26.5 | 20.0 | 19.0 | 14.0 | 13.2 | 5.0 | 4.75 | 2.0 | 0.425 | 0.075 | GM | LL | PI | LS | OMC | MDD | SWELL | 100% | 98% | 95% | 93% | 90% | COLTO CLASSIFICATION |
| 16+300 | IP10 | 10-200 | | 100 | 97 | 95 | 93 | 85 | 85 | 80 | 80 | 71 | 71 | 51 | 51 | 37 | 24 | 19 | 2.20 | 28 | 8 | 6.5 | 6.7 | 2146 | 1.0 | 93.0 | 51.0 | 21.0 | 12.0 | 4.7 | G10 |
| | IP10 | 200-1500 | | | | 100 | 99 | 98 | 98 | 98 | 98 | 97 | 97 | 95 | 95 | 90 | 70 | 67 | 0.73 | 51 | 16 | 12.0 | 19.1 | 1669 | 0.3 | 53.0 | 35.0 | 19.0 | 13.0 | 6.8 | G10 |
| 16+700 | IP9 | 10-700 | 96 | 96 | 86 | 85 | 83 | 78 | 78 | 72 | 72 | 63 | 63 | 45 | 45 | 39 | 31 | 21 | 2.1 | 28 | 9 | 4.5 | 8.7 | 2122 | 0.7 | 59.0 | 42.0 | 26.0 | 19.0 | 11.0 | G6 |
| | IP9 | 700-1500 | | | | | | | | | 100 | 99 | 99 | 94 | 94 | 86 | 68 | 66 | 0.80 | 48 | 15 | 10.5 | 18.3 | 1638 | 0.3 | 45.0 | 30.0 | 16.0 | 11.0 | 5.8 | NA |
| 18+250 | IP8 | 10-250 | 97 | 97 | 87 | 86 | 84 | 78 | 78 | 73 | 73 | 63 | 63 | 45 | 45 | 39 | 30 | 21 | 2.1 | 27 | 7 | 6 | 8.7 | 2106 | 0.6 | 99.0 | 50.0 | 18.0 | 8.9 | 3.2 | G9 |
| | IP8 | 250-1500 | | | | | | | | | | | 100 | 99 | 99 | 90 | 78 | 68 | 0.64 | 46 | 15 | 10.5 | 17.1 | 1692 | 0.1 | 11.0 | 10.0 | 9.5 | 9.0 | 8.3 | NA |
| 18+750 | IP7 | 10-200 | | 100 | 96 | 96 | 90 | 88 | 88 | 84 | 84 | 77 | 77 | 60 | 60 | 47 | 32 | 21 | 2.01 | 25 | 7 | 5.5 | 5.7 | 2235 | 0.4 | 62.0 | 34.0 | 14.0 | 7.6 | 3.1 | G10 |
| | IP7 | 200-1150 | | | | 100 | 96 | 94 | 94 | 88 | 88 | 85 | 85 | 77 | 77 | 70 | 62 | 51 | 1.17 | 40 | 12 | 9.5 | 15.5 | 1741 | 1.0 | 27.0 | 22.0 | 16.0 | 13.0 | 9.5 | G9 |
| 18+850 | IP11 | 10-100 | | 100 | 99 | 97 | 96 | 94 | 94 | 91 | 91 | 79 | 79 | 57 | 57 | 44 | 30 | 20 | 2.05 | 27 | 9 | 6 | 6.1 | 2202 | 0.3 | 107.0 | 66.0 | 32.0 | 20.0 | 9.4 | G7 |
| | IP11 | 100-1400 | | | | | | | | | 100 | 99 | 99 | 97 | 97 | 91 | 86 | 82 | 0.41 | 49 | 16 | 12 | 12.0 | 1724 | 0.5 | 26.0 | 20.0 | 14.0 | 10.0 | 7.0 | G9 |
| 19+250 | IP6 | 200-1000 | 100 | 97 | 96 | 96 | 94 | 93 | 93 | 93 | 93 | 92 | 92 | 89 | 89 | 84 | 73 | 61 | 0.82 | 54 | 19 | 11.0 | 22.0 | 1627 | 0.7 | 24.0 | 14.0 | 6.7 | 4.0 | 1.9 | >G10 |
| 19+750 | IP5 | 10-200 | 92 | 91 | 90 | 90 | 89 | 84 | 84 | 79 | 79 | 70 | 70 | 53 | 53 | 44 | 33 | 25 | 1.99 | 29 | 8 | 5.0 | 7.3 | 2163 | 0.2 | 85.0 | 48.0 | 21.0 | 12.0 | 5.0 | G8 |
