

**Phase 1 Palaeontological Impact Assessment of Section 14  
of the N1 National Road between the Trompsburg  
interchange and Fonteintjie, Kapanong Local Municipality,  
FS Province.**

Report prepared for:  
SRK Consulting  
Oakwood House, Palm Square,  
Bonza Bay Rd, Beacon Bay,  
East London  
5241  
eastlondon@srk.co.za



Dr. Lloyd Rossouw  
PO Box 38806  
Langenhovenpark  
9330

# Contents

Executive Summary .....	3
Introduction .....	4
Details of area surveyed .....	4
Methodology and Terms of Reference .....	5
Geology .....	5
Regional Palaeontology .....	6
Results .....	7
Impact statement and recommendations .....	12
References .....	12
Tables .....	14
Figures .....	18

## Executive Summary

- The South African National Roads Agency (SANRAL) proposes to rehabilitate and widen the N1 Section 14 between the Trompsburg interchange and Fonteintjie in the Kapanong Local Municipality.
- The main elements of the proposed development includes replacement of the base and sub base layers as well as the seal of the road, widening of the road, widening, rehabilitation and/ or replacement of bridges and culverts, construction of a temporary detour alongside the entire section to accommodate bi-directional traffic during construction, construction camp site and the operation of several borrow pits and quarries.
- The road reserve along Section 14 is extensively disturbed as a result of previous road-building activities and is considered to be of **low** palaeontological significance.
- There is no evidence for the accumulation and preservation of intact fossil material within alluvial (Quaternary) sediments flanking the culverts and bridges.
- The underlying sedimentary rocks (*Pa*) are moderately significant but palaeontological impact is generally considered to be moderate to low at the culverts and bridges.
- Except for one, all the Borrow Pits and all the Quarries are underlain by intrusive igneous dolerites. Dolerites are not fossiliferous and can be excluded from further consideration in the present assessment.
- There is a possibility of finding fossils in the contact metamorphic zones adjacent to the dolerite intrusions at the Poortjie BP. There is no major palaeontological reason to suspend development at the Poortjie BP, provided that fresh excavations will be sufficiently monitored during the site's operational phase.
- The footprint has been sufficiently recorded, mapped and documented in terms of conditions necessary for a Phase 1 palaeontological impact assessment and can be accessed for further development.

## • Introduction

The South African National Roads Agency (SANRAL) proposes to rehabilitate and widen the N1 Section 14 between the Trompsburg interchange and Fonteintjie in the Kapanong Local Municipality. The author of this report has been appointed by SRK Consulting to conduct a Phase 1 Palaeontological Impact Assessment for the proposed development. The survey is required as a prerequisite for new development in terms of the National Environmental Management Act and is also called for in terms of the National Heritage Resources Act 25 of 1999. A site visit and subsequent assessment took place in August 2012.

### Details of area surveyed

#### Locality data

1 : 50 000 topographic maps: 2925 DD Krugers & 3025 BB Trompsburg

1 : 250 000 geological maps: 2924 Koffiefontein & 3024 Colesberg

The affected area is Section 14 of the N1 between the Trompsburg interchange (Km19) and Fonteintjie (Km39) in the Kapanong Local Municipality (**Fig. 1**). The road section is located in the Free State province about 86 kilometres south of Bloemfontein. It traverses flat to gently undulating terrain characterized by open grassy plains. Topography and relief are largely determined by resistant dolerite koppies (**Fig. 2**).

The project includes the proposed rehabilitation and widening of the N1 along the section (**Fig. 3**). The current road is a two-lane single carriageway with travel lanes of about 3.7m wide and 2,4m paved shoulders. The current carriageway is built on the right hand side of the road reserve which means that it will become the southbound carriageway in the future when the additional northbound carriageway lanes are built. The road section comprises 10 culverts and 4 bridges. **The main elements of the proposed development include replacement of the base and sub base layers as well as the seal of the road, widening of the road, widening, rehabilitation and/ or replacement of bridges and culverts, construction of a temporary detour alongside the entire section to accommodate bi-directional traffic during construction, construction camp site and the operation of several borrow pits and quarries.**

Locality data for Section 14, including bridges, borrow pits and quarries, is summarized in Table 1.

## **Methodology and Terms of Reference**

Fossil heritage along Section 14 of the N1 could potentially be affected by excavations into sedimentary bedrock and Quaternary alluvial deposits at the designated borrow pits or at bridges and culverts where the road crosses rivers and streams. A Garmin Etrex Vista GPS hand model (set to the WGS 84 map datum) and a digital camera were used for recording purposes. Relevant geological and paleontological information were assimilated for the report and integrated with data acquired during the on-site inspection.

The task involved:

- identification of paleontological occurrences in the road reserve of Section 14;
- identification of paleontological occurrences in potentially fossil-bearing exposures in the marked borrow pits;
- identification of paleontological occurrences along drainage areas (rivers and streams) in the vicinity of bridges and culverts;
- an assessment of their significance, possible impact by the proposed development;
- and recommendations for mitigation where relevant.

## **Geology**

The geology of the region has been described by Zawada (1992), Le Roux (1993) and Johnson (2006) and is shown on the 1: 250 000 geological maps 2924 Koffiefontein and 3024 Colesberg (Council for Geoscience, Pretoria 1997). Sedimentary bedrock in the area is made up of alternating layers of Late Permian sandstone, siltstone and mudstone of the Adelaide Subgroup (*Pa*, Beaufort Group, Karoo Supergroup) (see **Fig. 4**). These sedimentary rocks form the base on which younger, superficial deposits of Late Cenozoic age have been deposited (Partridge *et al.* 2006). Superficial deposits include pedocretes, colluvial slope deposits, sheet wash and alluvium. The sedimentary rocks are penetrated in many places by weather-resistant dykes and sills of Jurassic dolerites (*Jd*).

They determine the relief of the surrounding area, with the resulting hills and groups of hills typically steep-sided, sometimes flat-topped.

## **Regional Palaeontology**

The Karoo geological strata within the affected area are generally accepted to be Late Permian in age and are assigned to the *Dicynodon* Assemblage Zone (AZ) (**Fig. 5 & 6**). This biozone is characterized by the presence of a distinctive and fairly common dicynodont genus (Kitching 1977, 1995).

