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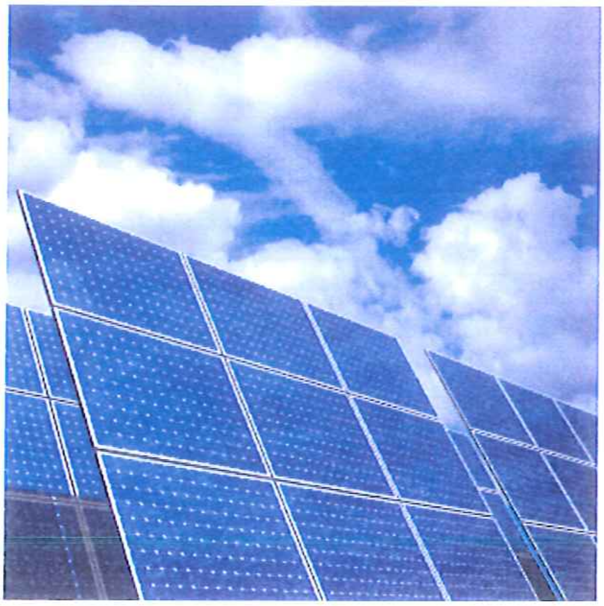
SiVEST
Established in 195

MULILO
RENEWABLE ENERGY

STORMWATER MANAGEMENT PLAN
for the
KLIPGATS PAN PHOTOVOLTAIC PLANT (PV)

REPORT N°: 2011/11134/KP Rev 0
December 2011



Document Control

- Project: Stormwater Management Plan for the Klipgats Pan Photovoltaic Plant
- Report N°: 2011/11134/KP

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Checked By:	Richard Hirst	12th December 2011		
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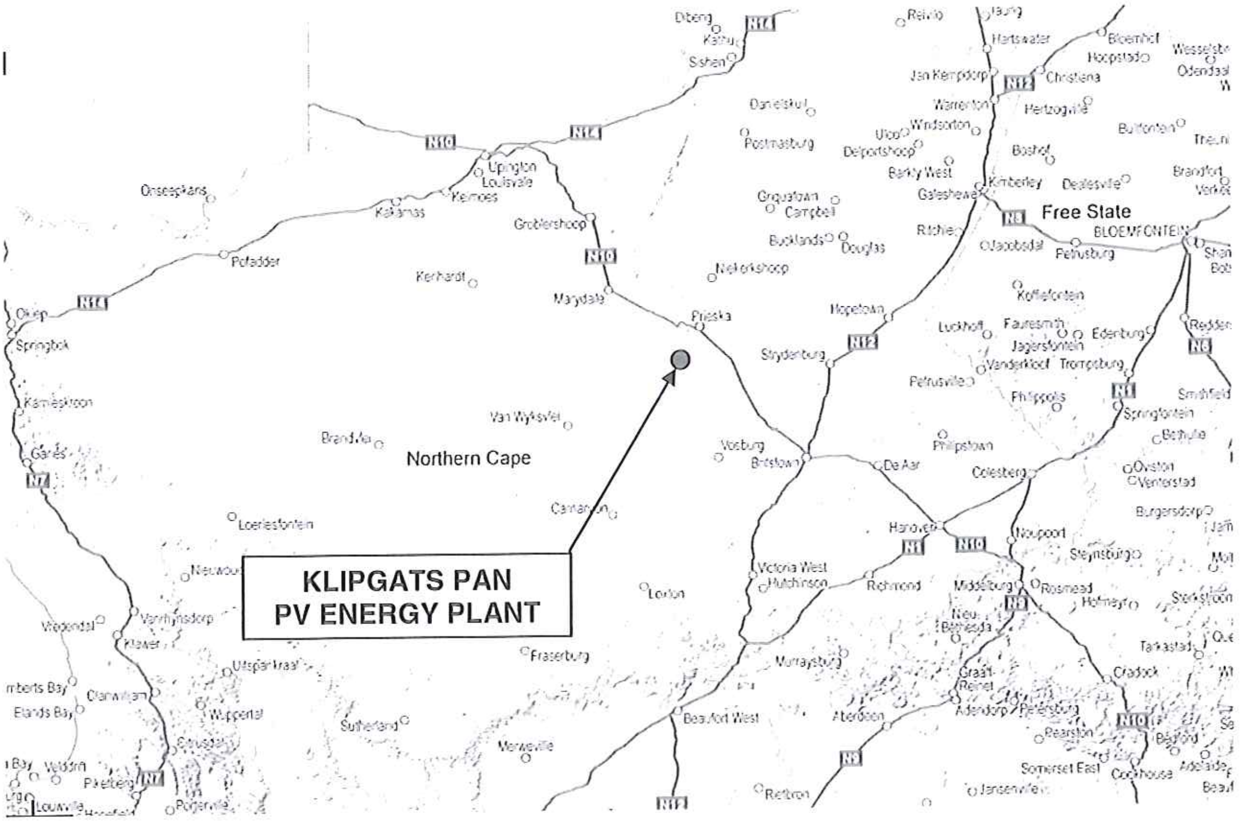
Checked By:				

SIVEST

VOGELSTRUISBULT

CONTENTS

1 Locality Plan



2 Introduction

SiVEST SA (Pty) Ltd was appointed by Messrs. Aurecon South Africa (Pty) Ltd on behalf of their client the developers, Messrs. Mulilo Renewable Energy (Pty) Ltd to carry out a desk top study of the surface hydrology on a proposed site for the purposes of establishing a new Solar Photovoltaic (PV) Energy Plant.

The proposed site is situated on the Farm Klipgats Pan 117 RE in the Northern Cape Province of South Africa, near the town of Copperton. The farm is bound to the east by the farms, Vogelstruisbult, Hoekplaas & Kaffirs Kolk, to the north by the farm Smous Pan, to the west by the farm Uitspan and to the south by the farm Groot Fourie's Kolk.

The farm Vogelstruisbult covers a total area of ±9833.17ha; however, it is the intention of the developer to only utilize ±300ha of the site for the new proposed PV plant.

This report therefore serves to outline the related surface, stormwater issues on the proposed site for the purposes of inclusion in the Environmental Management Assessment (EIA) submission.

3 Developer/Client & Consulting Engineer's Details

Client Details

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4 Geotechnical Information

A comprehensive geotechnical investigation is currently being completed by Messrs. Mulilo Renewable Energy (Pty) Ltd on the proposed site which will form part of the final reference during the detailed design stage of the project.

However, for the purposes of this document, so as to gain a better understanding of the soils, vegetation etc in the area, we have made use of the already completed geotechnical investigation[1] carried out on the adjacent property, by Messrs. Geotechnics Africa Western Cape, in August 2010.
We note that our assumptions therefore, may well change once we have reviewed the site specific, geotechnical investigation report.

In summary; the adjacent Vogelstruisbult farm is typically underlain with the following strata levels;-

0.0m – 0.2m	-	Topsoil (Vegetated layer of Silty fine/medium Sand)
0.2m – 0.5m	-	Weathered Silty Sandy Gravel (Present in Places)
0.5m – 0.6m	-	Sandy Clayey Calcrete Silt (Present in all tests)
0.6m – <	-	Medium/Hard Hardpan Calcrete

Refer Appendix 'A' – Geotechnical Reports dated August 2010

5 Stormwater

5.1 Introduction

Numerous ridges and valley lines are located on the farm with all the valley lines draining in a western direction towards the adjacent Uitspan Pan farm.

From the information provided, the two alternate sites have been proposed for the new PV plant and are located on the eastern side of the farm: referenced as 'Alternatives 1 and 2'.

5.2 Proposed Site Locations

5.2.1 'Alternative 1'

This proposed site is located adjacent to the eastern boundary of the farm, just north of the R357 Provincial Road. The site has both 'minor' ridges and valley lines which divide the site into four separate drainage catchments, It is therefore proposed that each catchment will have a separate drainage system and associated detention pond.

The average, natural slope for this proposed site is ±0.95% or a gradient of ±1:105.07.

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[1] GEOTECHNICS AFRICA WESTERN CAPE - Copperton PV Solar Plant Geotechnical Investigation *(August 2010)*

We note that, the existing drainage lines/valley lines would in all likely hood host a 1:100 Year Flood line and therefore would require further modelling to determine the extent of the inundation area. In addition, from the information and data received, it is evident that flooding along this drainage line has occurred in the past[2].

5.2.2 'Alternative 2'

This proposed site is located, south of the R357 Provincial Road, south west of the 'Alternative 1' site. The site is bisected by a valley line, separating the site into two equal catchments; each having separate drainage systems and associated detention ponds.

The average, natural slope for this proposed site is ±0.84% or a gradient of ±1:118.7.

We note that, the existing drainage line would in all likely hood host a 1:100 Year Flood line and therefore would require further modelling to determine the extent of the inundation area. From the information and data received, it is evident that flooding along this drainage line has occurred in the past[3].

5.3 Plant Drainage

The 'Draft Scoping Report' under Section 2 - Proposed Activity[4], makes reference to three different methods in which the proposed PV panels are to be fixed to the ground (Ref. - *Section 2.3.5 b) Mounting Systems)*. These difference methods could play a role in how the surface stormwater should be managed.

The three proposed methods and their descriptions are as follows;-

5.3.1 Fixed Axis PV Systems

The PV panel is fixed to a frame and the frame is anchored to a foundation, therefore NO movement of the panel or structure occurs.

5.3.2 Single Axis PV System

The PV panel is fixed to a single axis rotation frame, with the frame anchored to a foundation. The rotation of the frame occurs in a singular direction in which the panel is directed towards the sun to achieve the optimum absorption of the sun's rays.

5.3.3 Dual Axis Tracking System

The PV panel is fixed to a dual axis rotation frame (central pivot structure), with the frame anchored to a typical pile foundation. The rotation of the frame occurs in any direction and therefore the panel can be directed towards the sun to achieve the optimum absorption of the sun's rays.

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[2] GEOTECHNICS AFRICA WESTERN CAPE - Copperton PV Solar Plant Geotechnical Investigation *(August 2010)*

[3] GEOTECHNICS AFRICA WESTERN CAPE - Copperton PV Solar Plant Geotechnical Investigation *(August 2010)*

[4] AURECON Draft Scoping Report *(November 2011)* – '*Section 2*' Proposed Activity

From the image provided in the Draft Scoping Report[5] of the prototype PV plant currently in operation in the area, both the Fixed Axis System and the Single Axis System indicates a fairly low structure close to the ground and therefore would include *inter alia* some form of bulk earthworks and the clearing of the existing vegetation in order to construct the terraces.

As a result of the vegetation being cleared, the total volume of stormwater run-off emanating off the cleared area would increase and would therefore require stormwater management in the form of stormwater channels and chutes so as to direct the stormwater flows definitively and to minimize/control erosion.

However, for the Dual Axis System, it appears that the natural vegetation on the site is to remain and that only the large trees/shrubs would be removed. Furthermore, that the PV panels will be mounted on a central pivot structure, above the natural vegetation and therefore no bulk earthworks are required thus replicating the natural 'pre-development' run-off criteria. Due to the fact that no bulk earthworks will be required, we believe that minimal stormwater measures will therefore be required. This could take the form of 'mitre' chutes in order to direct the natural flow if required.

It is noted that the Mean Annual Precipitation (MAP) for the Klipgats Pan Farm is ±193mm/year[6] which further substantiates the minimal need for stormwater management.

5.4 Road Drainage

As limited information has been provided in the Draft Scoping Report[7] surrounding road positions and road types, we have assumed that the bulk of the terrace roads and the main access road to the plant will be gravel roads.

To assist with the stormwater run-off, these gravel roads should typically be graded and shaped with a 2% crossfall back into the slope, allowing stormwater to be channelled in a controlled manor towards the sites, natural drainage lines and to assist with any sheet flow on the site.

Where any proposed roads, intersect the natural, defined drainage lines, it is suggested that either suitably sized pipe culverts or drive through causeways are installed / constructed and should take into account the hydrology criteria for a selected major storm as outlined in section 5.6 below.

Refer Appendix 'B' – 'Indicative PV Layout and Proposed Stormwater' (Dwg No 11134/305)
Refer Appendix 'B' – 'Indicative PV Layout and Proposed Stormwater' (Dwg No 11134/306)
Refer Appendix 'B' – 'Proposed Stormwater Details' (Dwg No 11134/307)

[5] AURECON Draft Scoping Report *(November 2011)* – *'Section 2.3.4 Figure 2.7'*
[6] Design Rainfall and Flood Estimation in South Africa by JC Smithers & RE Schulze
[7] AURECON Draft Scoping Report *(November 2011)*

5.5 Minor Storm

The minor storm design period should be used, to determine the size of the earth channels. A return period of 1:5 years is applicable which approximates to an average intensity of 29mm/hour[8].

5.6 Major Storm

The major storm occurrence i.e. 1:25 year, 1:50 & 1:100 year return should be used to calculate culverts in defined drainage lines and to determine flood levels where necessary. Intensities for each occurrence are as follows; 1:25 year – 45mm/hour, 1:50 year – 52mm/hour and 1:100 year – 60mm/hour[9] respectively.

Refer Appendix 'C' – 'Design Rainfall and Flood Estimation in South Africa by JC Smithers & RE Schulze'

6 Conclusion

It should be noted that an indicative PV layout has been proposed for the process of identifying any possible constraints associated with the management of stormwater on the site and that once the final layout of the site has been concluded, a re-evaluation of this proposal would be required to ensure alignment with the environmental scoping criteria.