| | IP5 | 200-500 | 100 | 97 | 94 | 93 | 91 | 87 | 87 | 85 | 85 | 80 | 80 | 68 | 68 | 59 | 46 | 34 | 1.61 | 34 | 9 | 6.5 | 13.0 | 1872 | 0.5 | 22.0 | 15.0 | 8.5 | 5.9 | 3.3 | G10 |
| | IP5 | 500-1500 | | | | | | | 100 | 99 | 99 | 98 | 98 | 95 | 95 | 85 | 75 | 45 | 0.95 | 43 | 14 | 8.5 | 12.2 | 1701 | 2.4 | 28.0 | 18.0 | 9.4 | 6.0 | 3.1 | NA |
| 20+250 | IP4 | 10-200 | | 100 | 94 | 94 | 88 | 82 | 82 | 76 | 76 | 64 | 64 | 38 | 38 | 31 | 25 | 20 | 2.24 | 27 | 8 | 7.0 | 7.8 | 2101 | 0.7 | 116.0 | 71.0 | 34.0 | 21.0 | 10.0 | G7 |
| | IP4 | 200-540 | | | | 100 | 99 | 99 | 99 | 98 | 98 | 98 | 98 | 93 | 93 | 78 | 62 | 56 | 1.05 | 44 | 12 | 9.0 | 18.9 | 1593 | 1.8 | 19.0 | 15.0 | 11.0 | 8.6 | 6.2 | >G10 |
| | IP4 | 540-1400 | | | | 100 | 99 | 99 | 99 | 99 | 99 | 95 | 95 | 82 | 82 | 71 | 63 | 58 | 1.07 | 40 | 11 | 8.5 | 13.8 | 1749 | 0.8 | 10.0 | 9.9 | 9.4 | 9.2 | 8.8 | G9 |
| 20+750 | IP3 | 100-600 | | | | 100 | 99 | 99 | 99 | 98 | 98 | 97 | 97 | 94 | 94 | 79 | 63 | 58 | 1.00 | 43 | 16 | 9.0 | 19.2 | 1589 | 1.9 | 14.0 | 9.9 | 6.0 | 4.3 | 2.6 | >G10 |
| | IP3 | 600-1500 | 88 | 83 | 75 | 75 | 70 | 68 | 68 | 64 | 64 | 53 | 53 | 35 | 35 | 28 | 24 | 22 | 2.25 | 34 | 10 | 7.0 | 11.9 | 1945 | 0.2 | 19.0 | 16.0 | 13.0 | 11.0 | 8.5 | G8 |
| 21+250 | IP2 | 10-200 | 96 | 96 | 88 | 87 | 81 | 78 | 78 | 73 | 73 | 70 | 70 | 56 | 56 | 49 | 41 | 29 | 1.81 | 26 | 8 | 5.0 | 9.0 | 2051 | 1.1 | 43.0 | 20.0 | 6.0 | 2.7 | 0.8 | >G10 |
| | IP2 | 200-500 | | 100 | 96 | 96 | 96 | 93 | 93 | 93 | 93 | 91 | 91 | 87 | 87 | 85 | 82 | 77 | 0.56 | 36 | 12 | 7.5 | 15.5 | 1803 | 2.9 | 6.1 | 5.6 | 4.9 | 4.5 | 4.0 | >G10 |
| | IP2 | 500-930 | | | | | | | | | | | | | | 100 | 99 | 93 | 0.08 | 41 | 12 | 7.0 | 17.6 | 1771 | 2.7 | 7.8 | 5.1 | 2.7 | 1.8 | 0.9 | >G10 |
| 21+750 | IP1 | 10-200 | 98 | 98 | 95 | 95 | 93 | 87 | 87 | 80 | 80 | 70 | 70 | 53 | 53 | 46 | 38 | 28 | 1.88 | 27 | 6 | 4.5 | 8.2 | 2090 | 0.2 | 44.0 | 32.0 | 19.0 | 14.0 | 8.1 | G8 |
| | IP1 | 200-800 | | | | | | | | | | | 100 | 98 | 98 | 89 | 81 | 73 | 0.57 | 40 | 13 | 10.5 | 15.1 | 1710 | 0.1 | 17.0 | 13.0 | 9.0 | 6.9 | 4.7 | NA |
| | IP1 | 800-1500 | | | | | | | | | | | | | 100 | 99 | 96 | 53 | 0.52 | 35 | 11 | 8.0 | 15.3 | 1762 | 0.6 | 35.0 | 23.0 | 12.0 | 7.9 | 4.2 | NA |