The *Dicynodon* AZ occupies most the Balfour Formation, extending from the top of the Oudeberg Member to the base of the Palingkloof Member. East of 25° the *Dicynodon* AZ becomes indistinguishable from the underlying Cistecephalus Assemblage Zone (Keyser and Smith, 1977-78). Generally flat topography and widely scattered exposures makes it difficult to follow the *Dicynodon* AZ in the Free State, although small but rich exposures occur in the Bethulie, Smithfield, Thaba Nchu, Bloemfontein and Van Reenen districts.

The *Dicynodon* AZ represents the terminal phase of the Palaeozoic continental biota, which was dominated by therapsid “mammal-like reptiles” and *Glossopteris* Flora before it was largely wiped out by the end-Permian Mass Extinction Event. Other vertebrate fossils include palaeoniscoid fish and crocodile-like temnospondyls. Therapsids and other vertebrate fossils from this biozone are usually found as dispersed and isolated specimens in mudrock horizons, associated with an abundance of calcareous nodules. Fossil remains are commonly enclosed in some of these nodules. Plant fossils include *Dadoxylon* and *Glossopteris*. Trace fossils (arthropod trails, worm burrows) are also present. Productive localities occur mostly around areas of high relief such as on the slopes of koppies. Many exposures within the *Dicynodon* Assemblage Zone were metamorphosed by igneous dolerite intrusions causing changes in the colour and texture of the rocks as well as in the enclosed fossils.

The sediments assigned to the *Dicynodon* AZ are associated with stream deposits consisting of floodplain mudstones and subordinate, lenticular channel sandstones.

Overlying Late Cenozoic valley fill deposits may occasionally contain much younger fossil biotas, including the skeletal remains of large vertebrates, non-marine molluscs

and a variety of other microfossils (Klein 1984; Scott & Brink 1991; Churchill *et al.* 2000; Rossouw 2006). Numerous Quaternary-age fossils, assigned to the Pleistocene Period, have been recorded from various localities along the Riet and Modder Rivers and their tributaries to the north. Mammal fossils previously recorded in the region include the extinct species *Equus capensis*, *Megalotragus priscus*, *Pelorovis antiquus*, *Antidorcas bondi* and *Equus lylei* (**Fig. 6**).

## Results

Impact on potential palaeontological resources within the inspected area is summarized in **Table 2**.

### Road Reserve

Intact Quaternary sediments are absent along the road reserve and superficial deposits are mostly disturbed as a result of previous road-building activities (**Fig 7**). This also includes road cuttings made into bedrock during the original construction of the road section. The Quaternary sediments in the demarcated area are not palaeontologically vulnerable and are of **low** palaeontological significance.

Except for the segment between coordinates 30° 1'13.63"S 25°48'1.84"E and 30° 0'8.97"S 25°48'28.51"E, which is underlain by igneous dolerite intrusions, Section 14 is mainly located on top of Adelaide Subgroup bedrock (*Pa*) (**Fig 8**). The igneous dolerites are not fossiliferous and are not considered palaeontologically significant. The demarcated area has been sufficiently recorded, mapped and documented in terms of conditions necessary for a Phase 1 palaeontological impact assessment and can be accessed for further development.

### Culverts

Rehabilitation of drains and culverts will impact mainly on previously disturbed building rubble and superficial deposits of Quaternary age (**Fig. 9**). These superficial deposits are already heavily disturbed as a result of previous road-building activities. The Quaternary sediments in the demarcated area are not palaeontologically vulnerable and are of **low** palaeontological significance. There is no evidence for the accumulation and preservation of intact fossil material within the Quaternary sediments.

The culverts have been sufficiently recorded, mapped and documented in terms of conditions necessary for a Phase 1 palaeontological impact assessment and can be accessed for further development.

### Bridges

**Bridge 1** (S30 01 14.7 E25 48 01.2) is underlain by sedimentary bedrock (*Pa*) covered by a foundation of building rubble (**Fig 10 A**) Quaternary-aged alluvial deposits are exposed along a shallow drainage. Quaternary profiles are sterile. There is no evidence for the accumulation and preservation of intact fossil material within the Quaternary sediments. The underlying sedimentary rocks (*Pa*) are moderately significant and potential fossil heritage may be affected if substantial bedrock excavations are to be conducted here.

The area around **Bridge 2** (S29 59 47.6 E25 48 37.9) is underlain by sedimentary bedrock (*Pa*), covered by a foundation of building rubble and Quaternary alluvial overbank deposits from the Van Zyls River (**Fig. 10 B**). There is no evidence for the accumulation and preservation of intact fossil material within the Quaternary sediments. This is especially indicated by sterile Quaternary profiles exposed along the riverbanks where the N1 crosses the Van Zyls River. Superficial deposits on both sides of the bridge are heavily disturbed as a result of previous road-building activities. The underlying sedimentary rocks (*Pa*) are moderately significant and potential fossil heritage may be affected if substantial bedrock excavations are to be conducted here.

**Bridge 3** (S29 55 42.7 E25 50 24.6) is built over a farm road (**Fig. 10 C**). The structure rests on top of a foundation of building rubble which is underlain by sedimentary bedrock (*Pa*). Superficial sheet wash deposits cover the surrounding area. There is no evidence for the accumulation and preservation of intact fossil material within the Quaternary sediments in the vicinity of the bridge. The underlying sedimentary rocks (*Pa*) are moderately significant and potential fossil heritage may be affected if substantial bedrock excavations are to be conducted here.

**Bridge 4** (S29 53 39.8 E25 51 44.8) is underlain by sedimentary bedrock (*Pa*) covered by a foundation of building rubble (**Fig 10 D**). Shallow, Quaternary-aged alluvial deposits are exposed along the river bed. Quaternary profiles are sterile. There is no evidence for the accumulation and preservation of intact fossil material within the



Quaternary sediments in the vicinity of the bridge. The underlying sedimentary rocks (*Pa*) are moderately significant and potential fossil heritage may be affected if substantial bedrock excavations are to be conducted here.

The bridges have been sufficiently recorded, mapped and documented in terms of conditions necessary for a Phase 1 palaeontological impact assessment and can be accessed for further development.