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[8] Design Rainfall and Flood Estimation in South Africa by JC Smithers & RE Schulze
[9] Design Rainfall and Flood Estimation in South Africa by JC Smithers & RE Schulze

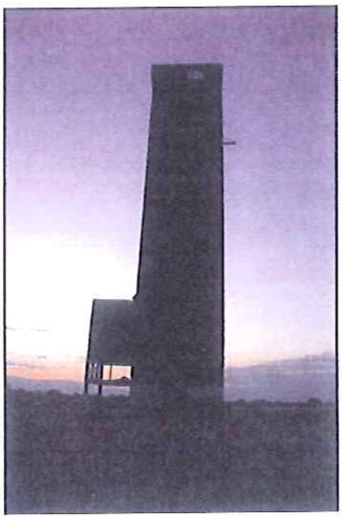
APPENDIX 'A'

GEOTECHNICS

MULILO RENEWABLE ENERGY AND YINGLI GREEN ENERGY HOLDING Co. LTD.

COPPERTON PV SOLAR PLANT

ON THE FARM VOGELSTRUISBULT 104



GEOTECHNICAL INVESTIGATION REPORT

AUGUST 2010

J623/VB

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AFRICA

CONTENTS

1.0 INTRODUCTION

In July 2010, Mr Dave Crombie of Arcus Gibb Consulting Engineers requested Geotechnics Africa Western Cape (GAWC), on behalf of Mulilo Renewable Energy and Yingli Green Energy Holding Co. Ltd, to prepare proposals and a cost estimate for a geotechnical investigation to be conducted near the Copperton mine on the farm Vogelstruisbult 104 in the North Western Cape. This quotation was accepted in principle and verbal instruction was received from Mr Crombie to proceed with the fieldwork.

This report presents the findings of the investigation, describes the general soil conditions and geology and makes recommendations in regard to drainage, excavatability of the strata within the top metre of the soil profile, site clearing and a visual assessment of the anticipated properties of the surficial soils in regard to trafficability and the preparation of the site for construction purposes.

2.0 INFORMATION SUPPLIED

Mr Crombie provided a set of Google Earth aerial images of the site showing the position of the proposed solar energy plant. In addition, a photograph without the overlay of the plant was obtained from Google's Digital Globe Tele Atlas, to enable the surface conditions on the site to be assessed.

The site was surveyed by Joubert and Brink Land Surveyors at the same time the geotechnical fieldwork was conducted. The resultant topographical survey data has been plotted at a scale of 1:500 on an unnumbered drawing obtained from Mr Warren Morse of Mulilo Renewable Energy. This drawing is presented in Figure 4.

In addition, GAWC consulted the following published maps:-

(i) 1: 250 000 Topocadastral Series

(ii) 1:250 000 Land Type Series

(iii) 1:250 000 Geological Series

All of the above maps are referenced, Sheet 2922 Prieska.

3.0 PROPOSED DEVELOPMENT

The proposed solar energy plant will have an output of 10MW that will be generated by 44000 230W Yingli solar panels covering a total area of approximately 17ha, i.e. 470m x 360m. A photograph of the existing pilot plant at the Alkantpan Village is included on Plate 2.

The panels will be supported on an aluminium frame that will be fixed to 300mm x 300mm pillars on 700mm x 700mm reinforced concrete bases that will be cast on a 100mm thick blinding layer at an average depth of 0,9m; the foundations are designed mainly to cater for wind uplift.

4.0 THE SITE

4.1 Site Location

The area of investigation lies approximately 3km south-east of the Copperton mine and occupies an open piece of veld that extends north of the Vanwyksvlei road, west of the road to the Alkantpan Lodge and village, and east and south of the two access roads to the mine, see Figures 2 and 3.

4.2 Site Description

4.2.1 Topography

The site has a very gentle fall of approximately 4m from south to north at an average gradient of about 1:120 (maximum 1:60 and minimum 1:160).

The highest point on the site is on the south-west corner, which is close to the survey beacon located diagonally opposite the entrance gate on the Vanwyksvlei road.

4.2.2 Drainage

There are a number of very poorly defined drainage lines to the north of the site; these are barely discernible on the ground, but can be traced on the aerial photograph, see Figure 3.

It is understood that flooding of the mine during flash floods necessitated stormwater control measures to be implemented; these took the form of soil berms placed across the drainage lines to the north of the site, see Figure 2.

4.2.3 **Power Lines**

There are two power lines that pass the south-west corner of the site. A vehicle track approximately follows these lines to the mine and its northern and southern access roads.

4.2.4 **Railway Line**

The discontinued railway line that runs parallel to, and south of the Vanwyksvlei road, passes through a cutting approximately along the entire width of the site, see Plate 11. It attains a maximum depth of about 3m in the vicinity of the survey beacon, see Plate 2.

4.2.5 **Old Borrow Pits**

There are a number of shallow borrow pits along the southern perimeter of the site, Plates 2 to 4. These surface scrapings, which provided a source of calcrete gravel, presumably for the construction of the Vanwyksvlei road, are delineated on the aerial photograph in Figure 3.

4.2.6 Animal Burrows and Termite Mounds

Animal burrows inhabited mainly by nocturnal mammals, e.g. aardvark, jackal and porcupine, are scattered across the site. These occur in areas of relatively easy excavation or where solutional hollows in the hardpan calcrete surface have afforded these animals access to the underlying less calcretised material, see Plates 9 and 10.

5.0 FIELD INVESTIGATION

Mr Mike Meyer of the Request Trust supervised the manual excavation of six test pits aided by a Cango-hammer. The approximate positions of the pits are shown on the attached aerial photograph in Figure 3.

Photographs of the site and relevant surface features are presented on Plates 1 to 17 in Appendix A.

The descriptions of the soil profiles have been based on standard terminology recommended by Jennings *et al* (Ref 1). In order to obtain a permanent visual record of the soil profiles, the strata encountered and their detailed descriptions are depicted on photographs presented on Plates 18 to 23 in Appendix B.

Indicator samples have been taken of the dominant soil horizons; however, these will only be tested if required for the design and construction phase of the development.

6.0 GEOLOGY

6.1 General

The geology of the region comprises gneissic rocks, and highly metamorphosed sedimentary and volcanic rocks, which include amphibolite of the Copperton Formation; all of these rocks fall within the Central Zone of the Namaqua Metamorphic Province.

Economic copper mineralization gave rise to the establishment of the Copperton mine on the farm Vogelstruisbult. This copper-zinc sulphide ore body sustained extraction by the Prieska Copper Mines Ltd in 1967. The reserves dwindled, which brought mining that lasted for almost 30 years, to an end.

The geology exposed in the railway cutting to the south of the site is highly variable, ranging from strongly deformed granitoid and foliated amphibolite gneisses with several intrusions of younger dyke material, see Plates 12 to 14.

Preserved in depressions, scoured into the much older Namaqua Province bedrock surface, are highly to completely weathered remnants of Dwyka tillite, which is a glacial deposit. The photos on Plates 15 to 17 show the unstructured nature of the tillite, with clasts (fragments of rock contained in the fine grained rock mass) of various shapes, sizes and origins, that were ripped up and abraded by ice sheets that once traversed the continent. More weather-resistant crystalline veinlets of secondary minerals can be seen projecting from the eroded face of the embankment formed in the tillite deposit, see Plate 16.

A thin veneer of reddish wind-blown Kalahari sand and calcrete of Tertiary age obscures the highly deformed rocks of the Namaqua Metamorphic Province.

6.2 Strata Encountered

The following generalised soil profile has been compiled from the detailed descriptions of the six test pit exposures presented on Plates 18 to 23 in Appendix B; these should be read in conjunction with the summary of strata encountered presented in the attached table.

Transported Horizon: A less than 0,2m thick red-brown predominantly loose intact silty to slightly silty fine and medium SAND with abundant to scattered calcrete nodules and gravel.

Concretionary Calcrete: This 0,2m to 0,45m thick pedogenic horizon was intersected in TP3 to TP6 and comprises abundant fine, medium and coarse sub-rounded to rounded GRAVEL of mixed origin and calcrete NODULES in a little pale brown to pale reddish-brown loose to medium dense intact silty SAND matrix. A layer of larger concretions and calcrete boulders is considered to represent a weathered partially broken down hardpan calcrete horizon.

Powder Calcrete: This off-white to pale grey-white stiff to very stiff intact to thinly striated sandy clayey calcrete SILT to calcareous sandy SILT with some calcrete nodules and concretions, underlies the concretionary calcrete horizon in TP3 to TP6. Excavation was stopped in this stratum at depths ranging from 0,6m to 1,0m below ground level.

Hardpan Calcrete: This stratum could only be excavated with the aid of a Cango-hammer; it comprises a cream-coloured to off-white medium hard rock to hard rock HARDPAN CALCRETE, which contains occasional thin silcrete layers and lenses; it may also be closely to medium fractured, however, this was only encountered in isolated areas.

7.0 Groundwater

The up to 3m deep railway cutting on the south side of the site confirms that the water table is not present at a shallow depth.

8.0 EVAULATION AND RECOMMENDATIONS

8.1 Site Clearing and Grading

Since there is hardly an organic layer at the surface, site clearing would only entail the removal of the vegetation. However, the surface horizon would have to be scarified to remove all the scrub roots where necessary.

Levelling of the surface will be required where the solar panel modules will extend over the shallow borrow pits along the Vanwyksvlei road. Material may not have to be imported to fill these depressions if the surface can be graded to soften the side slopes to acceptable gradients.

Special attention should be paid to the detection of animal burrows before commencing with any site clearing operations. These cavities would have to be treated and appropriately backfilled where they coincide with the foundations. They would have to be properly exposed and backfilled with engineered fill or mass concrete to eliminate the risk of subsidence of the foundations.

8.2 Excavation

The thin veneer of transported sand, the concretionary calcrete and powder calcrete horizons can be readily excavated by hand. The honeycomb and hardpan ferricrete strata will require pneumatic tools to facilitate and expedite manual excavation.

A standard tractor-mounted loader-backactor (TLB) should be capable of excavating into the very soft rock and soft rock hardpan calcrete. However, a heavy track-mounted excavator, equipped with a ripper bucket would have to be used to dig into the medium hard rock to hard rock hardpan calcrete. Provision should be made for the use of pneumatic tools, including a Montebert, to expedite excavation in the medium hard rock and hard rock calcrete horizons.

The sides of temporary excavations should stand vertically without any support under dry conditions; however, collapse of their sides may result when disturbed or subjected to erosion during heavy rains and/or flash floods. If appropriate drainage precautions are taken, shuttering of the foundation and services excavations will not be necessary.

8.3 Groundwater and Drainage

The depressions along the southern boundary would have to be graded to prevent ponding of run-off. Water is unlikely to drain away due to the practically impervious hardpan calcrete horizon exposed in these depressions.

The fact that the railway cutting is dry and unaffected by groundwater confirms that the permanent water table is deeper than 3m and will therefore not affect development of the site.

Conditions are favourable for the development of a shallow perched water table; however, the arid climate environment makes this highly unlikely.

8.4 Foundations

In view of the very light loads of the solar modules, all the strata observed in the test pits and nearby cuttings will be suitable to support their foundations. However, special care should be taken to ensure that the foundations are not underlain by relic termite chambers or animal burrows. The foundation excavations should therefore be probed in an attempt to detect any cavities; where encountered, they should be exposed and backfilled, either with engineered fill or mass concrete.

8.5 Aggressive Ground Conditions

Close inspection of ferrous-based metal objects that have been lying on the surface and remained in contact with the soil for a considerable time show very little signs of corrosion.

The waste rock from the mine, on the other hand, is high sulphides, which even in small quantities impart deleterious properties under certain conditions. In the presence of oxygen and water, the sulphide minerals oxidise to ferrous sulphate, which generates sulphuric acid.

It is therefore important that tests be conducted and the advice of a specialist in this field be sought, i.e. if the dump rock will be considered as a source of hard aggregate. The assumption of the dump rock's corrosive tendencies is supported by corroded pieces of iron found in the railway ballast in the cutting, see Plate 11.

9.0 REFERENCE

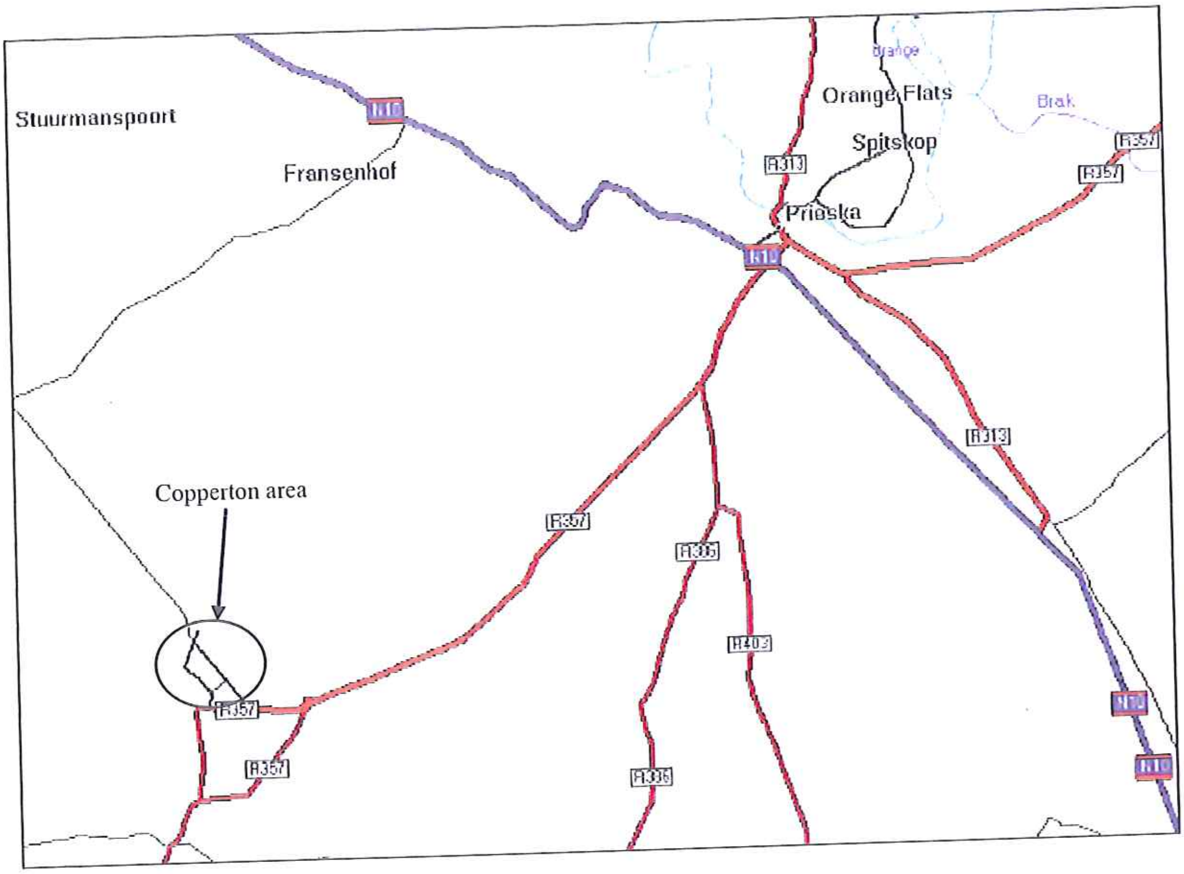
Jennings JE et al (1973). Revised Guide to Soil Profiling for Civil Engineering Purposes in Southern Africa. The Civil Engineer in South Africa, January 1973.