## 4.5 Test Pit Discussion

Materials Investigation Done by VNA Consulting

The following two horizons were derived from the test pit results.

- The first horizon had an average depth of 300mm with a COLTO classification between G5 and G8. Three (3) tests did not obtain any COLTO classification. The CBR values ranged between 4.0 – 55.0 at 95% MOD AASHTO Density.
- The second horizon had an average depth of 500mm with a COLTO classification between G7 and G10. Four (4) tests did not obtain any COLTO classification. The CBR ranged between 4.0 – 30.0 at 95% MOD AASHTO Density.

The material that could not be classified was mostly as a result of very low Grading Moduli. From the results above it is evident that that the material varies substantially along the road.

Materials Investigation Done by Ilifa Africa Engineers

The following three horizons were derived from the test pit results.

- The first horizon had an average depth of 300mm with a COLTO classification between G6 and bigger than G10. The CBR ranged between 6.0 – 34.0 at 95% MOD AASHTO Density.
- The second horizon had an average depth of 600mm with a COLTO classification between G7 and G10. Four (4) tests did not obtain any COLTO classification. The CBR ranged between 9.0 – 19.0 at 95% MOD AASHTO Density.
- A third horizon had only been encountered between km 19+750 to km 21+750. The average depth was 800mm with a COLTO classification between G9 and bigger than G10. Two (2) sections, km 19.750 and km 21+750, did not obtain any COLTO classification. The CBR ranged between 2.7 – 12.0 at 95% MOD AASHTO Density.

The material that could not be classified was mostly as a result of very low Grading Moduli. From the results above it is evident that that the material varies substantially along the road.

The existing material to a depth of approximately 300mm (for both sections of road) can be used for mass earthworks and selected material. Any in-situ material not obtaining a COLTO classification, will have to be removed, spoiled, and replaced with G10 material.

## 4.6 DCP Test Results

DCP Test Done by VNA Consulting

**Table 4-4** indicates a summary of the DCP test results conducted by VNA Consulting for the depths of the horizons as per the test pits

**TABLE 4-4: SUMMARY OF DCP RESULTS: VNA CONSULTING**

| POSITION (KM) | CBR @ 0.3M | CBR @ 0.8M | POSITION (KM) | CBR @ 0.3M | CBR @ 0.8M |
|---|---|---|---|---|---|
| 4+600 | Refusal | Refusal | 7+400 | 40 | 39 |
| 4+800 | Refusal | Refusal | 7+600 | 30 | 28 |
| 5+000 | 50 | 37 | 7+800 | 70 | Refusal |
| 5+200 | 50 | 30 | 8+000 | 70 | Refusal |
| 5+400 | Refusal | Refusal | 8+400 | 30 | Refusal |
| 5+600 | 55 | 47 | 8+600 | 45 | Refusal |
| 5+800 | Refusal | Refusal | 8+800 | 75 | Refusal |
| 6+000 | Refusal | Refusal | 9+000 | 45 | 39 |
| 6+200 | Refusal | Refusal | 9+200 | Refusal | Refusal |
| 6+400 | 30 | 50 | 9+400 | Refusal | Refusal |
| 6+600 | 30 | 38 | 9+600 | 75 | Refusal |
| 6+800 | 75 | Refusal | 9+800 | 50 | Refusal |
| 7+000 | 22 | 45 | 10+000 | 60 | Refusal |
| 7+200 | 8 | 35 | | | |

Refusal was encountered on 8 of the DCP tests at a depth of 300mm, while refusal at a depth of 800mm were encountered 17 times.

The CBR value at a depth of 300mm varies between 8 and 75 with an average of CBR of 48.
The CBR value at a depth of 800mm varies between 28 and 50 with an average of CBR of 39.

The DCP refusals may be the result of a very dense layer of rocks. It can be assumed that since the existing road was constructed on the ridge lines, the refusal is due to scattered rocks in the underlying layers.

DCP Test Done by Ilifa Africa Engineers

**Table 4-5** indicates a summary of the DCP test results conducted by Ilifa Africa Engineers for the depths of the horizons as per the test pits.

**TABLE 4-5: SUMMARY OF DCP RESULTS: ILIFA AFRICA ENGINEERS**

| POSITION (KM) | CBR @ 0.3M | CBR @ 0.6M |
|---|---|---|
| 16+300 | 15 | 10 |
| 16+700 | 15 | 10 |
| 18+250 | 14 | 7 |
| 18+750 | 21 | 19 |
| 18+850 | 10 | 14 |
| 19+250 | 17 | 14 |
| 19+750 | 25 | 27 |
| 20+250 | 27 | 21 |
| 20+750 | 19 | 21 |
| 21+250 | 12 | 8 |

The CBR value at a depth of 300mm varies between 14 and 27 with an average of CBR of 18.

The CBR value at a depth of 600mm varies between 7 and 27 with an average of CBR of 15.

No refusal was encountered on any of the DCP tests.

## 4.7 Test Pits and DCP Conclusions

According to the test pit and DCP tests results, it can be concluded that the in-situ material is of poor quality and only the classified materials can be used as earth works.

The average CBR for the test pits and the DCP tests are similar for each horizon.

The TRH4 states that the CBR of the in-situ subgrade material must be higher than 15, to provide proper bearing capacity. Where the sub grade strength (CBR) is below 15, material of a better quality will have to be imported. This will only be done at certain areas of the road.

According to test pit results and DCP tests, the material for both sections, km 4.40 to km 9.4 and km 17.0 to km 22.0, are of similar nature.

## 4.8 Borrow Pit Investigation

During the initial materials investigation done by Soilco, three borrow pits have been identified close to Main Road P419. The coordinates of the borrow pits are provided in **Table 4-5** and the positions indicated on the aerial map in **Figure 4-4**.