### Borrow Pits

**Quarry 2** is located on intrusive dolerite bedrock, covered by superficial sheet wash deposits and a veneer of unconsolidated topsoil (**Fig. 11**). The igneous dolerites are not fossiliferous and not considered palaeontologically significant. A pedestrian survey of the borrow pit and its surroundings found no evidence for the accumulation and preservation of intact fossil material within the superficial sheet wash deposits. The footprint is not considered to be palaeontologically vulnerable and potential impact on palaeontological remains is unlikely. The demarcated area has been sufficiently recorded, mapped and documented in terms of conditions necessary for a Phase 1 palaeontological impact assessment and can be accessed for further development.

**Borrow Pit 4** is located on intrusive dolerite bedrock, covered by superficial sheet wash deposits (**Fig. 12**). The igneous dolerites are not fossiliferous and are not considered palaeontologically significant. A pedestrian survey of the borrow pit and its surroundings found no evidence for the accumulation and preservation of intact fossil material within the superficial sheet wash deposits. The footprint is not considered to be palaeontologically vulnerable and potential impact on palaeontological remains is unlikely. The demarcated area has been sufficiently recorded, mapped and documented in terms of conditions necessary for a Phase 1 palaeontological impact assessment and can be accessed for further development.

Situated less than 100 m from each other, the **Quarry 1** and **Bloemhof Borrow Pit** sites are located on intrusive dolerite bedrock and covered by superficial sheet wash deposits. The igneous dolerites are not fossiliferous and are not considered palaeontologically significant. A pedestrian survey of the borrow pit and its surroundings found no evidence for the accumulation and preservation of intact fossil material within the

superficial sheet wash deposits. The footprints of these two sites are not considered to be palaeontologically vulnerable. Potential impact on palaeontological remains is unlikely. The demarcated area has been sufficiently recorded, mapped and documented in terms of conditions necessary for a Phase 1 palaeontological impact assessment and can be accessed for further development.

**Borrow Pit 3** is located on intrusive dolerite bedrock, covered by superficial sheet wash deposits (**Fig. 13**). The igneous dolerites are not fossiliferous and are not considered palaeontologically significant. A pedestrian survey of the borrow pit and its surroundings found no evidence for the accumulation and preservation of intact fossil material within the superficial sheet wash deposits. The footprint is not considered to be palaeontologically vulnerable and potential impact on palaeontological remains is unlikely. The demarcated area has been sufficiently recorded, mapped and documented in terms of conditions necessary for a Phase 1 palaeontological impact assessment and can be accessed for further development.

**Borrow Pit 2** is located on intrusive dolerite bedrock, covered by superficial sheet wash deposits. The igneous dolerites are not fossiliferous and are not considered palaeontologically significant. A pedestrian survey of the borrow pit and its surroundings found no evidence for the accumulation and preservation of intact fossil material within the superficial sheet wash deposits. The footprint is not considered to be palaeontologically vulnerable and potential impact on palaeontological remains is unlikely. The demarcated area has been sufficiently recorded, mapped and documented in terms of conditions necessary for a Phase 1 palaeontological impact assessment and can be accessed for further development.

The **Straussfontein Borrow Pit** locality is located on intrusive dolerite bedrock and superficial sheet wash deposits (**Fig. 14**). The igneous dolerites are not fossiliferous and are not considered palaeontologically significant. A pedestrian survey of the affected area and its surroundings found no evidence for the accumulation and preservation of intact fossil material within the superficial sheet wash deposits. The footprint is not considered to be palaeontologically vulnerable. Potential impact on palaeontological remains is considered unlikely. The demarcated area has been sufficiently recorded,

mapped and documented in terms of conditions necessary for a Phase 1 palaeontological impact assessment and can be accessed for further development.

**Borrow Pit 1** is located on intrusive dolerite bedrock, covered by superficial sheet wash deposits (**Fig. 15**). The igneous dolerites are not fossiliferous and are not considered palaeontologically significant. A pedestrian survey of the affected area and its surroundings found no evidence for the accumulation and preservation of intact fossil material within the superficial sheet wash deposits. The footprint is not considered to be palaeontologically vulnerable and potential impact on palaeontological remains is unlikely. The demarcated area has been sufficiently recorded, mapped and documented in terms of conditions necessary for a Phase 1 palaeontological impact assessment and can be accessed for further development.

**Poortjie Borrow Pit** is partially located on Balfour Frm. sandstone and mudstone that are intruded by dolerite bedrock, and covered by superficial sheet wash deposits (**Fig. 16**). The igneous dolerites are not fossiliferous, but fossils may well be preserved near the contact metamorphic zones. A pedestrian survey of the borrow pit and its surroundings found no evidence for the accumulation and preservation of intact fossil material within Balfour Frm. outcrop and the superficial sheet wash deposits. The sedimentary bedrock is considered to be of moderate palaeontological significance. The demarcated area has been sufficiently recorded, mapped and documented in terms of conditions necessary for a Phase 1 palaeontological impact assessment and can be accessed for further development, provided that fresh excavations will be sufficiently monitored during the site's operational phase. It is advised that newly uncovered palaeontological material found during the course of excavation activities into sedimentary bedrock must be reported to SAHRHA, that excavations into *in situ* sediments should allow for inspection by a specialist at the appropriate time and that possible intact finds may require a Phase 2 rescue operation at the cost of the developer.

**Quarry 3** is located on intrusive dolerite bedrock, covered by superficial sheet wash deposits that have been extensively (**Fig. 17**). The igneous dolerites are not fossiliferous and are therefore not considered palaeontologically significant. A pedestrian survey of the borrow pit and its surroundings found no evidence for the accumulation and preservation of intact fossil material within the superficial sheet wash deposits. The footprint is not considered to be palaeontologically vulnerable.

## Impact statement and Recommendations

The road reserve along Section 14 is extensively disturbed as a result of previous road-building activities and is considered to be of **low** palaeontological significance. Furthermore, a large segment is underlain by igneous dolerite intrusions, which are not considered palaeontologically significant.

There is no evidence for the accumulation and preservation of intact fossil material within alluvial (Quaternary) sediments flanking the culverts and bridges. The underlying sedimentary rocks (*Pa*) are moderately significant and potential fossil heritage may be affected if substantial bedrock excavations are to be conducted here. However, palaeontological impact is generally considered to be moderate to low at the culverts and bridges.