GEOTECHNICS AFRICA WESTERN CAPE

DJ VAN ROOYEN (Pr.SciNat)
Engineering Geologist

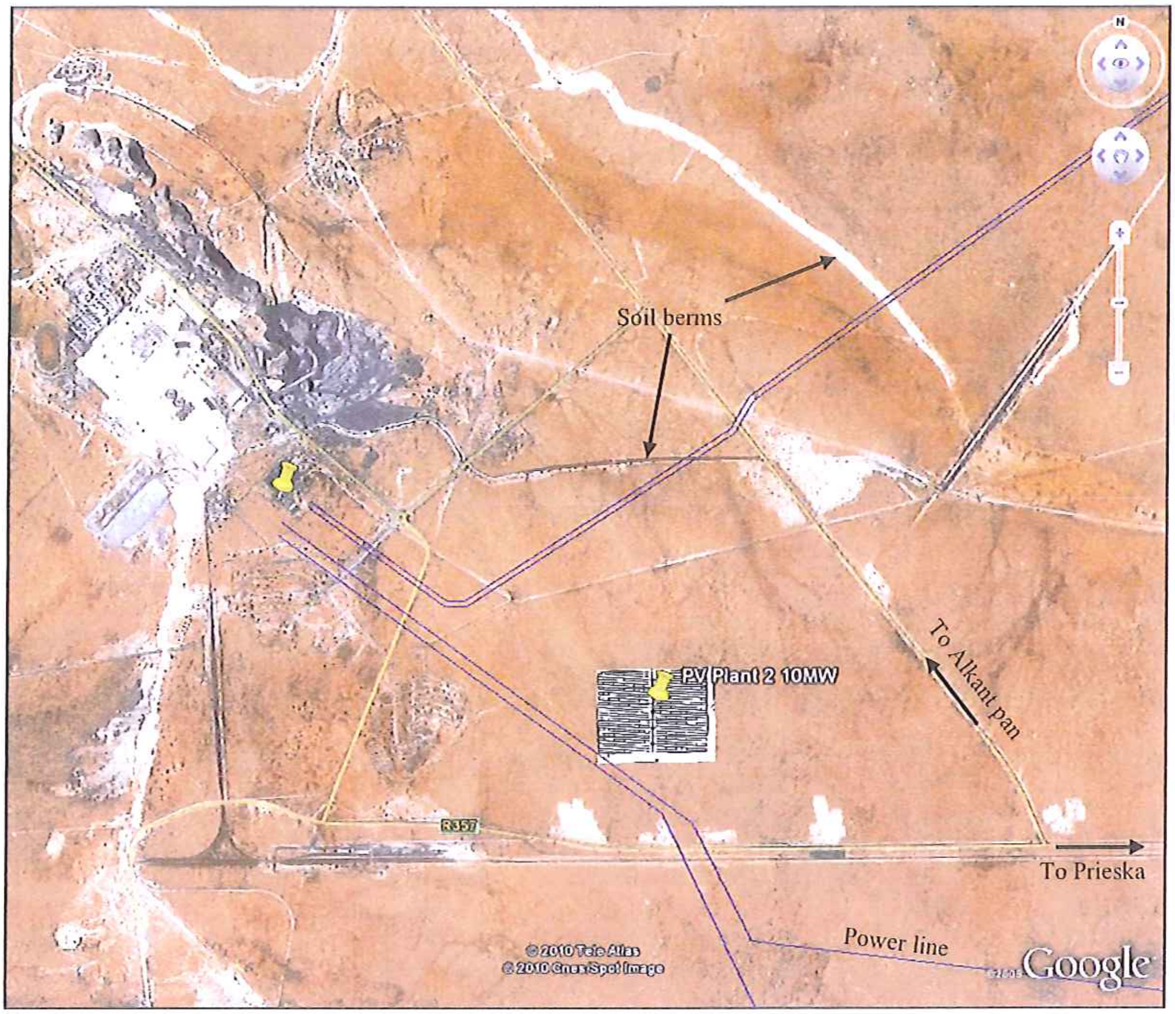
TABLE: SUMMARY OF STRATA ENCOUNTERED

TEST PIT NO	TRANSPORTED	PEDOGENIC			STRATUM AT DEPTH OF TEST PIT
		CONCRETIONARY CALCRETE	POWDER CALCRETE	HARDPAN CALCRETE	
TP1	**0,0-0,2** (0,2) Abundant sub-rounded to rounded GRAVEL of mixed origin in red-brown loose to medium dense intact slightly silty fine and medium SAND.	-	-	**0,2-0,5** (0,3) Cream-coloured to off-white medium hard rock HARDPAN CALCRETE; closely to medium fractured and discontinuous in places. Note: Contains pockets of transported gravel and sand below 0,3m.	**At 0,5** Indurated surface of hard rock HARDPAN CALCRETE.
TP2	**0,0-0,1** (0,1) Red-brown loose to medium dense intact silty fine and medium SAND with some calcrete concretions and sub-angular to rounded gravel of mixed origin.	-	-	**0,1-0,4/0,5** (0,3/0,4) Cream-coloured to off-white soft rock to medium hard rock HARDPAN CALCRETE with thin bands hard rock to very hard rock silcrete. Note: Contains pockets of sub-rounded calcrete.	**At 0,4/0,5** Hard rock HARDPAN CALCRETE
TP3	**0,0-0,05/0,1** (0,05/0,1) Reddish-brown medium dense intact silty fine and medium SAND with some fine and medium sub-rounded to rounded gravel and calcrete nodules.	**0,05/0,1-0,5** (0,4/0,45) Small, medium and large calcrete BOULDERS in a pale brown medium dense to dense intact calcareous silty fine and medium SAND matrix.	**0,5-1,0** (0,5) Off-white to pale grey-white stiff to very stiff powder CALCRETE (sandy clayey SILT) with some predominantly fine and medium calcrete NODULES and CONCRETIONS.	-	**At 1,0** Powder calcrete with relics of highly weathered intensely fractured friable amphibolite schist.
TP4	**0,0-0,1** (0,1) Red-brown loose intact slightly silty fine and medium SAND with scattered gravel and occasional calcrete nodules.	**0,1-0,3** (0,2) Abundant fine, medium and coarse calcrete BOULDERS and some gravel and coarse calcrete concretions in a pale brown, medium dense intact slightly calcareous silty SAND matrix.	**0,3-0,65** (0,35) Off-white very stiff intact sandy SILT with some calcrete nodules.	-	**At 0,65** Very stiff powder calcrete with occasional gravel and cobbles.
TP5	**0,0-0,1** (0,1) Red-brown loose intact fine and medium SAND with occasional fine calcrete nodules and traces of gravel.	**0,1-0,3** (0,2) Abundant fine medium and coarse sub-rounded to rounded GRAVEL and calcrete NODULES and CONCRETIONS in a little pale reddish-brown loose to medium dense intact silty SAND matrix.	**0,3-0,7** (0,4) Off-white very stiff thinly striated sandy SILT with some calcrete nodules.	-	**At 0,7** Very stiff powder calcrete.
TP6	**0,0-0,05** (0,05) Reddish-brown loose intact silty fine and medium SAND with a little calcrete nodules and gravel of various origins.	**0,05-0,3** (0,25) Abundant small and medium calcrete BOULDERS, CONCRETIONS and NODULES with some gravel in a pale brown medium dense intact calcareous silty SAND matrix.	**0,3-0,6** (0,3) Angular to sub-rounded GRAVEL and some calcrete concretions in an off-white very stiff intact calcareous SILT-SAND matrix.	-	**At 0,6** Very stiff intact calcareous SILT-SAND and calcrete CONCRETIONS.