**TABLE 4-5: BORROW PIT POSITIONS**

| Location of Possible Borrow Pit Sites | | | |
|---|---|---|---|
| Borrow Pit No. | Road Name | Latitude | Longitude |
| 1 | D2423 | 29° 47' 55.21" | 29° 52' 36.32" |
| 2 | D1208 | 29° 50' 35.7" | 29° 52' 09.9" |
| 3 | P419 | 29° 47' 54.1" | 29° 52' 33.0" |

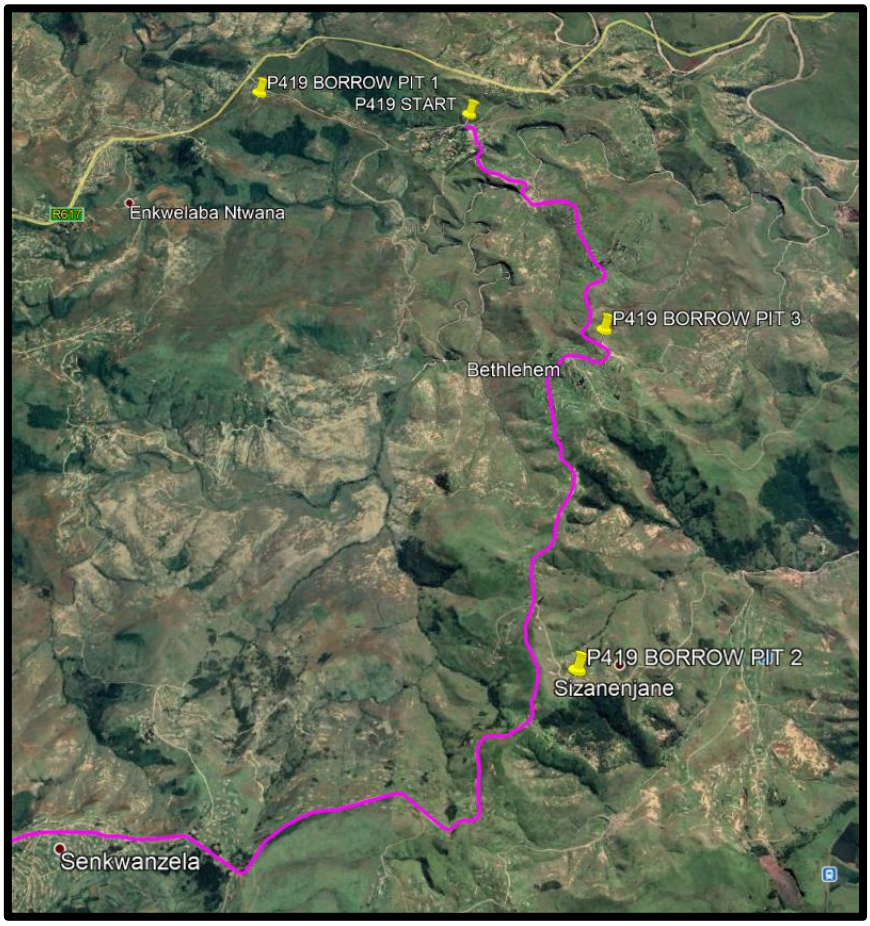



**FIGURE 4-4: BORROW PIT LOCATIONS**

Details of the borrow pits are described in the following paragraphs.

4.8.1 Borrow Pit 1

The material identified in this borrow pit consists of a very hard to hard Dolerite rock. This borrow pit is situated adjacent to road D2423 approximately 4.5km form Main road P419. The volume of material in this borrow pit would easily provide sufficient materials for both the base and sub-base layers.

The volume of the borrow pit is approximately 27000m³ with a depth of 4.0 to 6.0metres. Several scattered boulders were visible indicating signs of previous mining.

The material from this borrow pit was not tested or classified. From the visual appearance, the material appears to be between G5 and G6 quality. If this material is crushed and broken down sufficiently it should be possible to stabilize the material to at least C4 stabilized layer. The overburden material recovered from the bulk excavation process of this borrow pit can be utilised in the lower pavement layers. This potential hard rock borrow pit would only be considered as a last option, as the site is approximately 4.5 kilometres from Main Road P419. In needed, the material will be tested to confirm the assumed properties

4.8.2 Borrow Pit 2

This borrow pit is situated adjacent to road D1208 which intersects Main Road P419 at km 7.4. The material identified in borrow pit 2 consists predominately of hard to medium dense weathered Shale. This borrow pit appears to have been mined by the Department of Transport for the re-graveling activities of the roads in the close vicinity. The volume of the borrow pit is approximately 10000m³ with a depth of 2.0 to 4.0metres.

The material of this borrow pit was sampled and tested by *Soilco Materials Investigations* during their material investigation of the road centre line. The borrow pit has good quality material conforming to G5 and G7 standards.