Except for one, all the Borrow Pits and all the Quarries are underlain by intrusive igneous dolerites. Dolerites are not fossiliferous and can be excluded from further consideration in the present assessment. There is a possibility of finding fossils in the contact metamorphic zones adjacent to the dolerite intrusions at the Poortjie BP, but palaeontological impact is, on the whole, considered to be low. There is no major palaeontological reason to suspend development at the Poortjie BP, provided that fresh excavations will be sufficiently monitored during the site's operational phase.

## References

Johnson *et al.* 2006. Sedimentary rocks of the Karoo Supergroup. **In:** M.R. Johnson, *et al.* (eds). *The Geology of South Africa*. Geological Society of South Africa.

Keyser, A.W. & Smith, R.M.H. 1978-79. Vertebrate biozonation of the Beaufort Group with special reference to the western Karoo Basin. *Annals of the Geological Survey of South Africa* 12: 1-35.

Kitching, J.W. 1977. The distribution of Karoo Vertebrate Fauna. Bernard Price Institute for Palaeontological Research. Memoir 1, 1 – 131.

Kitching, J.W. 1995. Dicynodon AZ. **In:** Rubidge, B. S. (ed.) *Biostratigraphy of the Beaufort Group*. Biostrat. Ser. S.Afr. Comm. Strat. 1, 1 – 45.

Klein, R.G. 1984. The large mammals of southern Africa: Late Pliocene to Recent. **In:**

Klein, R.G. (Ed.) *Southern African prehistory and paleoenvironments*, pp 107-146.

Balkema, Rotterdam.

Le Roux, F.G. 1993. Die geologie van die gebied Colesberg. Explanation to 1: 250 000 scale geological sheet 3024 Colesberg, 12 pp. Council for Geoscience, Pretoria.

Partridge, T.C. *et al.* 2006. Cenozoic deposits of the interior. **In:** M.R. Johnson, *et. al.* (eds). *The Geology of South Africa*. Geological Society of South Africa.

Rossouw, L. 2006. Florisian mammal fossils from erosional gullies along the Modder River at Mitasrust farm, central Free State, South Africa. *Navorsing van die Nasionale Museum* 22(6): 145-162.

Scott, L and Brink, J.S.1991. Quaternary palaeoenvironments of pans in central South Africa: palynological and palaeontological evidence. *SA Geographer* 19: 22-34

Zawada, P.K. 1992. Die geologie van die gebied Koffiefontein. Explanation to 1: 250 000 scale geological sheet 3924 Koffiefontein, 30 pp. Council for Geoscience, Pretoria

## Tables

Table 1. Locality data for Section 14, including bridges, borrow pits and quarries.

Feature	Coordinates	
Upgrade Start	25 47' 16.400" E	30° 03' 01.000" S
Upgrade Ends	25 52' 46.500" E	29° 52' 42.200" S
Bloemhof BP	25° 48' 33.051" E	29° 58' 59.049" S
Poortjie BP	25° 50' 13.300" E	29° 55' 38.200" S
Borrow Pit 2	25° 48' 26.700" E	29° 57' 56.200" S
Borrow Pit 1	25° 49' 16.700" E	29° 57' 29.300" S
Straussfontein BP	25° 48' 31.000" E	29° 57' 37.200" S
Borrow Pit 3	25° 48' 10.800" E	29° 58' 31.300" S
Borrow Pit 4	25° 47' 49.800" E	30° 00' 02.900" S
Quarry 1 (km 26.2)	25° 48' 29.370" E	29° 58' 55.460" S
Quarry 2 (km 24)	25° 47' 32.530" E	30° 00' 56.450" S
Quarry 3 (km 42.2)	25° 53' 02.300" E	29° 51' 06.900" S
Bridge 1	25° 48' 01.200" E	30° 01' 14.700" S
Bridge 2 (Van Zyl's River)	25° 48' 37.900" E	29° 59' 47.600" S
Bridge 3	25° 50' 24.600" E	29° 55' 42.700" S
Bridge 4	25° 51' 44.800" E	29° 53' 39.800" S

Table 2. Summary of potential impact and recommendation for mitigation.

<b>Feature</b>	<b>Rock type</b>	<b>Age</b>	<b>Palaeontological Significance/ Impact</b>	<b>Mitigation required</b>
Bloemhof BP	Unconsolidated soils, sheet wash	Quaternary	Low	none
	Dolerite ( <i>Ja</i> )	Jurassic	Low	
Poortjie BP	Unconsolidated soils, sheet wash	Quaternary	Low	None
	Sandstone, mudstone ( <i>Pa</i> )	Late Permian	Moderate	Monitoring of fresh excavations
Borrow Pit 2	Unconsolidated soils, sheet wash	Quaternary	Low	None
		Jurassic	Low	None
Borrow Pit 1	Unconsolidated soils, sheet wash	Quaternary	Low	None
		Jurassic	Low	None
Straussfontein BP	Unconsolidated soils, sheet wash	Quaternary	Low	None
		Jurassic	Low	None
Borrow Pit 3	Unconsolidated soils, sheet wash	Quaternary	Low	None
		Jurassic	Low	None
Borrow Pit 4	Unconsolidated soils, sheet wash	Quaternary	Low	None
		Jurassic	Low	None

Quarry 1 (km 26.2)	Unconsolidated soils, sheet wash	Quaternary	Low	None
		Jurassic	Low	None
Quarry 2 (km 24)	Unconsolidated soils, sheet wash	Quaternary	Low	None
		Jurassic	Low	None
Quarry 3 (km 42.2)	Unconsolidated soils, sheet wash	Quaternary	Low	None
		Jurassic	Low	None
Bridge 1	Building rubble	Quaternary	Low	None
	Unconsolidated soils, sheet wash		Moderate to low	None, but monitoring necessary if bedrock excavations are required
	Sandstone, mudstone ( <i>Pa</i> )		Late Permian	
Bridge 2 (Van Zyl's River)	Building rubble	Quaternary	Low	None
	Unconsolidated soils, sheet wash		Moderate to low	None, but monitoring necessary if bedrock excavations are required
	Sandstone, mudstone ( <i>Pa</i> )		Late Permian	
Bridge 3	Building rubble	Quaternary	Moderate to low	None
	Unconsolidated soils, sheet wash		Moderate to low	None, but monitoring necessary if bedrock
	Sandstone, mudstone ( <i>Pa</i> )		Late Permian	



				excavations are required
Bridge 4	Building rubble  Unconsolidated soils, sheet wash  Sandstone, mudstone ( <i>Pa</i> )	Quaternary  Late Permian	Low  Moderate to low	None  None, but monitoring necessary if bedrock excavations are required
Culverts	Building rubble  Unconsolidated soils, sheet wash  Sandstone, mudstone ( <i>Pa</i> )	Quaternary  Late Permian	Low  Moderate to low	None  None, but monitoring necessary if bedrock excavations are required
Section 14 Road Reserve	Building rubble  Unconsolidated soils, sheet wash  Dolerite	Quaternary  Jurassic	Low  Low	None  None