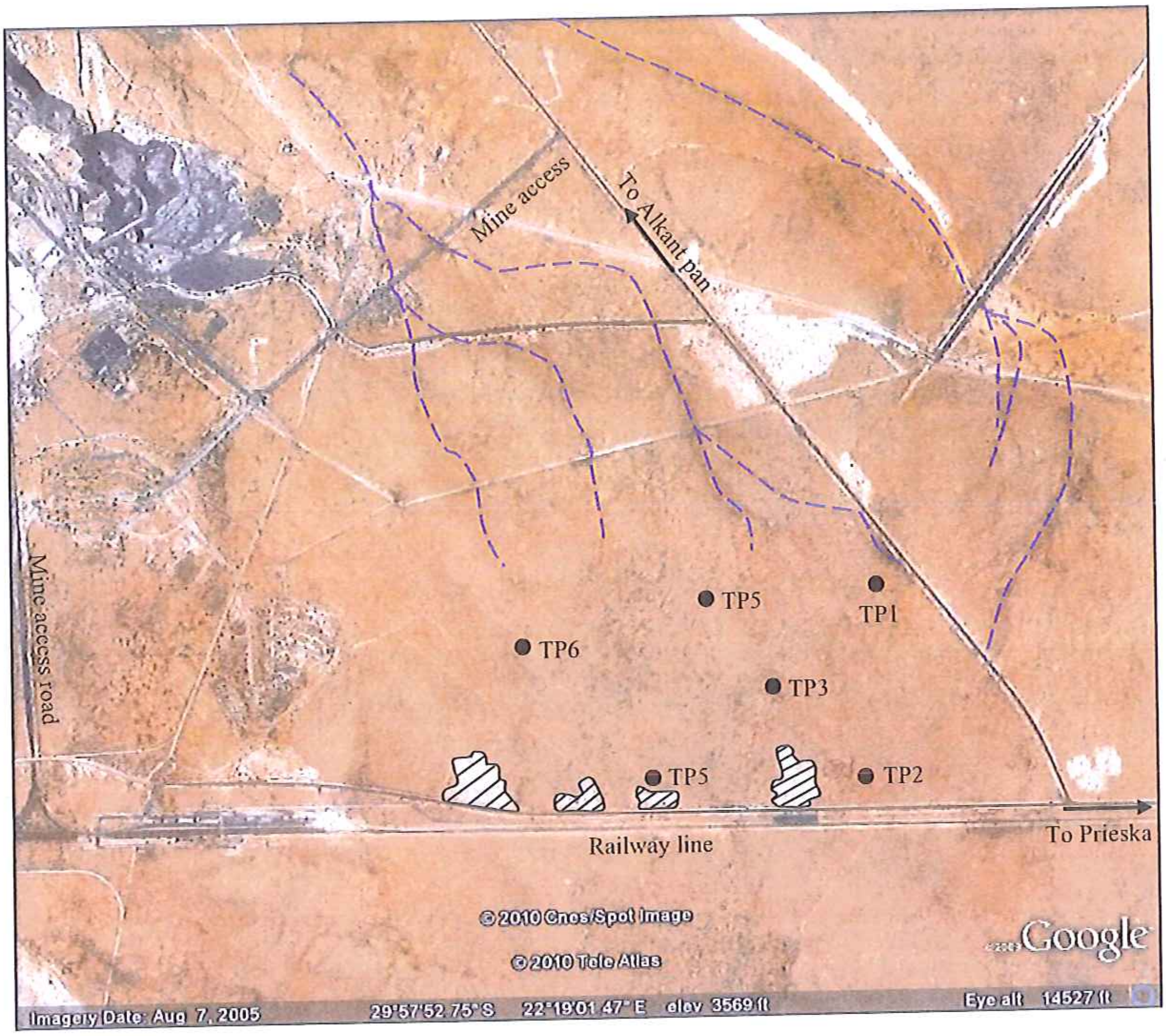
VOGELSTRUISBULT, COPPERTON SOLAR PLANT
SITE LOCATION PLAN
FIGURE 1

J623/VB



VOGELSTRUISBULT, COPPERTON SOLAR PLANT
PROPOSED 10MW PV PLANT 2

J623/VB FIGURE 2

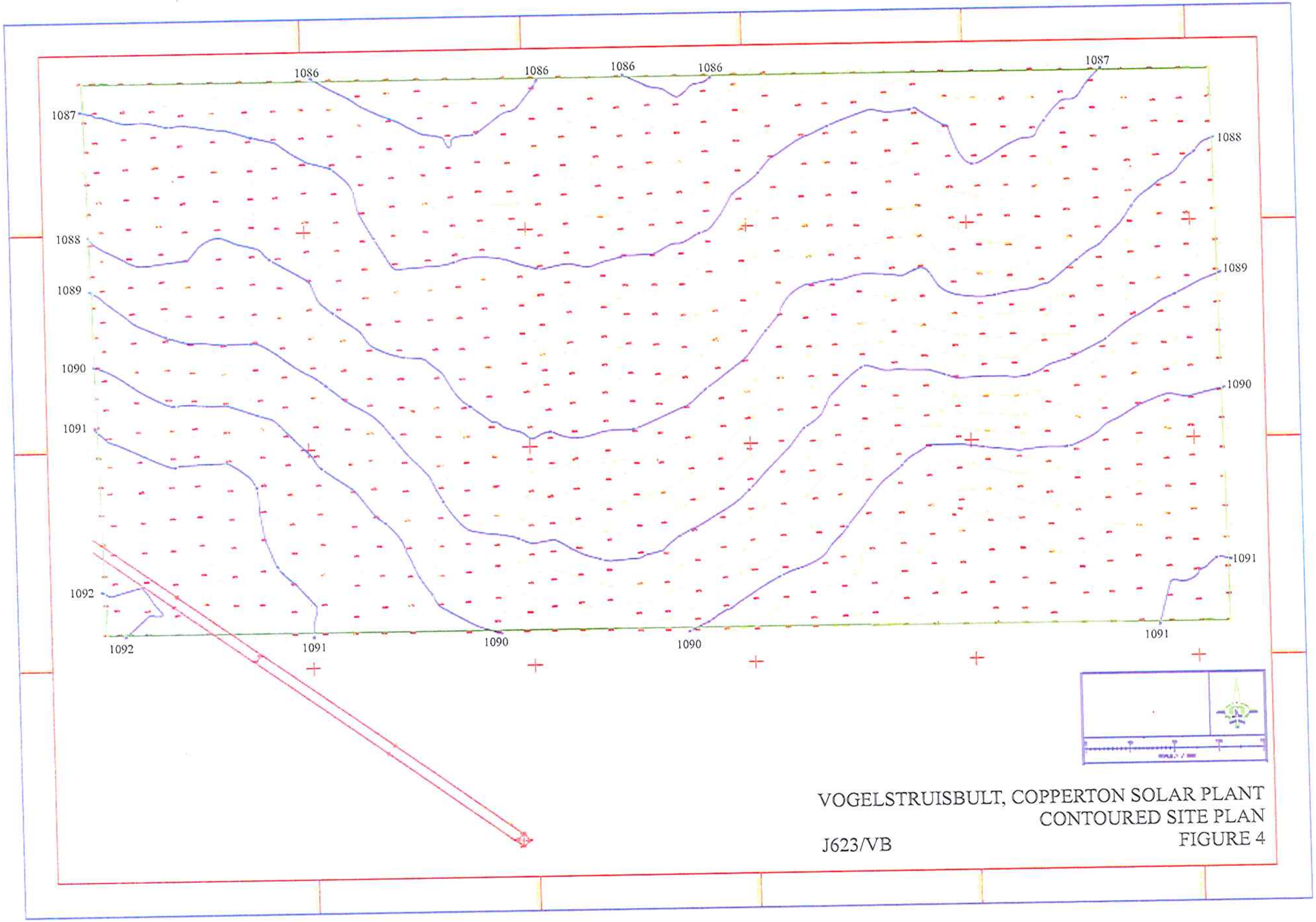


LEGEND

- TP5 Approximate test pit positions
- Shallow calcrete borrow pits
- Drainage lines

VOGELSTRUISBULT, COPPERTON SOLAR PLANT
AERIAL PHOTOGRAPH
FIGURE 3

J623/VB



VOGELSTRUISBULT, COPPERTON SOLAR PLANT
CONTOURED SITE PLAN
FIGURE 4

J623/VB

APPENDIX A

PLATES 1 to 17

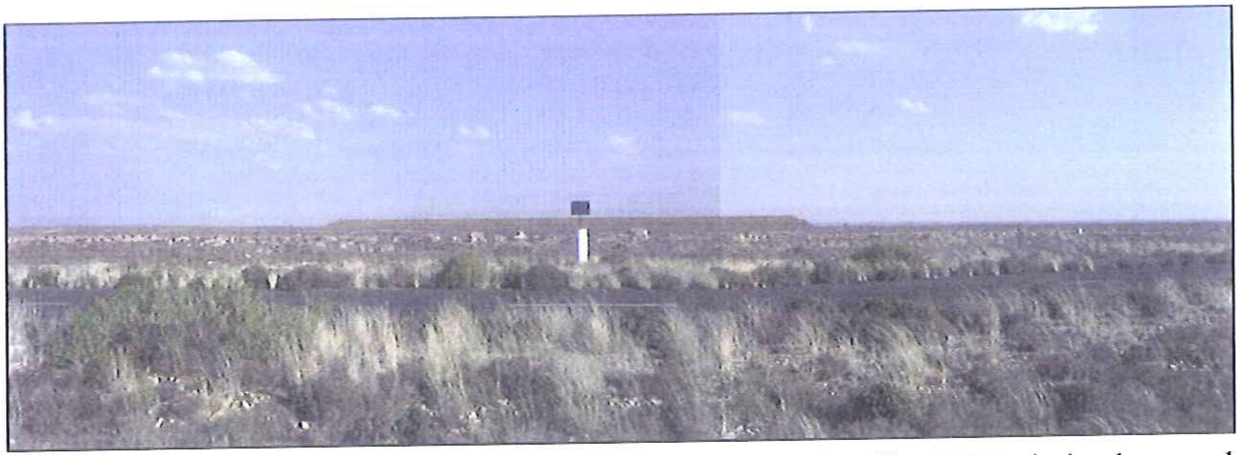
PHOTOS OF SITE FEATURES

Pilot PV solar plant similar to the one to be erected on the site.

Foundations and aluminium frame supporting solar panel modules.

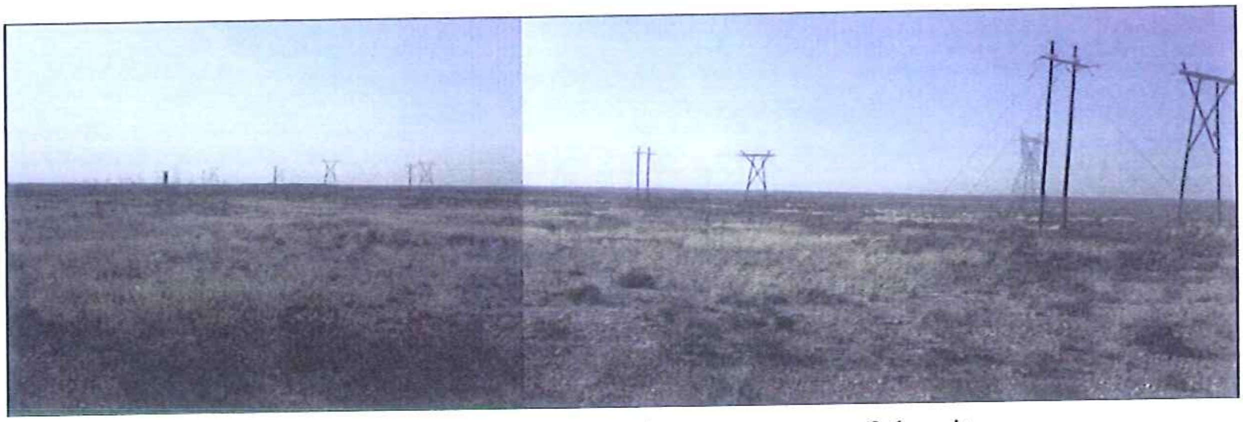
The site viewed from the entrance gate on the southern boundary with shallow calcrete borrow pit in foreground.

Above borrow pit viewed from the north.



Trig beacon on opposite (south) side of Vanwyksvlei Road; tailings dam in background.

Shallow borrow pit next to Vanwyksvlei Road on the south-west corner of the site.

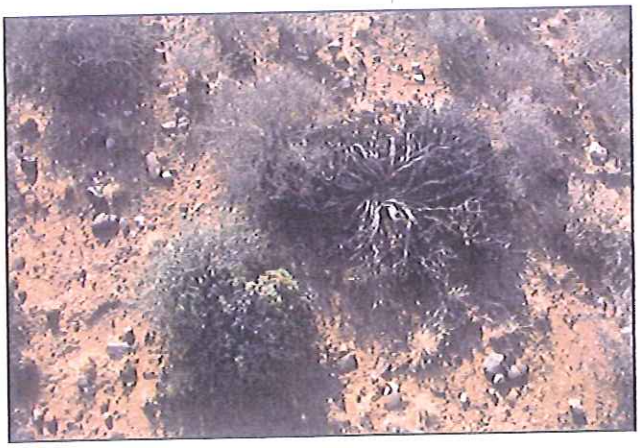
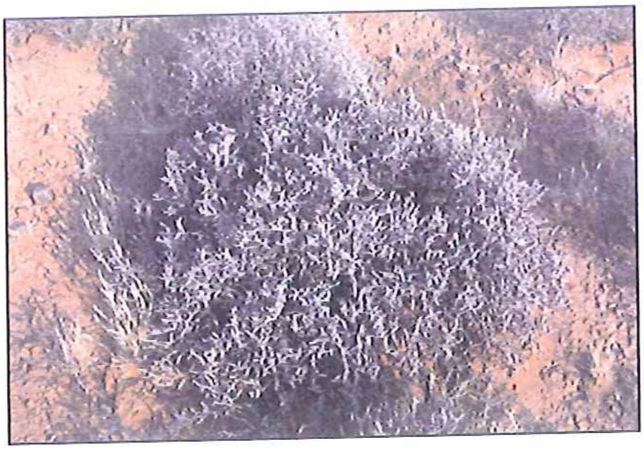


Power lines passing the south-west corner of the site.

Hardpan calcrete exposed in the shallow borrow pit, where layers of concretionary calcrete and gravel of mixed origins have been scraped from the surface, presumably for road construction purposes.

Relic amphibolitic bedrock pieces cemented in hardpan calcrete horizon exposed in shallow borrow pit.

PLATE 4

Typical vegetation comprising a variety of karroid scrub.

Stand of taller more dense karroid scrub in area of thicker sand cover, possibly relic of ancient termite mound, also referred to as a hillock.


Patch of tufted grass amongst the scrub surrounding test pit, TP2.

Typical windblown sand cover supporting more dense scrub and grass cover.

Barren gravel patches where thin sand veneer had been eroded by wind.

PLATE 6

Small dolomite boulders (transported) containing thin random layers and lenses of less soluble fine grained chert giving it a crinkled appearance, hence the term "elephant skin" weathering. These carbonate rocks may have contributed to the accumulation of pedogenic calcrete.

PLATE 7

Calcrete concretions and calcrete coated gravel of mixed origin cemented to honeycomb calcrete.

Transition of honeycomb calcrete to hardpan calcrete.

Partially coalesced concretionary calcrete.

Calcrete-cemented gravel forming thick hardpan horizon.

PLATE 8

Animal burrows formed in transported sand and gravel horizon.

Animal burrow extending beneath hardpan calcrete capping layer.

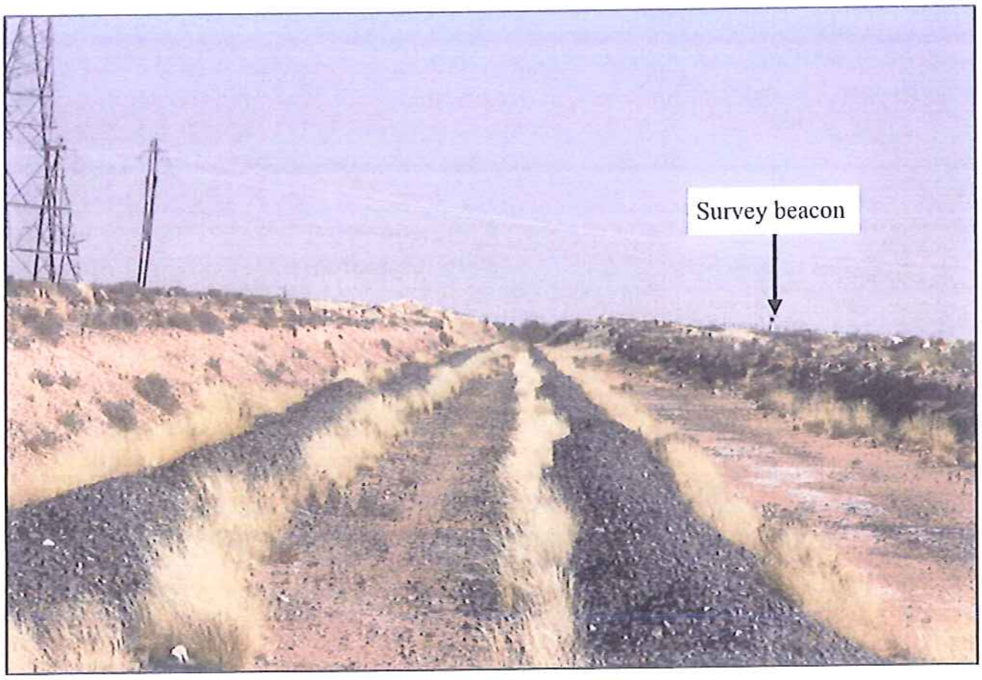
Animal burrow formed in concretionary calcrete horizon.