If material from this borrow pit can be used for the layer works, it would contribute to a saving of the hauling cost of importing commercial material. There is sufficient material in the borrow pit to provide at least 50% of the material for the base and sub-base

4.8.3 Borrow Pit 3

Borrow pit 3 is situated along Main Road P419 at km 12.5. The material identified in borrow pit 3 consisted predominately of hard to medium dense Dolerite rock and weathered Shale. This borrow pit appears to have been rehabilitated from previous use. This material was probably mined by Department of Transport for the re-graveling activities of the roads in the close vicinity.

The material was sampled and tested by *Soilco Materials Investigations* during their materials investigation of the road centre line. The quality of material conforms to G5 and G7 quality.

The volume of material in the borrow pit is estimated at approximately 18000m³ with a depth of about 4.0m. This borrow pit is located approximately 4.0 kilometres from the start of the project on the Polela side and ideally situated to limit the cost of moving the material.

This borrow pit site has a good open area for stockpiling operations during construction, which would aid the contractor in materials selection.
The overburden material that will be recovered from the bulk excavations can be used for the fill or lower pavement layers.

During construction, it is envisaged to make use of a mobile laboratory or alternatively a commercial laboratory to manage the quality control of materials leaving the borrow pit as well as classifying various faces of the borrow pit. An environmental officer will also be appointed to the project to ensure the contactor complies with all environmental laws surrounding the sourcing of natural material for road construction.

The laboratory results are attached hereto as **Annexure C.**

# 5. TRAFFIC ANALYSIS

## 5.1 INFORMATION AND DESIGN GUIDELINES:

The following design guidelines were utilized to calculate the design traffic and to determine the pavement design:

- Human Settlement Planning and Design : Guidelines (Red book)
- TRH4 : Structural design of inter urban and rural roads
- TRH17 : Geometric Design of Rural Roads
- TRH13 : Cementitious Stabilizers in Road Construction
- COLTO : Standard Specifications for Road and Bridge Works for State Road Authorities (1998 edition)

## 5.2 TRAFFIC COMPOSITION:

A complete Traffic Impact Assessment was conducted by Iliso Consulting in May 2012. **Table 5-1** indicates the estimated design traffic:

**TABLE 5-1: DESIGN TRAFFIC (2012)**

| ADT PER LANE | % HEAVIES | ADTT | 80 KN EQUIVALENT STANDARD AXLES | | TOTAL PRESENT 80 KN EQUIV. STANDARD AXLES/DAY |
|---|---|---|---|---|---|
| | | | LIGHTS | HEAVIES | |
| 343 | 3.2% | 11 | 0.91 | 36.3 | 37.21 |

The above-mentioned figures were first extrapolated to 2022 values (time of opening the road), using a growth rate of 4%, after this a growth rate of 6% was applied to determine the final traffic volumes for the pavement design. The growth rates applied, are as per the TRH 4. If a value of 54 E80's per day and a design life of 20 years are assumed, the total design E80's for this section of road is 0.765 million (ES 1).

**TABLE 5-2: DESIGN LOADING SECTION**

| PARAMETER | VALUE |
|---|---|
| HEAVIES/LANE/DAY | 11 |
| E80/HEAVY (BASED ON HEAVY VEHICLE SPLIT) | 1.5* |
| E80/LANE/DAY | 54 |
| **PAVEMENT STRATEGY 1: RESTORATION** | |
| DESIGN LIFE | 20 |
| DESIGN E80/LANE/DAY | 54 |
| DESIGN E80'S FOR LIFE | 0.765 |
| PAVEMENT CLASS | ES1 |

*The average E80's per heavy vehicle was determined by the weighted average of the split between long, medium and short heavy vehicles and the E80's for each type. The split and E80's per heavy vehicle can be seen in **Figure 5-1.**

In **Figure 5-1** a sensitivity analysis was carried out to determine the effect of various growth rates on the pavement classification. For typical growth rates varying between 4%-6%, the traffic classification remains as an ES 1 and therefore the growth rate is not sensitive to the design E80's.

The Traffic Impact Assessment done by Iliso Consulting is attached hereto as **Annexure D.**

## TRAFFIC PROJECTIONS

| | |
|---|---|
| CLIENT | DEPARTMENT OF TRANSPORT: KWAZULU NATAL |
| PROJECT | THE UPGRADING OF ROAD P419 FROM GRAVEL TO BLACKTOP |
| DATE | 03 May 2019 |

### TRAFFIC COUNTS IN WORST LANE

| CLASS (ave E80's) | Light Vehicles | Busses (1.03) | 2-Axles (1.08) | 3-Axles (2.51) | 4-Axles (2.66) | 5-Axles (3.25) | 6-Axles (5.17) | 7-Axles (6.51) |
|---|---|---|---|---|---|---|---|---|
| COUNTS | 332 | | 0 | | 0 | 11 | 0 | |

| | | | | | |
|---|---|---|---|---|---|
| INITIAL AADT/LANE | 343 | HEAVIES | 3,2% | INITIAL AADTT/LANE | 11 |
| AVE AXLES/HEAVY VEHICLE | 4 | | | INITIAL HEAVY AXLES/LANE/DAY | 44 |