# Figures

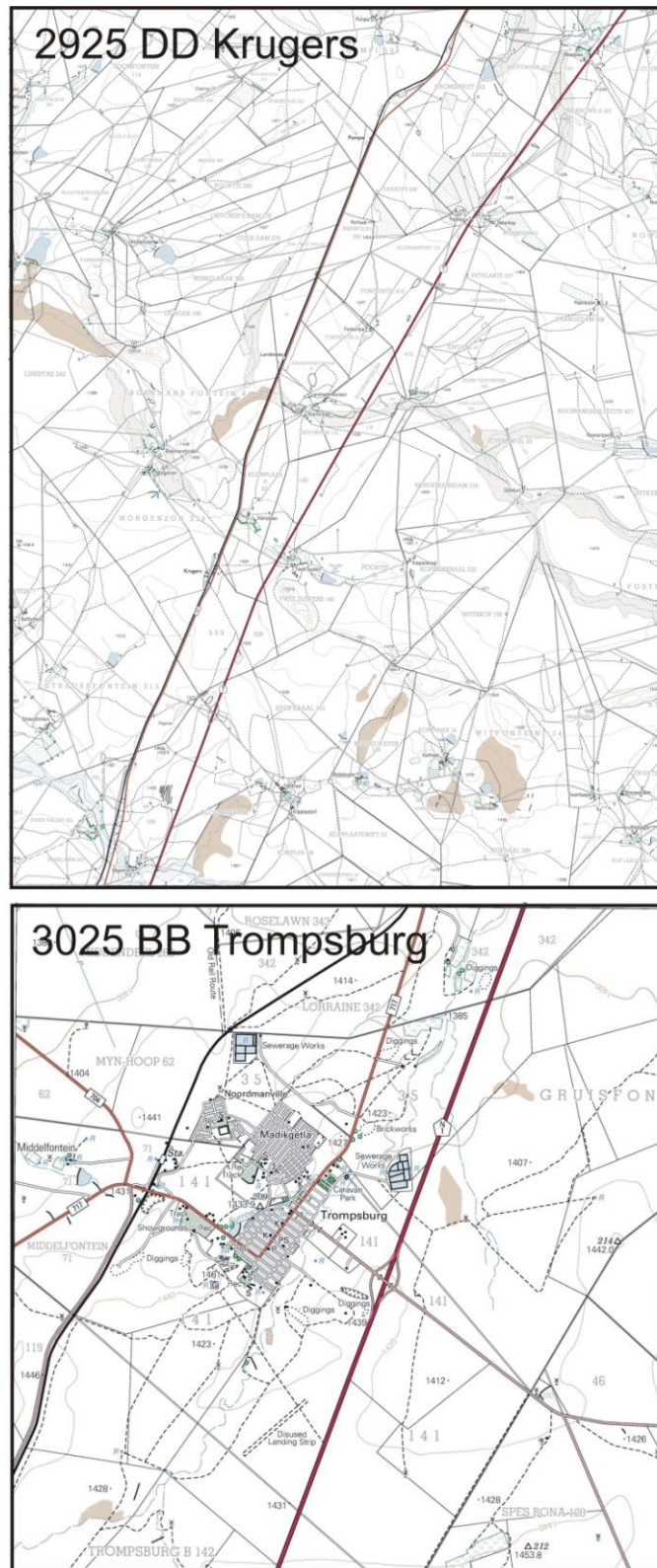


Figure 1. N1 Section 14 indicated by portions of 1:50 000 scale topographic maps 2925 DD Krugers and 3025 BB Trompsburg.