Close-up of concretionary calcrete horizon.

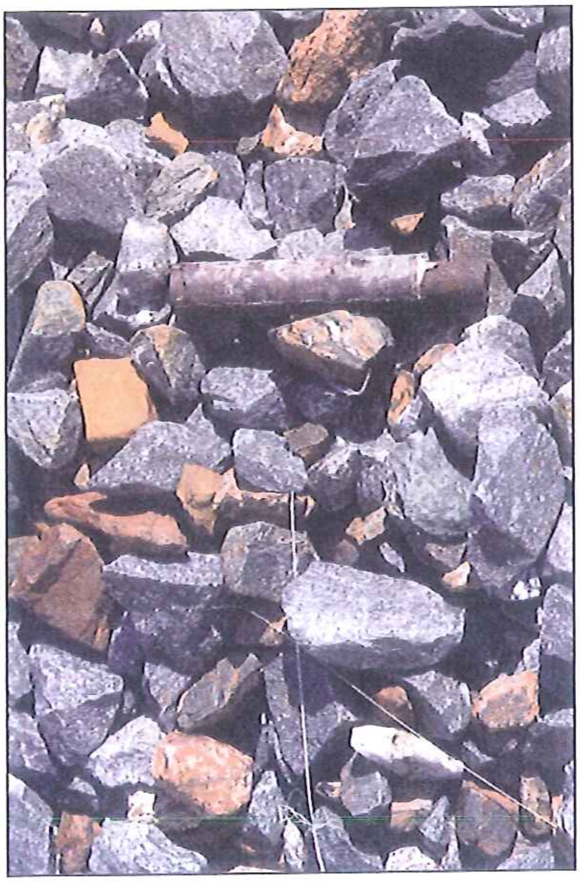
Opening to solutional hollow beneath hardpan calcrete horizon.

Solutional hollows in hardpan calcrete surface utilized by burrowing animals to access 'softer' horizon beneath the hardpan layer.

PLATE 10



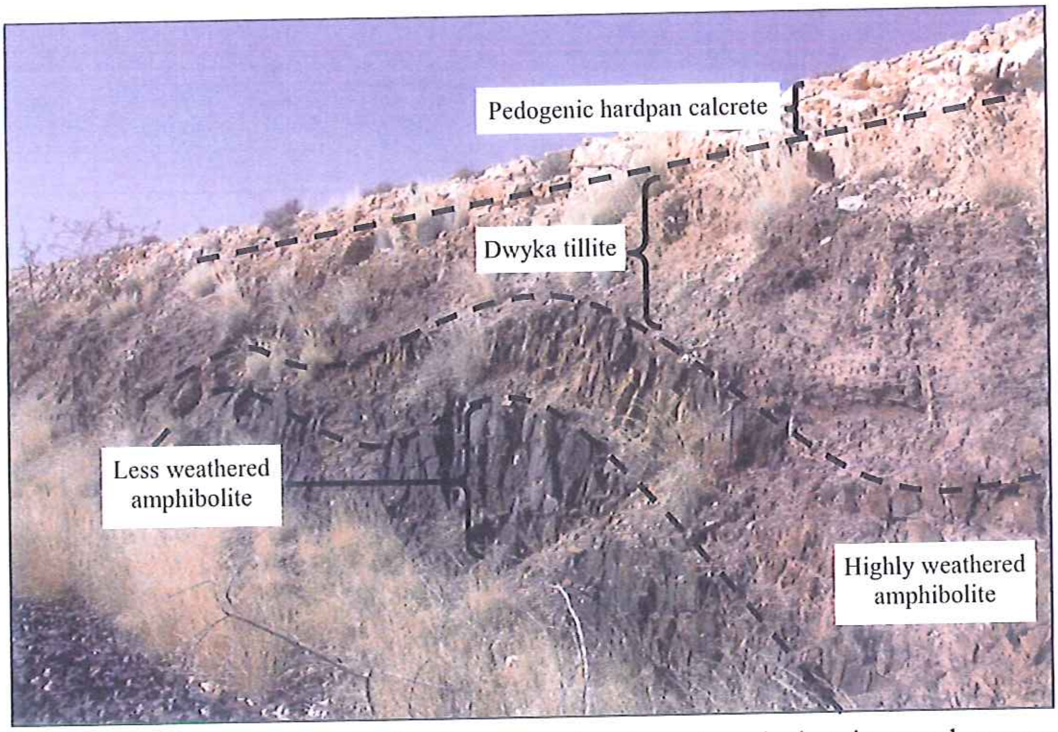
Disused railway cutting running parallel to Vanwyksvlei Road.



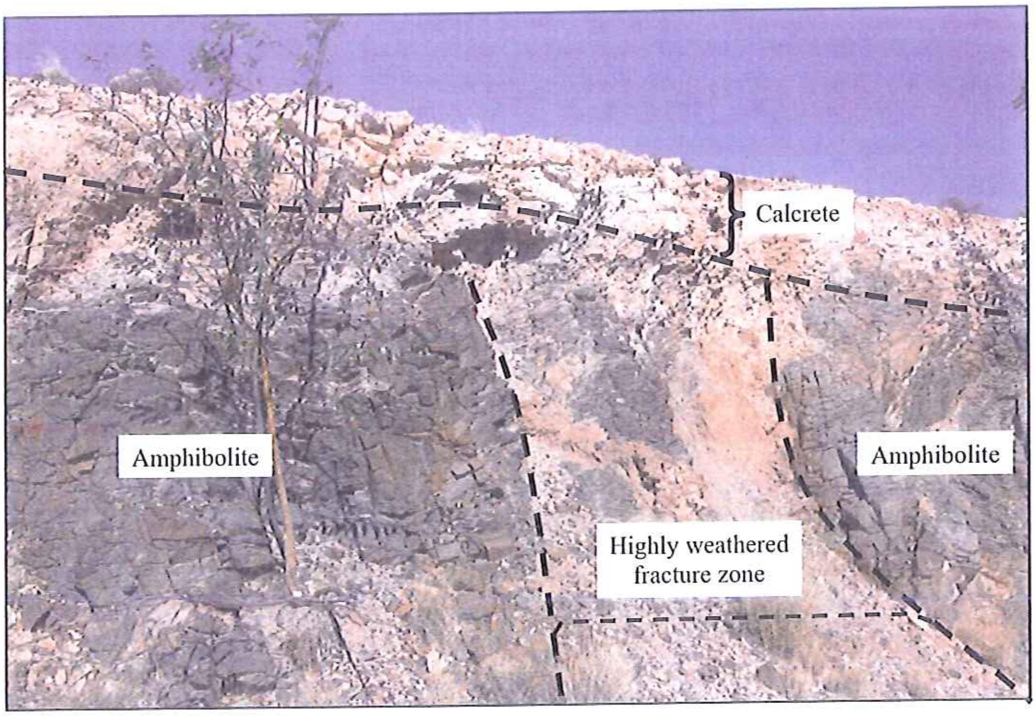
Dumo rock, used as railway ballast; rich in sulphides, hence corrosion of metal objects that have been exposed to this material for some time.

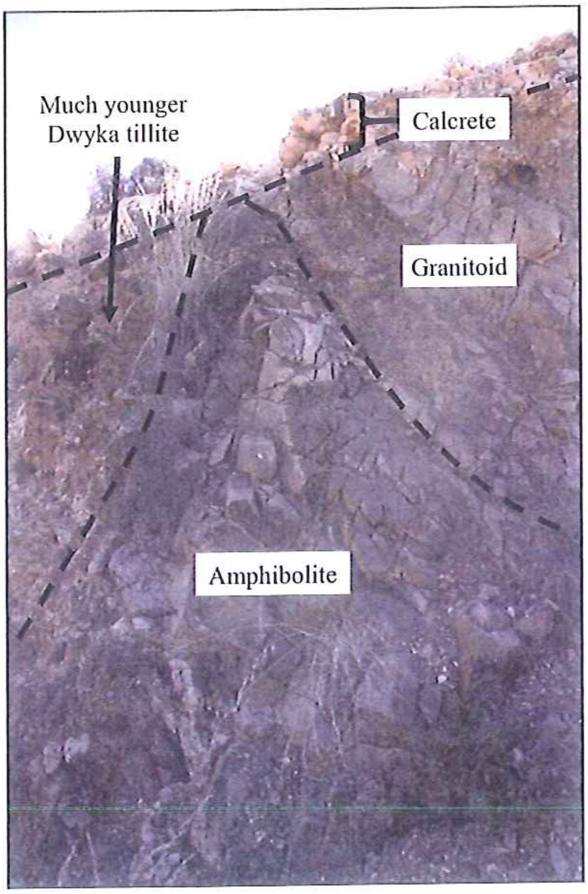
PLATE 11

Highly fractured granitoid gneiss exposed in railway cutting near trig beacon.



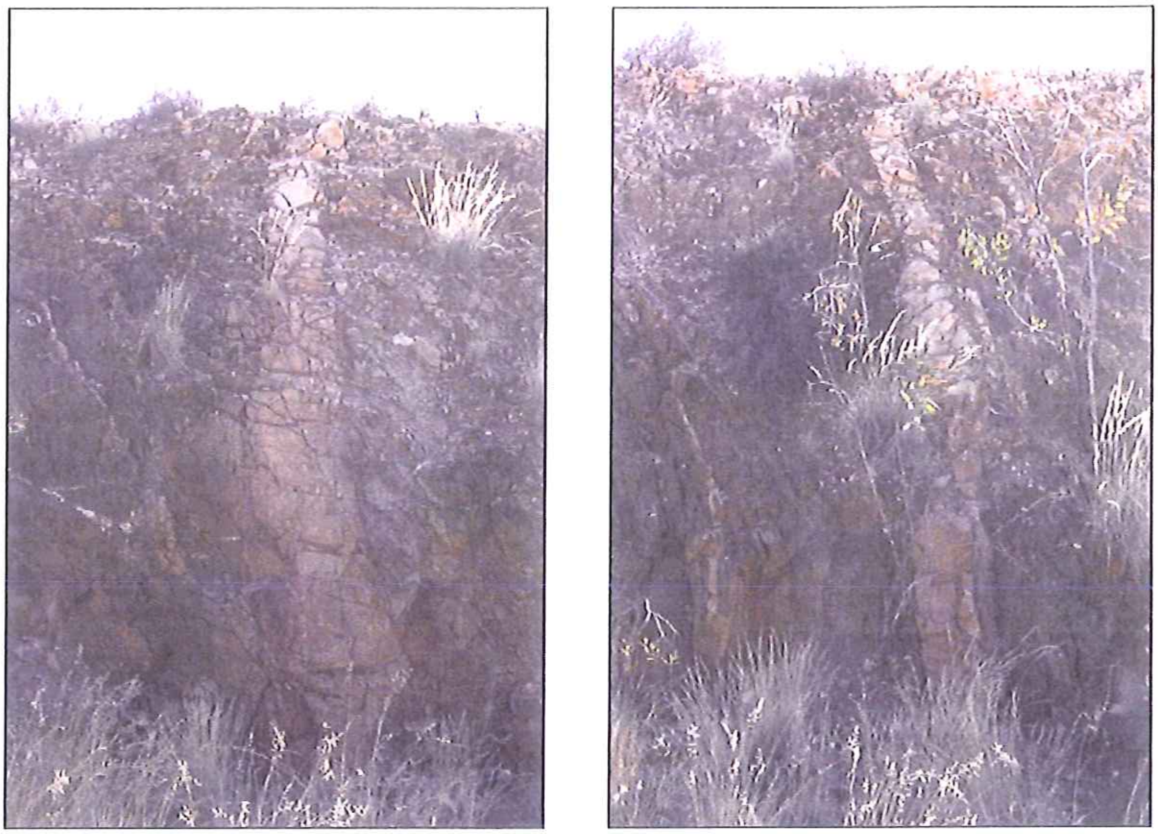
Typical profile showing weathering of bedrock and variation in much younger Dwyka tillite deposit covered by pedogenic calcrete capping layer.





Differential weathering of different rock types.