### HEAVY AXLE DISTRIBUTION

| CATEGORY( KN) | 20-40 | 40-60 | 60-80 | 80-100 | 100-120 | 120-140 |
|---|---|---|---|---|---|---|
| % - AXLES (TOTAL 100%) | 0% | 0% | 0% | 0% | 0% | 0% |
| NUMBER OF AXLES | 0 | 0 | 0 | 0 | 0 | 0 |

OR AVE E80 AXLES/HEAVY VEHICLE: 3,3

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| n VALUE (4.2) | 4,2 | | | INITIAL E80 AXLES/LANE/DAY | 36 | AXLE LOAD FACTOR (P) | 0,83 |
| DATE OF COUNTS | 2012 | DATE OF CONSTRUCTION | 2022 | DESIGN LIFE | 20 | | |
| GROWTH RATE TO CONST | 4% | YEARS | 10 | DESIGN E80 AXLES/LANE/DAY | 54 | | |
| GROWTH RATE 1 | 0% | YEARS | 0 | | | | |
| GROWTH RATE 2 | 6% | YEARS | 20 | DESIGN E 80's FOR LIFE | 0,765 | mil | |

### SENSITIVITY (AXLE LOAD FACTOR VARIES BETWEEN 0.2 AND 0.8)

GROWTH RATE VARIES BETWEEN 4% AND 10%

| E80 GROWTH | AXLE LOAD FACTOR | E 80- REPETITIONS (millions) over various design life's with different axle load factors & traffic growth rates (Years) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2 | 4 | 5 | 6 | 8 | 10 | 12 | 14 | 15 | 16 | 18 | 20 | 25 |
| 4,00% | 0,2 | 0,0100 | 0,0209 | 0,0266 | 0,0326 | 0,0453 | 0,0590 | 0,0739 | 0,0899 | 0,0984 | 0,1073 | 0,1260 | 0,1464 | 0,2047 |
| | 0,4 | 0,0201 | 0,0417 | 0,0532 | 0,0652 | 0,0906 | 0,1180 | 0,1477 | 0,1798 | 0,1968 | 0,2145 | 0,2521 | 0,2927 | 0,4094 |
| | 0,6 | 0,0301 | 0,0626 | 0,0799 | 0,0978 | 0,1359 | 0,1770 | 0,2216 | 0,2697 | 0,2952 | 0,3218 | 0,3781 | 0,4391 | 0,6141 |
| | 0,8 | 0,0401 | 0,0835 | 0,1065 | 0,1304 | 0,1811 | 0,2360 | 0,2954 | 0,3596 | 0,3937 | 0,4291 | 0,5042 | 0,5854 | 0,8187 |
| 5,50% | 0,2 | 0,0102 | 0,0216 | 0,0278 | 0,0343 | 0,0485 | 0,0642 | 0,0817 | 0,1012 | 0,1117 | 0,1229 | 0,1470 | 0,1738 | 0,2550 |
| | 0,4 | 0,0205 | 0,0433 | 0,0557 | 0,0687 | 0,0969 | 0,1284 | 0,1634 | 0,2024 | 0,2235 | 0,2457 | 0,2940 | 0,3477 | 0,5101 |
| | 0,6 | 0,0307 | 0,0649 | 0,0835 | 0,1030 | 0,1454 | 0,1926 | 0,2451 | 0,3035 | 0,3352 | 0,3686 | 0,4410 | 0,5215 | 0,7651 |
| | 0,8 | 0,0410 | 0,0866 | 0,1113 | 0,1374 | 0,1939 | 0,2568 | 0,3268 | 0,4047 | 0,4469 | 0,4914 | 0,5880 | 0,6954 | 1,0202 |
| 7,00% | 0,2 | 0,0105 | 0,0225 | 0,0291 | 0,0362 | 0,0519 | 0,0699 | 0,0905 | 0,1140 | 0,1271 | 0,1410 | 0,1719 | 0,2073 | 0,3198 |
| | 0,4 | 0,0209 | 0,0449 | 0,0582 | 0,0723 | 0,1038 | 0,1397 | 0,1809 | 0,2281 | 0,2541 | 0,2820 | 0,3438 | 0,4146 | 0,6397 |
| | 0,6 | 0,0314 | 0,0674 | 0,0872 | 0,1085 | 0,1556 | 0,2096 | 0,2714 | 0,3421 | 0,3812 | 0,4231 | 0,5158 | 0,6219 | 0,9595 |
| | 0,8 | 0,0419 | 0,0898 | 0,1163 | 0,1447 | 0,2075 | 0,2795 | 0,3618 | 0,4561 | 0,5083 | 0,5641 | 0,6877 | 0,8292 | 1,2793 |
| 8,50% | 0,2 | 0,0107 | 0,0233 | 0,0304 | 0,0381 | 0,0555 | 0,0761 | 0,1002 | 0,1287 | 0,1448 | 0,1622 | 0,2016 | 0,2481 | 0,4034 |
| | 0,4 | 0,0214 | 0,0466 | 0,0608 | 0,0762 | 0,1111 | 0,1521 | 0,2005 | 0,2574 | 0,2895 | 0,3244 | 0,4033 | 0,4961 | 0,8068 |
| | 0,6 | 0,0321 | 0,0698 | 0,0911 | 0,1143 | 0,1666 | 0,2282 | 0,3007 | 0,3861 | 0,4343 | 0,4866 | 0,6049 | 0,7442 | 1,2101 |
| | 0,8 | 0,0428 | 0,0931 | 0,1215 | 0,1524 | 0,2221 | 0,3043 | 0,4010 | 0,5148 | 0,5791 | 0,6488 | 0,8065 | 0,9922 | 1,6135 |
| 10,00% | 0,2 | 0,0109 | 0,0241 | 0,0317 | 0,0401 | 0,0594 | 0,0829 | 0,1112 | 0,1454 | 0,1652 | 0,1869 | 0,2370 | 0,2977 | 0,5113 |
| | 0,4 | 0,0218 | 0,0483 | 0,0635 | 0,0802 | 0,1189 | 0,1657 | 0,2223 | 0,2909 | 0,3303 | 0,3738 | 0,4741 | 0,5955 | 1,0225 |
| | 0,6 | 0,0328 | 0,0724 | 0,0952 | 0,1203 | 0,1783 | 0,2486 | 0,3335 | 0,4363 | 0,4955 | 0,5607 | 0,7111 | 0,8932 | 1,5338 |
| | 0,8 | 0,0437 | 0,0965 | 0,1269 | 0,1604 | 0,2378 | 0,3314 | 0,4447 | 0,5817 | 0,6607 | 0,7475 | 0,9482 | 1,1910 | 2,0450 |