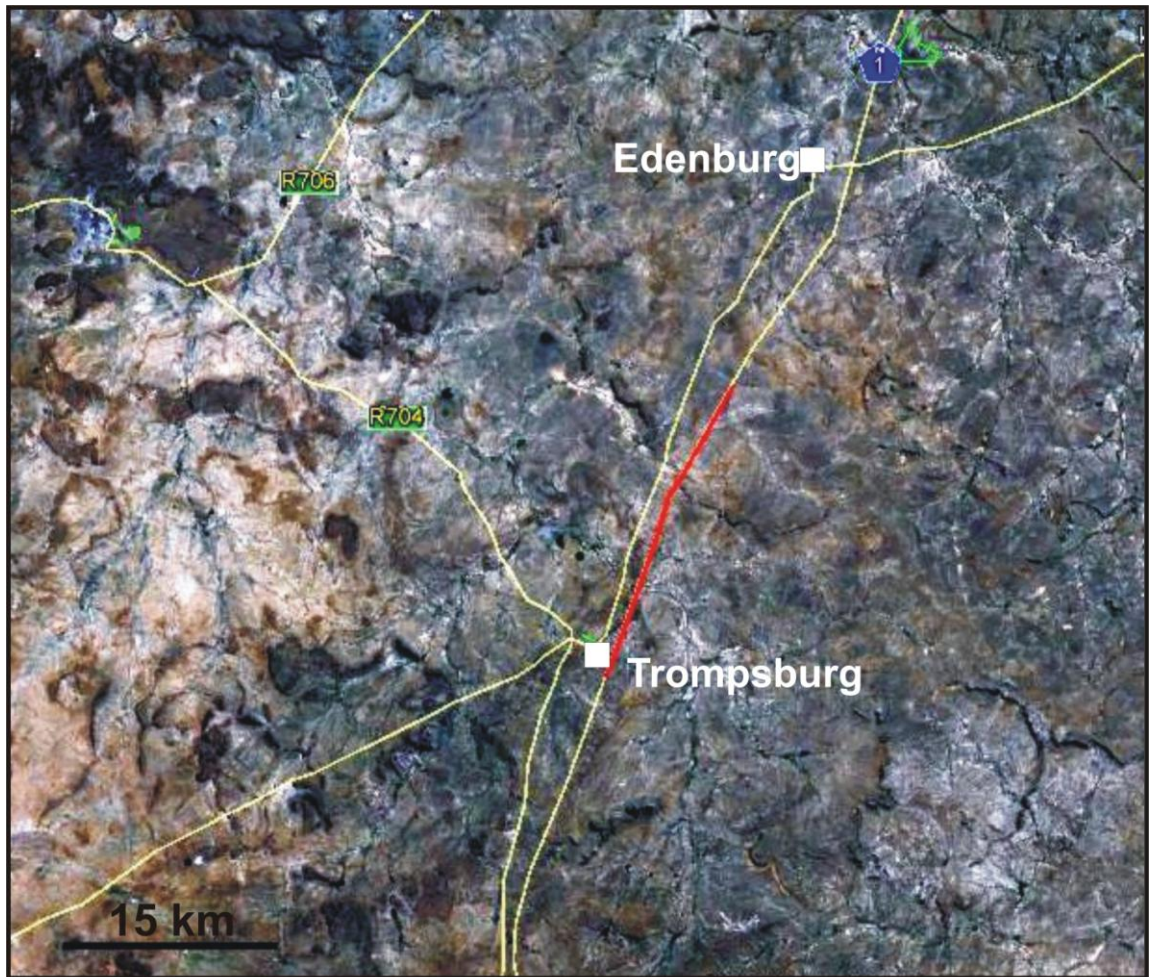


Figure 2 . Aerial and regional view of NI Section 14 (indicated by red line).



Figure 3. Aerial view of quarry, borrow pit and bridge localities. Section 14 marked by red line.

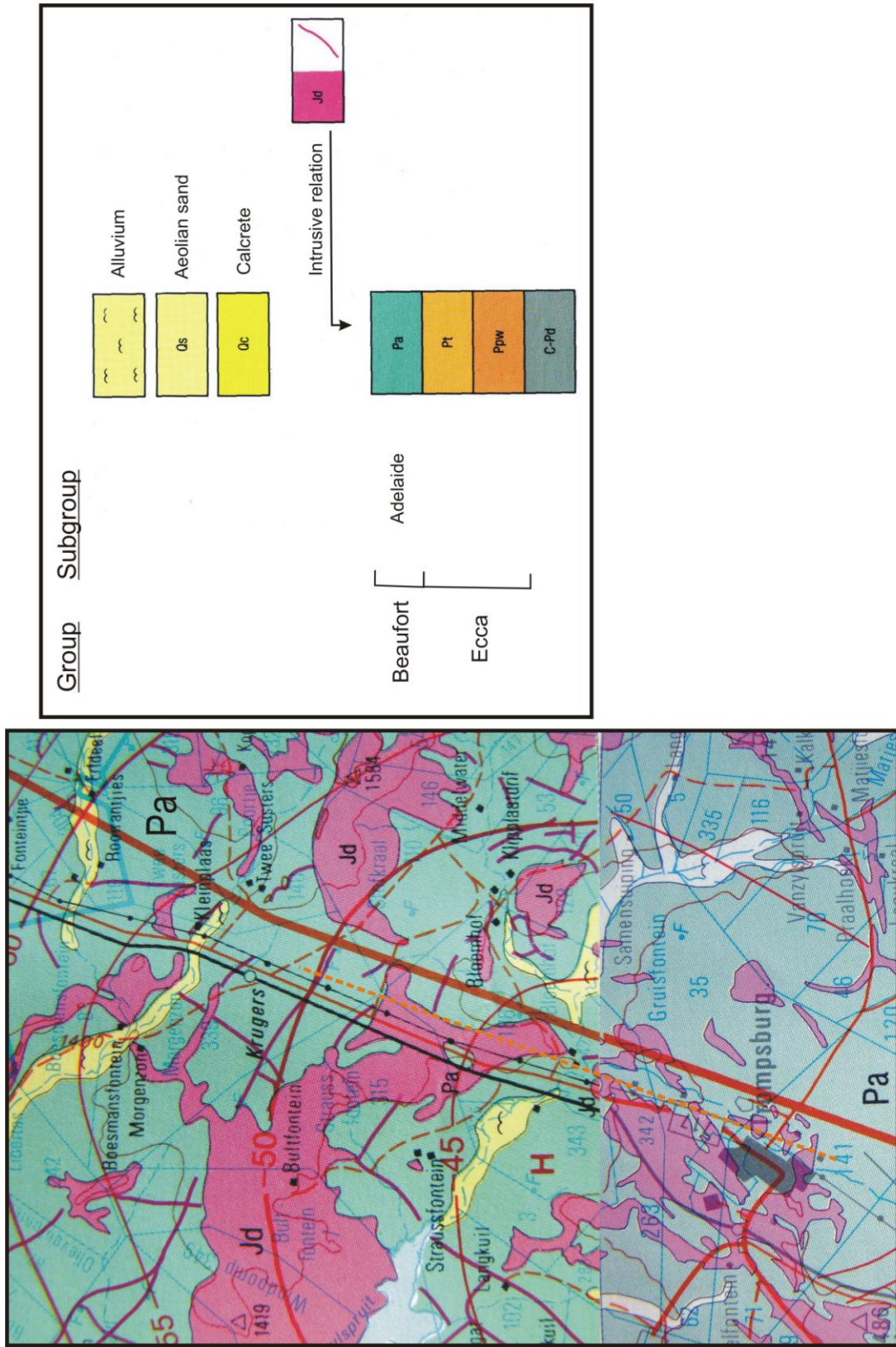


Figure 4. Regional geology. Portions of 1:250 000 scale geological maps 2924 Koffiefontein and 3024 Colesberg.