PLATE 13

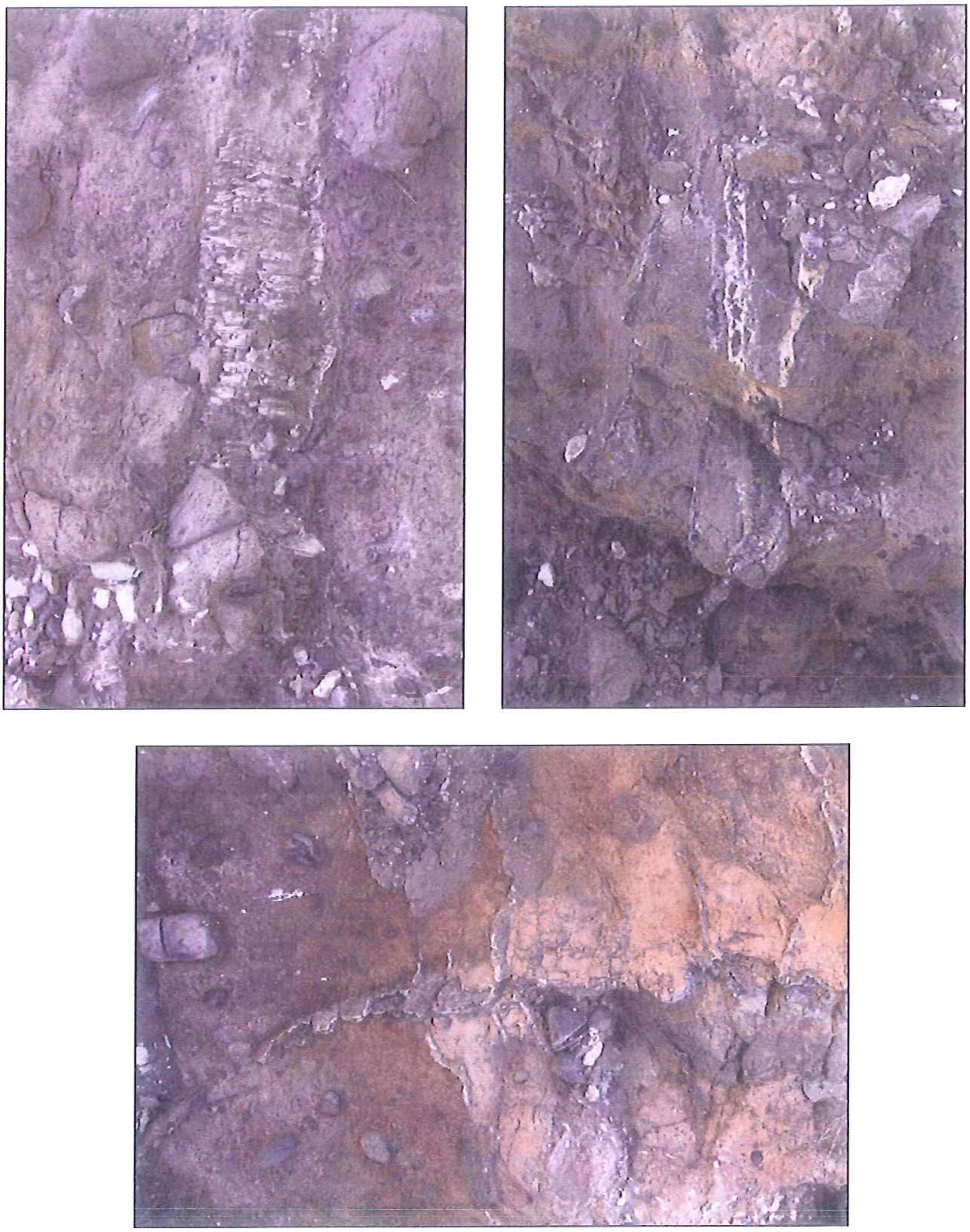


Paler dyke intrusive into amphibolite.

Drag fold on left hand side of intrusive dyke.

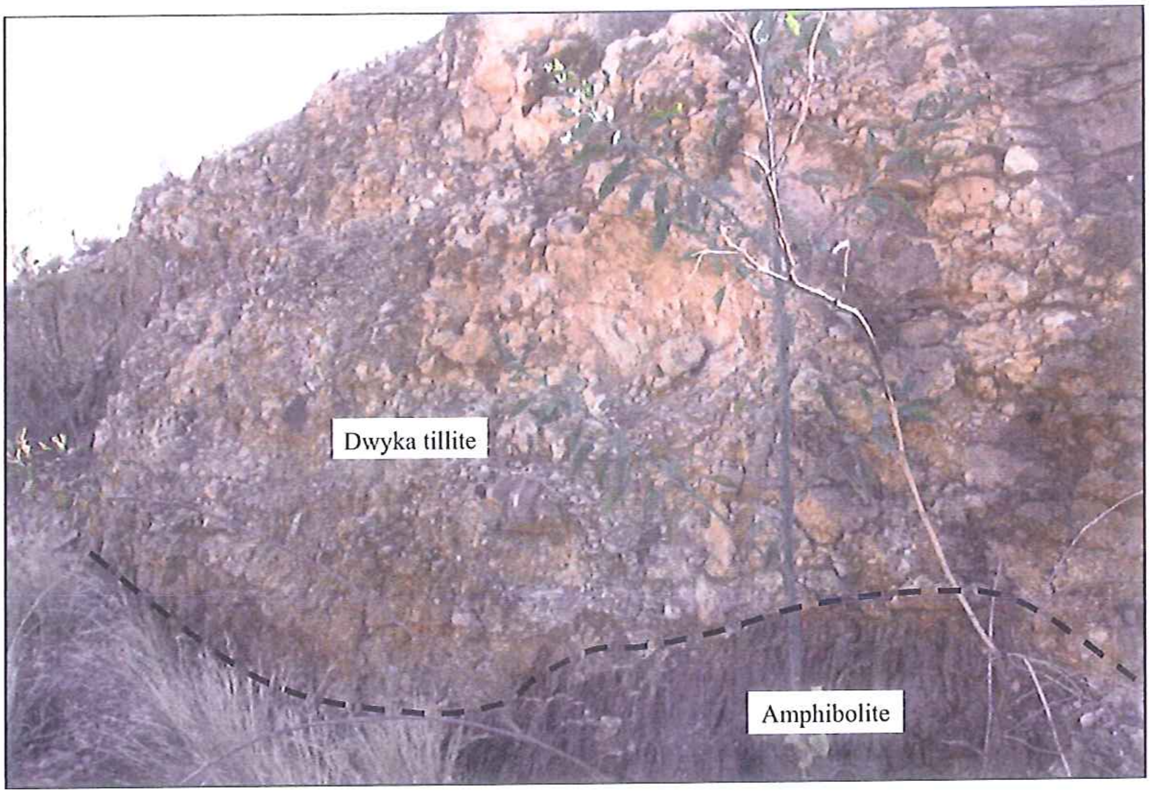
Completely weathered much younger Dwyka tillite with poorly sorted angular to sub-rounded clasts of various origins.

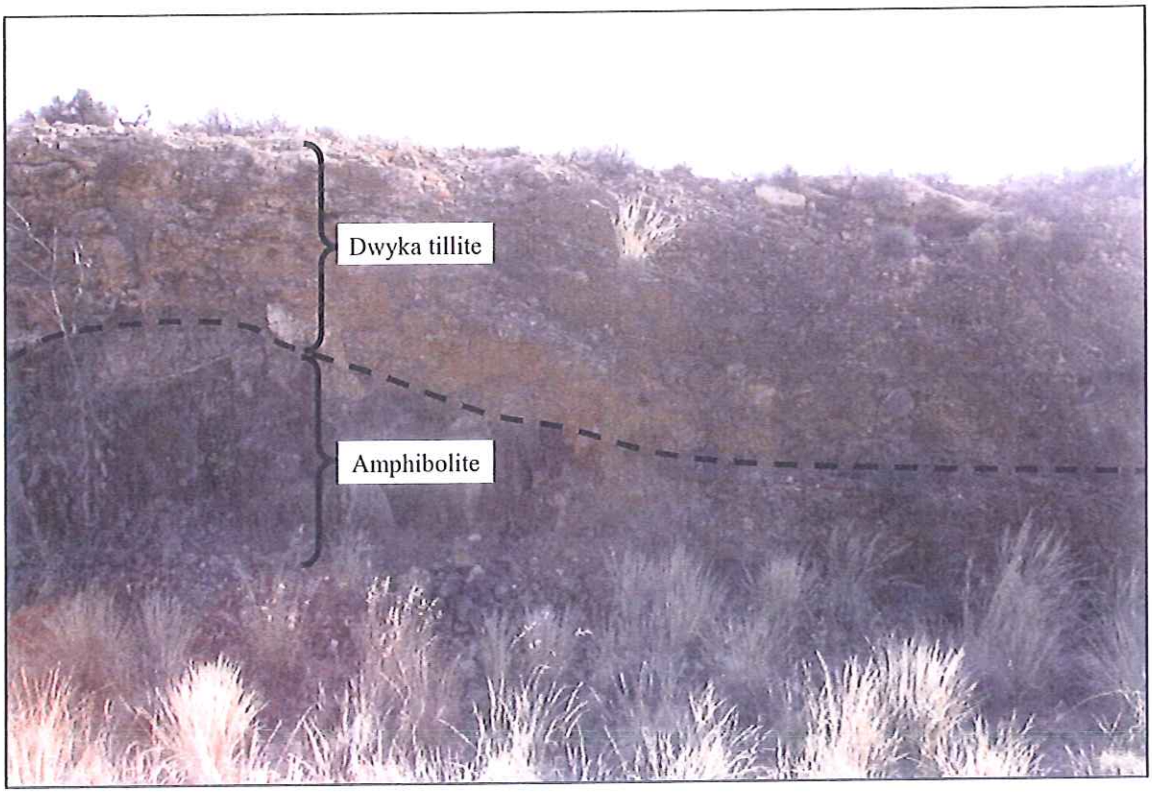
PLATE 15



Close-ups of crystalline veinlets in completely weathered Dwyka tillite shown on Plate 15.

PLATE 16





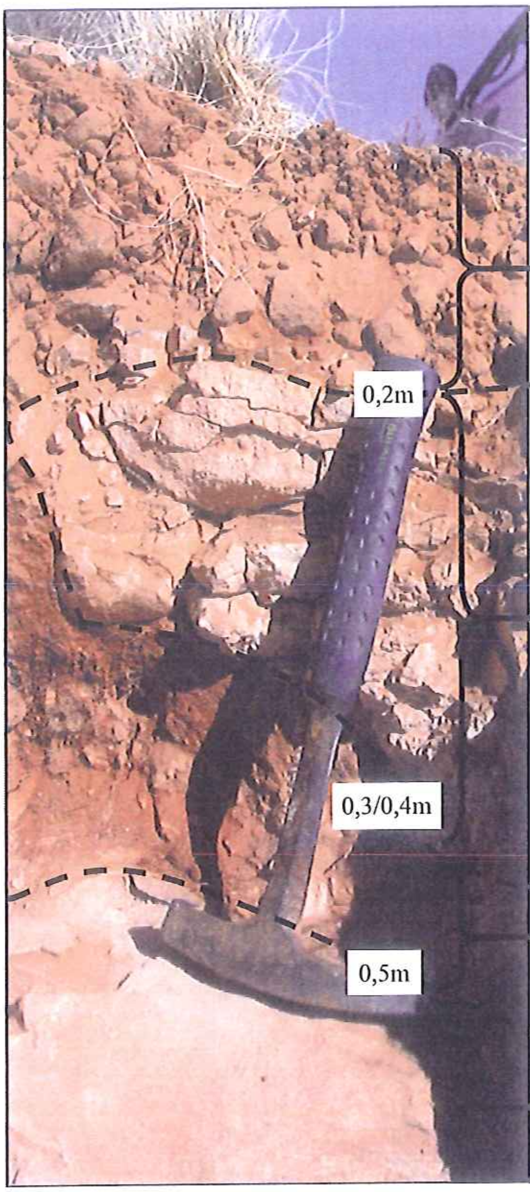
Calcretised completely weathered Dwyka tillite over amphibolite gneiss.

PLATE 17

APPENDIX B

PLATES 18 to 23

PHOTOS OF TEST PIT EXPOSURES DEPICTING SOIL PROFILES



Abundant sub-rounded to rounded fine medium and course GRAVEL of mixed origins in a little dry to slightly moist red-brown, loose to medium dense intact slightly silty fine and medium SAND. Transported.

Cream-coloured to off-white medium hard rock HARDPAN CALCRETE closely to medium fractured and discontinuous in places.
Note: Displays signs of weathering and breakdown of earlier solid hardpan calcrete.

As above but with pockets of sand and gravel (possibly old infilled animal burrow).

Indurated solid surface of hard rock HARDPAN CALCRETE.
Note: Jackhammer penetrated surface but could not break up hardpan layers into smaller pieces.

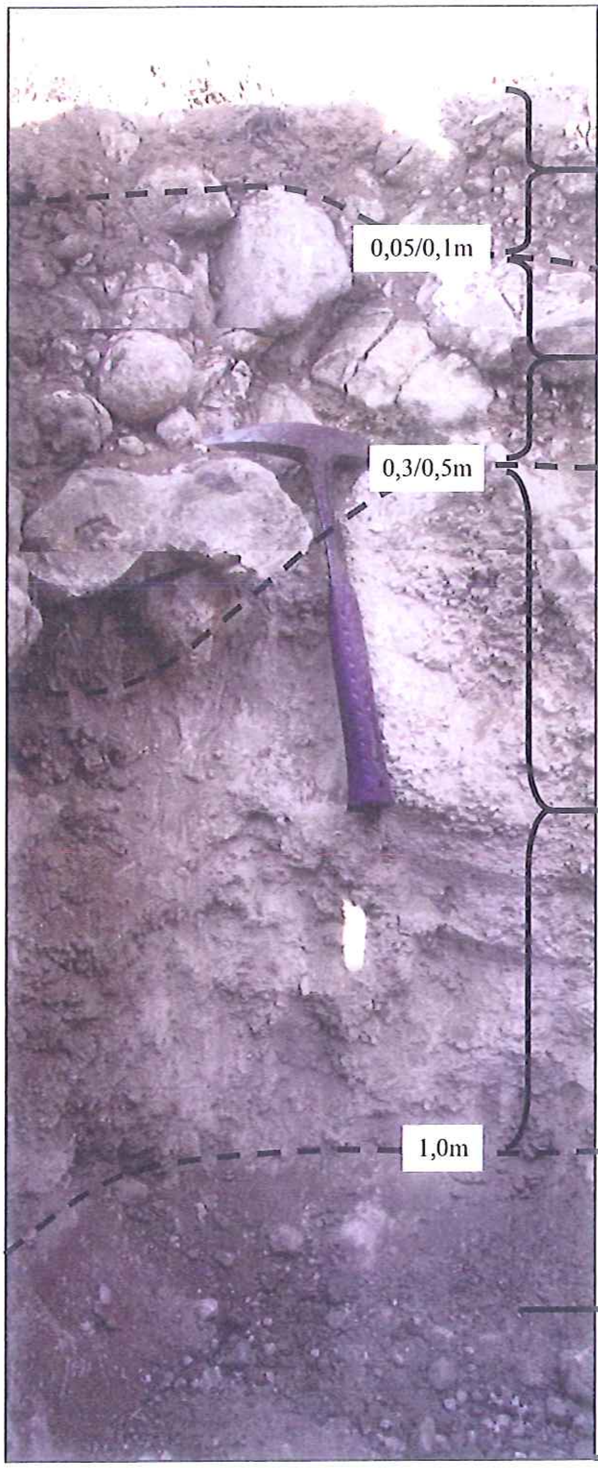
TP1: Strata encountered in 0,5m deep test pit.