### SENSITIVITY ANALYSIS

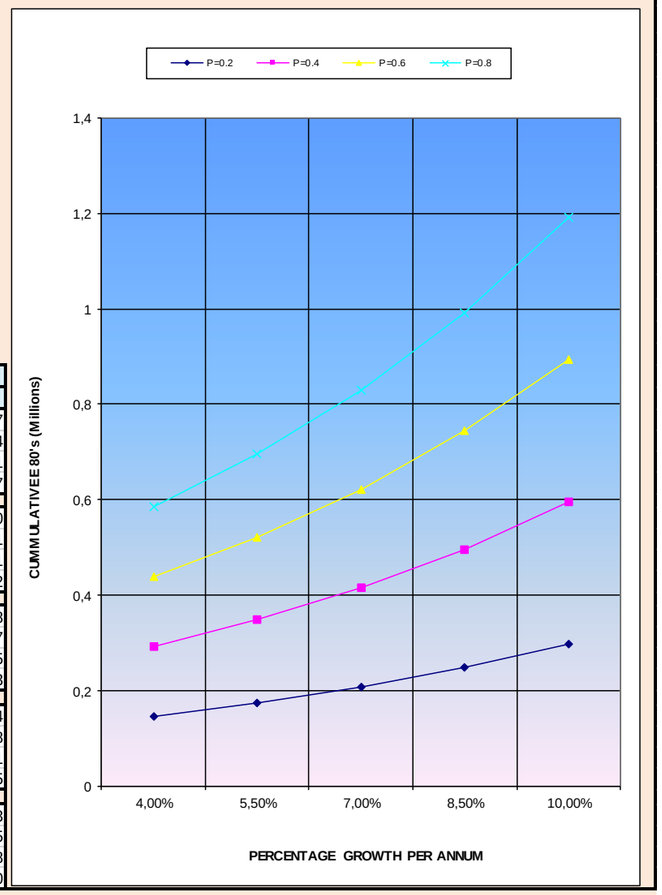



**FIGURE 5-1: SENSITIVITY ANALYSIS**

# 6. PAVEMENT DESIGN

## 6.1 PAVEMENT DESIGN

The pavement design was based on the TRH 4 document for a Category C road and a wet region, and ES1 design traffic loading **Table 6-1** indicates the proposed layer works based on TRH4. Since the materials of both sections of road are of similar nature, one pavement design will be considered.

**TABLE 6-1: PROPOSED PAVEMENT DESIGN**

| SUBGRADE | ROADBED | FILL | SELECTED | SUBBASE | BASE | WEARING |
|---|---|---|---|---|---|---|
| Semi infinite<br>E = 40MPa | Rip and recompact the roadbed compacted to 93% MDD | Mass earthworks consisting of G10 material compacted to 93% MDD in layers of 150mm, where required | 150mm G7 upper selected layer compacted to 95% MDD | 150mm C4 material compacted to 96% MDD | 150mm G2 Crushed stone base compacted to 85% BRD | 30mm Medium Continuously Graded Asphalt |

The total required material depth for a category C road is 800mm. Based on the layer thicknesses indicated above, the following additional earthworks will therefore be required in areas of fill.

- G10 material compacted to 93% MDD.
- The subgrade must conform to G10 material.