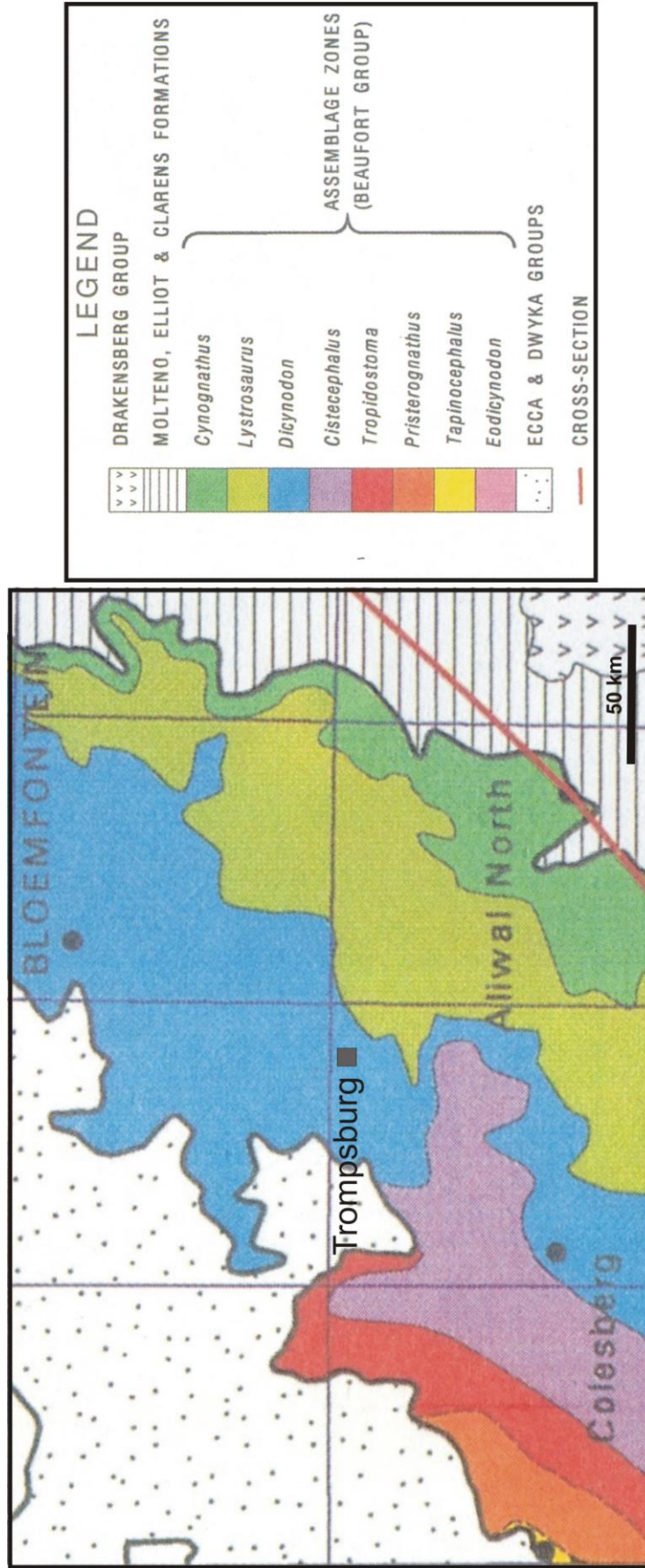


Figure 5. Geographical distribution of Karoo vertebrate biozones of the Beaufort Group near Trompsburg (after Rubidge 1995).