Dry to slightly moist red-brown loose to medium dense intact silty fine and medium SAND with some calcrete nodules and sub-angular to rounded gravel. Transported.

Cream-coloured to off-white soft rock to medium hard rock HARDPAN CALCRETE with thin bands of very hard silcrete. Note: Contains small pockets of powdered calcrete and red-brown transported sand.

Excavation stopped on hard rock HARDPAN CALCRETE as above.

TP2: Strata encountered in 0,4/0,5m deep test pit.



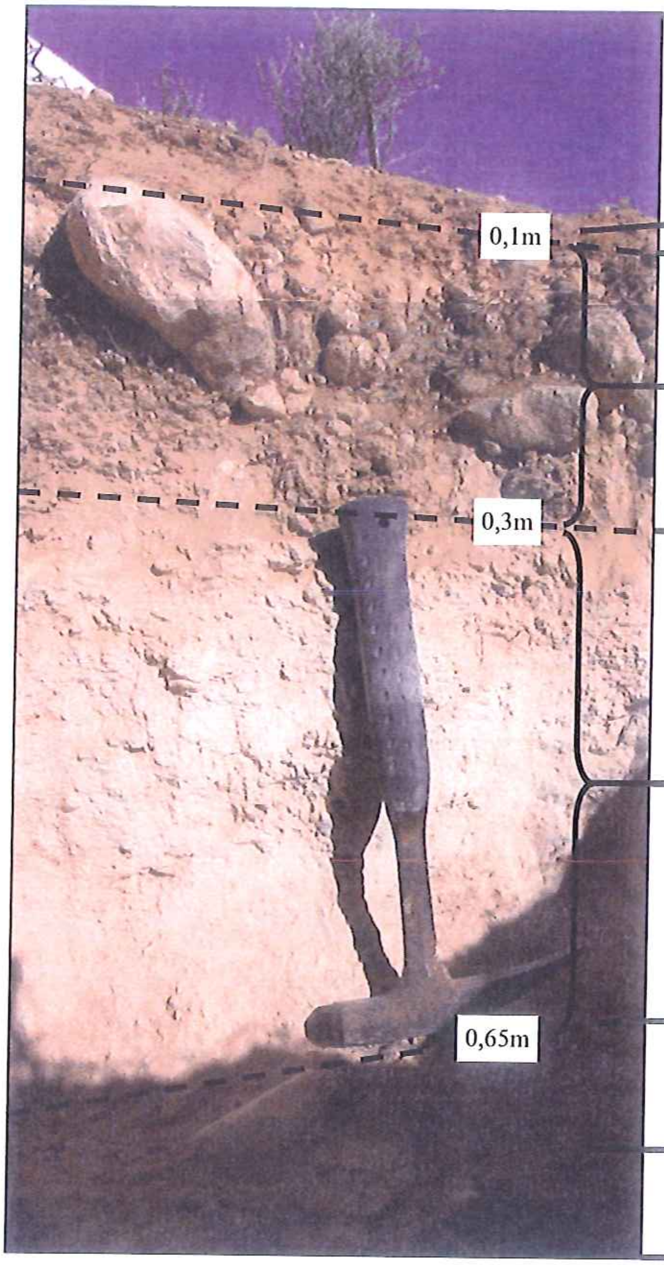
Dry reddish-brown medium dense intact silty fine and medium SAND with some fine and medium sub-rounded to rounded gravel and calcrete nodules. Transported.

Small, medium and large hard rock calcrete BOULDERS (up to 0,2m in diameter) and fine, medium and coarse calcrete nodules contained in a little dry pale brown medium dense to dense intact calcareous silty fine and medium SAND matrix. Weathered and broken down hardpan horizon.

Dry off-white to pale grey-white stiff to very stiff powder CALCRETE with predominantly fine and medium calcrete NODULES and CONCRETIONS. Pedogenic.

As above with some relics of dark brown highly weathered intensely fractured and friable soft rock schist. Partially replaced Amphibolite.

TP3: Strata encountered in 1,0m deep test pit.



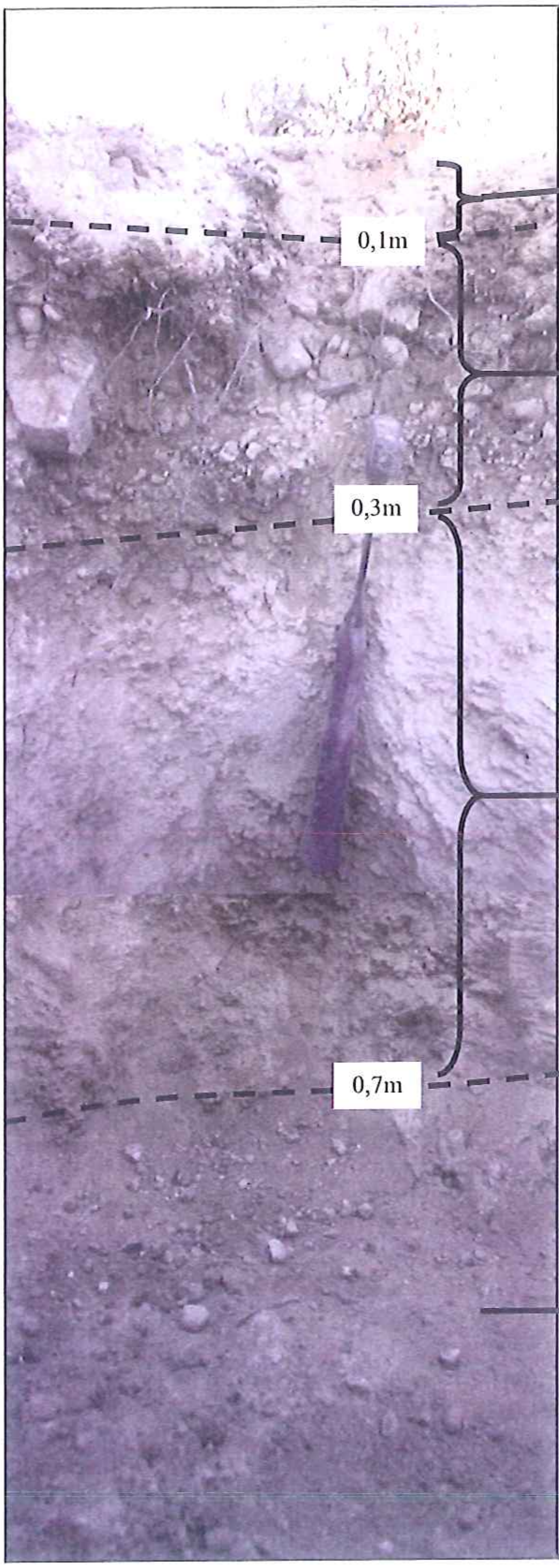
Dry red-brown loose intact slightly silty fine and medium SAND with scattered fine and medium gravel and occasional calcrete nodules. Transported.

Abundant small and medium calcrete BOULDERS (up to 0,1m in diameter) and some gravel and coarse calcrete concretions in a little dry to slightly moist pale brown medium dense intact slightly calcareous silty SAND matrix. Pedogenic.

Dry to slightly moist off-white very stiff intact sandy SILT with some fine calcrete nodules. Powder Calcrete.

As above but with occasional sub-rounded gravel and cobbles up to 80mm to 100mm in diameter.

TP4: Strata encountered in 0,65m deep test pit.



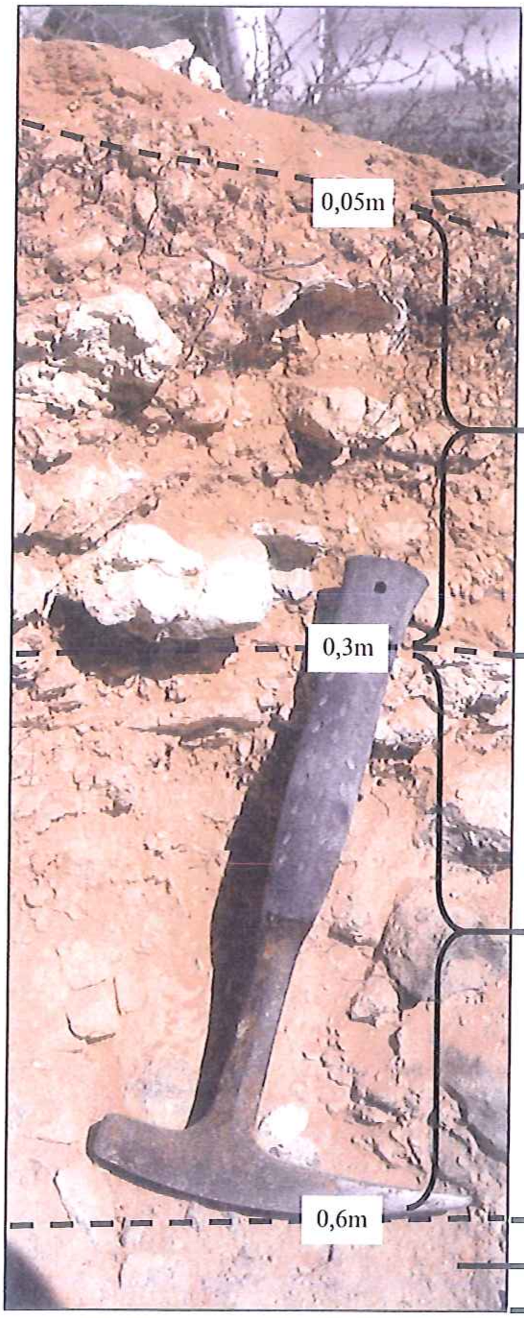
Dry to slightly moist red-brown loose intact fine and medium SAND with occasional fine calcrete nodules and traces of gravel. Transported.

Abundant fine medium and coarse angular to sub-rounded and rounded GRAVEL and calcrete NODULES and CONCRETIONS in a little dry pale reddish-brown loose to medium dense intact silty SAND matrix. Pedogenic.

Dry off-white very stiff thinly striated sandy SILT with some calcrete nodules. Powder Calcrete. Pedogenic.

Excavation ends in very stiff powder calcrete as above.

TP5: Strata encountered in 0,7m deep test pit.



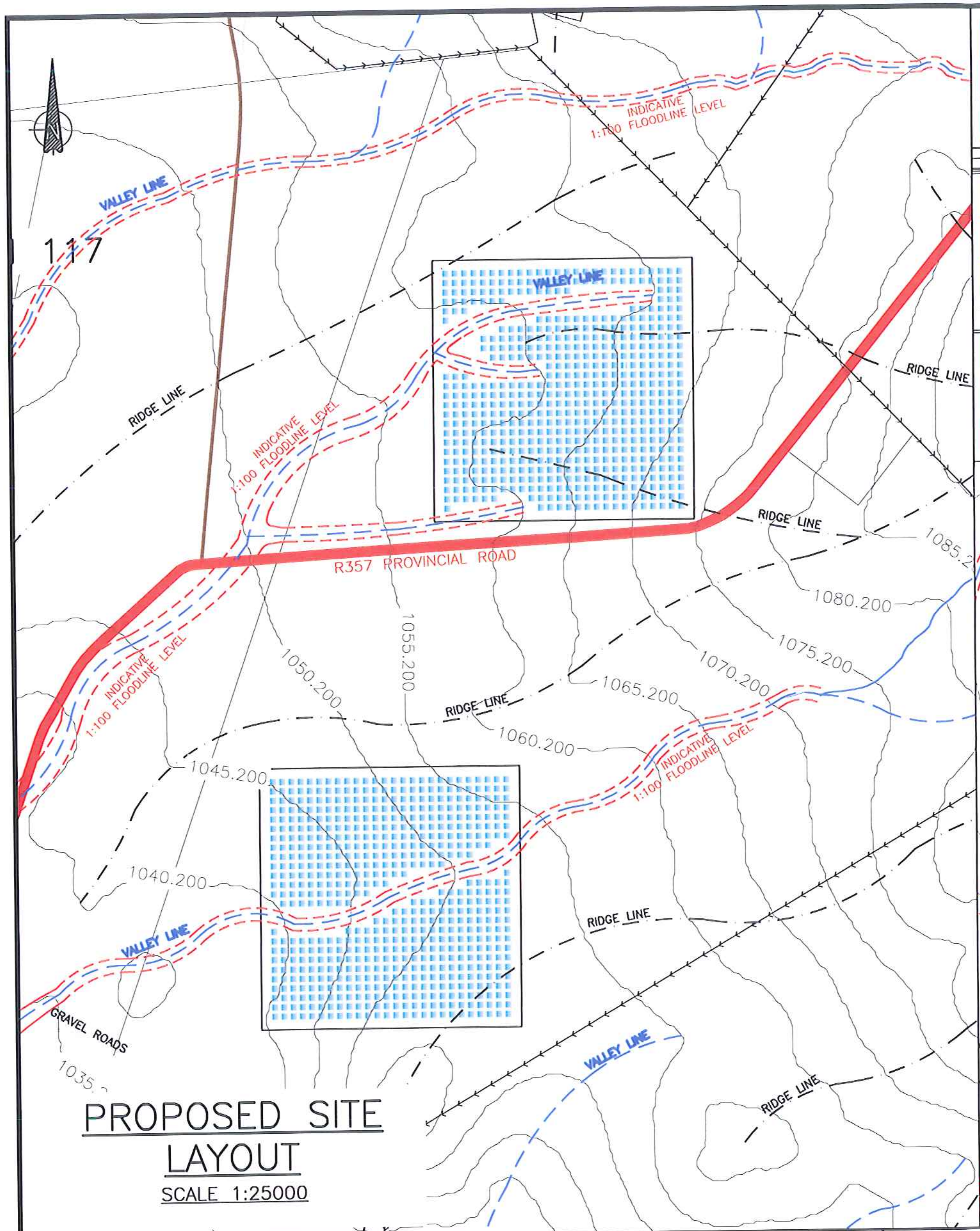
Dry to slightly moist reddish-brown loose intact silty fine and medium SAND with a little calcrete nodules and gravel of various origins. Transported.