The above pavement layers were analysed using the Rubicon Mechanistic Pavement Design Software which takes into account the increased tyre pressures of 750kPa that was introduced after the TRH4 has been published. The TRH4 is based on tyre pressures of 520kPa. The two methods gave similar design traffic. According to the TRH 4, the G2 layer must be 125mm thick. After the Rubicon Design Software analysis, the thickness of the G2 layer was changed to 150mm due to the increase in tyre pressure and to get a longer design life.

Rubicon Design Software gave a design life of 22.75 years for 700 000 E80's. The results from Rubicon Design Software is attached hereto as **Annexure E.**

Since the two short surfaced sections of Main Road P419 upgraded earlier have an asphalt overlay, it was requested by the Client that the two new sections of P419 should also be surfaced with Asphalt. If there are budgetary constraints a double seal can be considered.

There are new sidewalks planned next to the road at several sections. The proposed layer works for the sidewalk are as follows:

- 20mm Medium Continuously Graded Asphalt
- 125mm G5 material compacted to 97% MDD
- 150mm G6 material compacted to 95% MDD
- Rip and recompact the roadbed compacted to 93% MDD
- Mass earthworks consisting of G10 material compacted to 93% MDD in layers of 150mm, where required

# 7. CONSTRUCTION MATERIALS

The required construction materials are discussed under the following headings.

## 7.1 SELECTED SUBGRADE AND SUBBASE LAYERS

The material for the selected subgrade and subbase layers will be obtained from the borrow pits along Main Road P419.

Alternative sources can be investigated by the appointed contractor.

The appointed contractor is required to submit all test results to the engineer for approval before any material is delivered to site.

## 7.2 CRUSHED STONE BASE

The G2 crushed stone base required for the construction of the base shall be obtained from commercial sources.

The appointed contractor is required to submit all test results to the engineer for approval before any material is delivered to site.

## 7.3 WATER

No specific source of water for construction purposes was identified. The Contractor will have to make his own arrangements in this regard. Water may be available from local rivers and streams, but the Contractor will have to apply for the required permit for the abstraction from natural sources as well as for the necessary testing to prove its suitability.

# 8. STORM WATER DRAINAGE

The storm water will be directed to both sides of the road into concrete or earth channels, after which it will be channelled to the low points and released into the existing or new storm water drainage system and natural vegetation.

Several existing culverts will be extended, and several new pipe and box culverts will be constructed, as part of the project. The new bridge over the Luhane River was only partially constructed when the contract was terminated. This bridge will also be completed now under a separate contract

# 9. CONCLUSIONS AND RECOMMENDATION

## 9.1 CONCLUSIONS

The following conclusions can be made from the report:

- In general, the in-situ material is of poor quality and only certain sections of the in-situ material can be used for layer works.
- The proposed pavement design for the two sections of road, Km 4.4 to Km 9.4 and Km 17.0 to Km 22.0, is as follows:
    - Mass earthworks consisting of G10 material compacted to 93% MDD in layers of 150mm, where required.
    - Rip and recompact the roadbed and compact the material to 93% MDD
    - 150mm G7 selected layer compacted to 95% MDD
    - 150mm C4 subbase compacted to 96% MDD
    - 150mm G2 crushed stone base compacted to 85% BRD
    - 30mm Medium Continuously Graded Asphalt
- The proposed layer works for the sidewalk is:
    - Mass earthworks consisting of G10 material compacted to 93% MDD in layers of 150mm, where required
    - Rip and recompact the roadbed and compact the material to 93% MDD
    - 150mm G6 material compacted to 95% MDD
    - 125mm G5 material compacted to 97% MDD
    - 20mm Fine Graded Asphalt
- The upgrading of Main Road P419, Km 4.4 to Km 9.4 and Km 17.0 to Km 22.0 will benefit the community and create a substantial number of local jobs.
- The upgrading of the road will also provide much needed training and upliftment of local SMME's.

## 9.2 RECOMMENDATIONS

It is recommended that:

- The report be reviewed and approved by the Department of Transport.
- The proposed pavement design for the be approved and a Pavement Design Certificate be issued for the project

# 10. APPROVAL

_____ _____

**Xolani Ngcobo** **DATE**

**Support:** **supported** / **not supported** / **as amended**

**Remarks**:

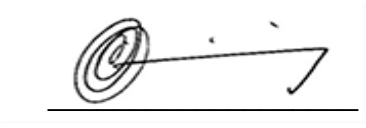
_____ _____

**Craige Dewar:** **DATE**

**Approval:** **approved** / **not approved** / **as amended**

**Remarks**:

REPORT APPROVED BY:



**J J OLIVIER (Pr. Eng)**

# ANNEXURE A: VNA CONSULTING MATERIAL TEST RESULTS

# ANNEXURE B: ILIFA AFRICA MATERIAL TEST RESULTS

# ANNEXURE C: BORROW PIT TEST RESULTS

# ANNEXURE D: ILISO TRAFFIC STUDY

# ANNEXURE E: RESULTS FROM RUBICON DESIGN SOFTWARE