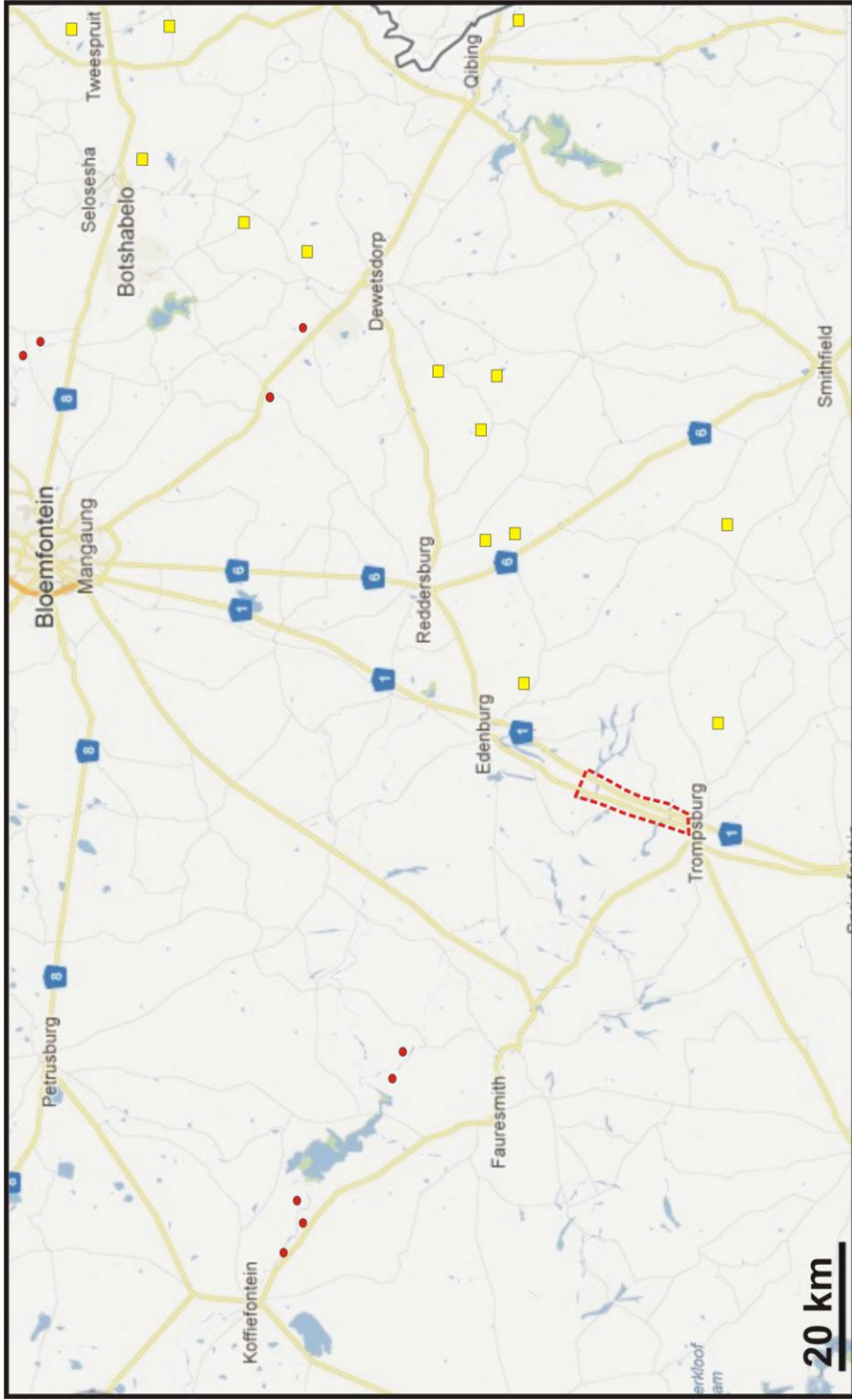


Figure 6. Known palaeontological sites / occurrences in the region south of Bloemfontein.



Figure 7. Intact Quaternary sediments are absent along the road reserve and superficial deposits are mostly disturbed as a result of previous road-building activities.



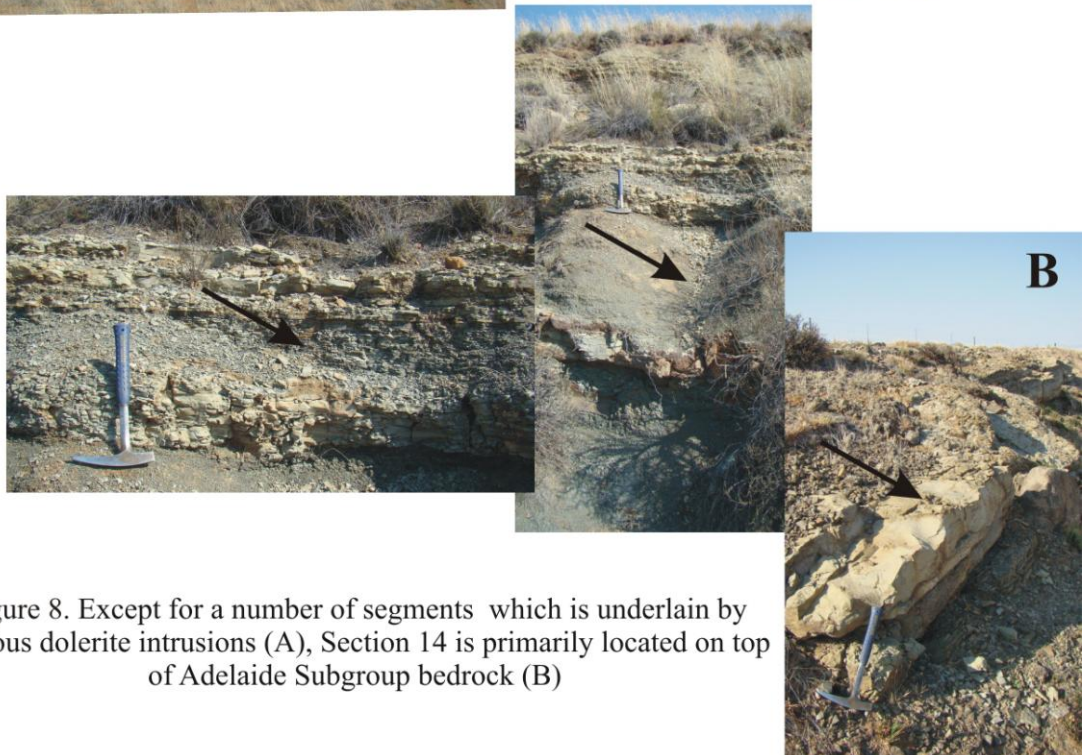


Figure 8. Except for a number of segments which is underlain by igneous dolerite intrusions (A), Section 14 is primarily located on top of Adelaide Subgroup bedrock (B)



Figure 9. Rehabilitation of culverts will impact mainly on previously disturbed residual deposits and superficial deposits of Quaternary age.



Figure 10. The bridge structures are underlain by sedimentary bedrock (*Pa*) that is covered by a foundation of building rubble. Associated Quaternary-aged alluvial deposits are sterile.



Figure 11. Quarry 2



Figure 12. Borrow Pit 4

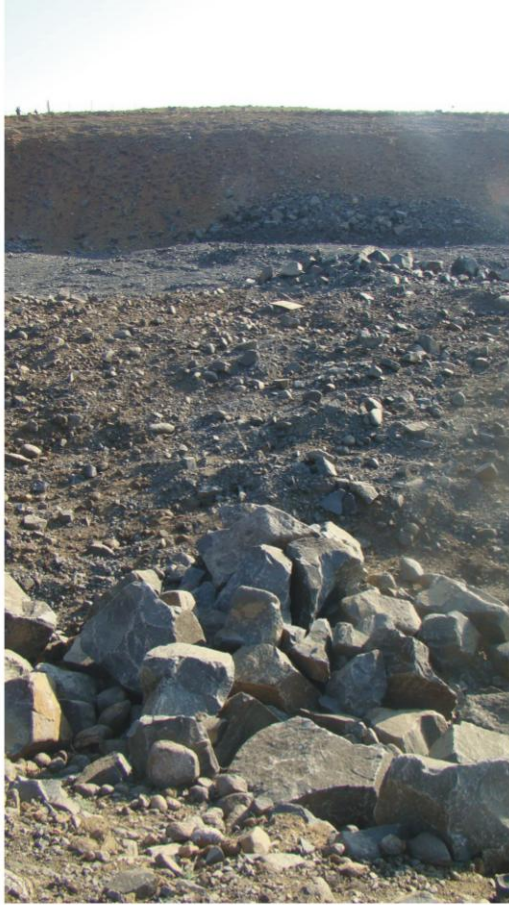


Figure 13. Quarry 1



Figure 14. Borrow Pit 3.



Figure 15. Straussfontein Borrow Pit



Figure 16. Borrow Pit 1.



Figure 17. Poortjie Borrow Pit.



Figure 18. Quarry 3.