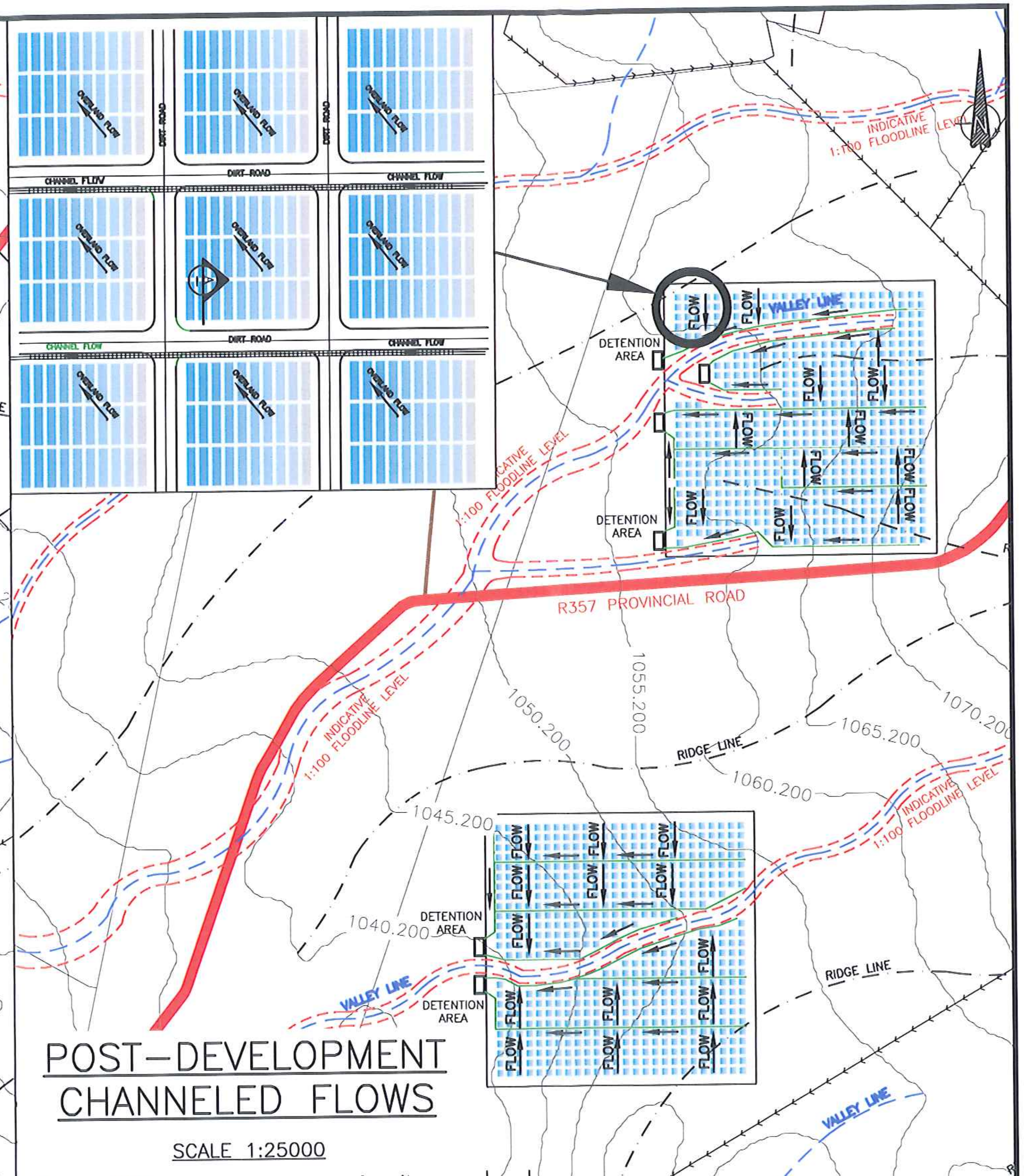
Abundant small and medium BOULDERS, CONCRETIONS and NODULES with some gravel in a little dry to slightly moist pale brown medium dense intact calcareous silty SAND matrix. Possibly weathered and broken down hardpan horizon.

Angular to sub-rounded GRAVEL and some calcrete concretions in an off-white very stiff intact calcareous SILT-SAND matrix. Powder Calcrete.
Note: Possibly weathered and broken down hardpan horizon.

Excavation ends in stratum as above.

TP6: Strata encountered in 0,6m deep test pit.



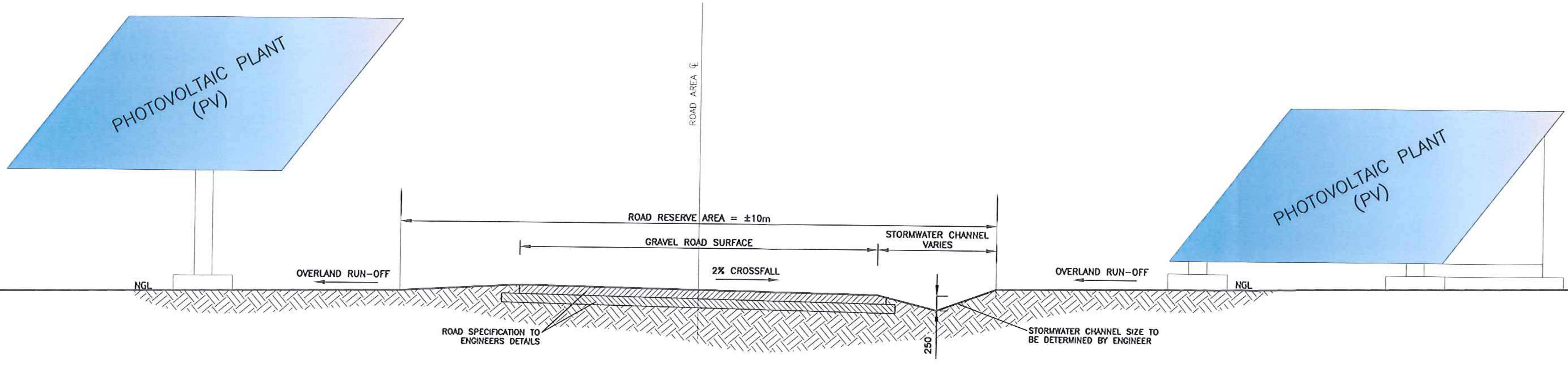


REV	DATE	BY	DESCRIPTION
A	02.12.11	GPK	ISSUED FOR INFORMATION

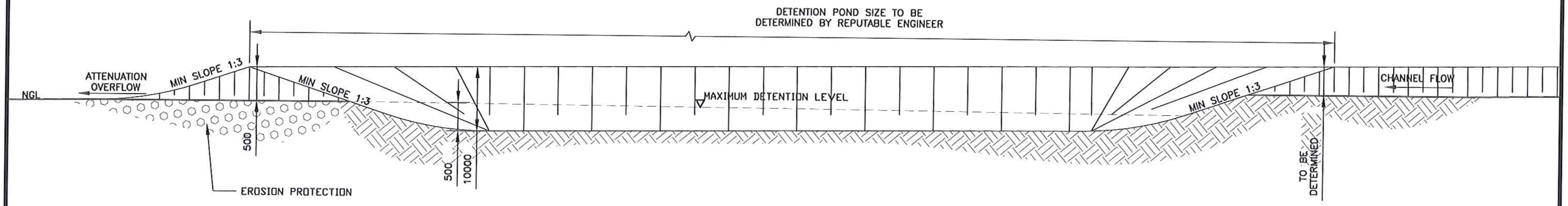
PROJECT	KLIPGATS PAN PV PLANT		
SiVEST ENGINEERING DIVISION	51 Wessel Road Rivonia 2128 South Africa P.O. Box 2921 Rivonia 2128 Phone: (+27 11) 798 0600 Fax: (+27 11) 803 7272 e-mail: info@sivest.co.za www.sivest.co.za		
DWG. TITLE	INDICATIVE PV LAYOUT AND PROPOSED STORMWATER		

DRAWN	DATE	DESIGNED	DATE
GPK	2.12.11	MLM	30.11.11
APPROVED			
ENGINEER	RICHARD HIRST		
Pr Eng No	200430110		
SIGNATURE			

SCALE	
VERTICAL	*
HORIZONTAL	AS SHOWN
DRG. No.	REV.
11134/306	A



TYPICAL SECTION A-A



TYPICAL SECTION THROUGH DETENTION POND

REV	DATE	BY	DESCRIPTION
A	02.12.11	GPK	ISSUED FOR INFORMATION

PROJECT

KLIPGATS
PV PLANT

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DWG. TITLE

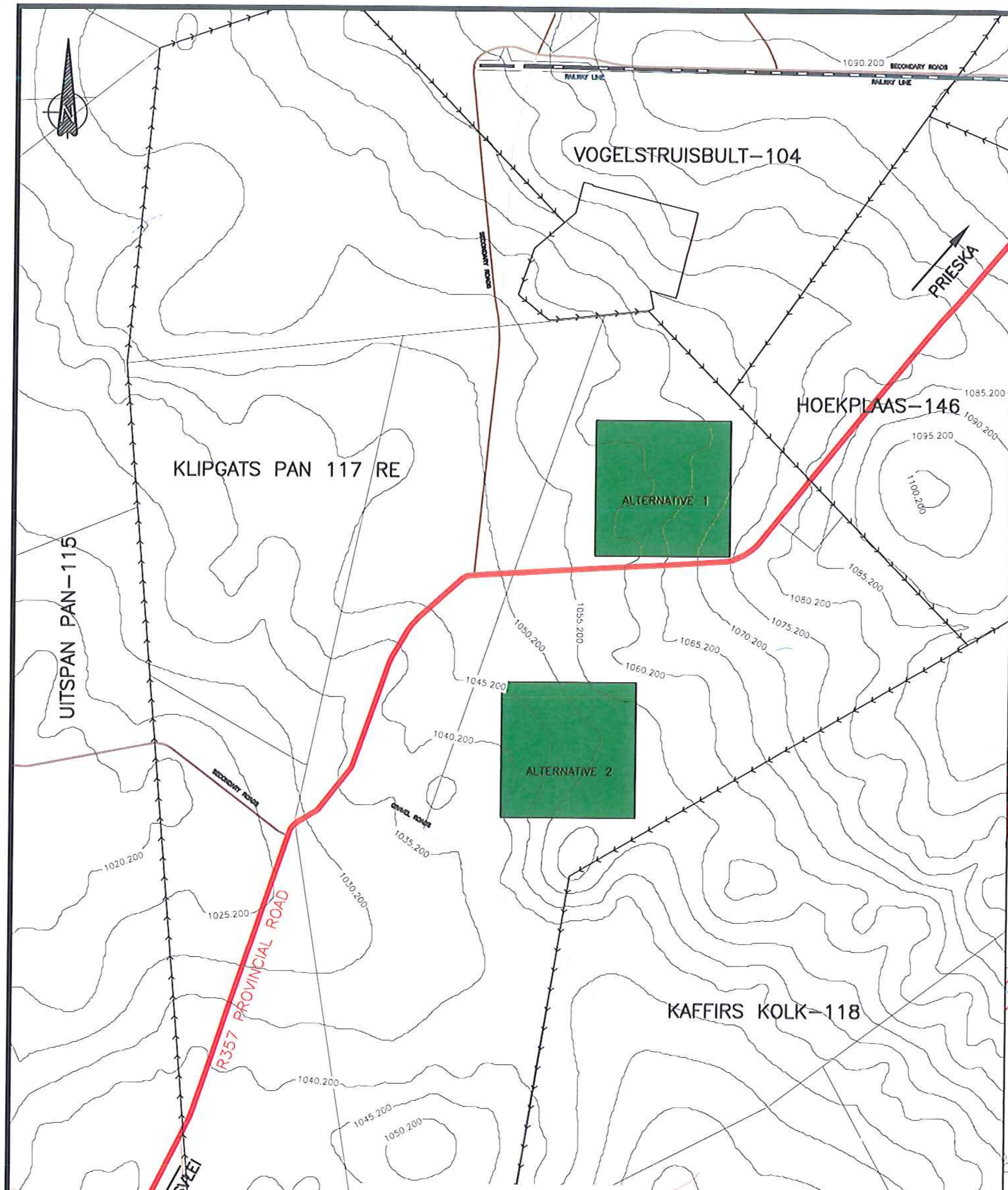
PROPOSED STORMWATER
DETAILS

DRAWN	DATE	DESIGNED	DATE
*	*	*	*

APPROVED	
ENGINEER	RICHARD HIRST
Pr Eng No	200430110
SIGNATURE	

SCALE	
VERTICAL	*
HORIZONTAL	NTS

DRG. No.	REV.
11134/307	A



STUDY AREA

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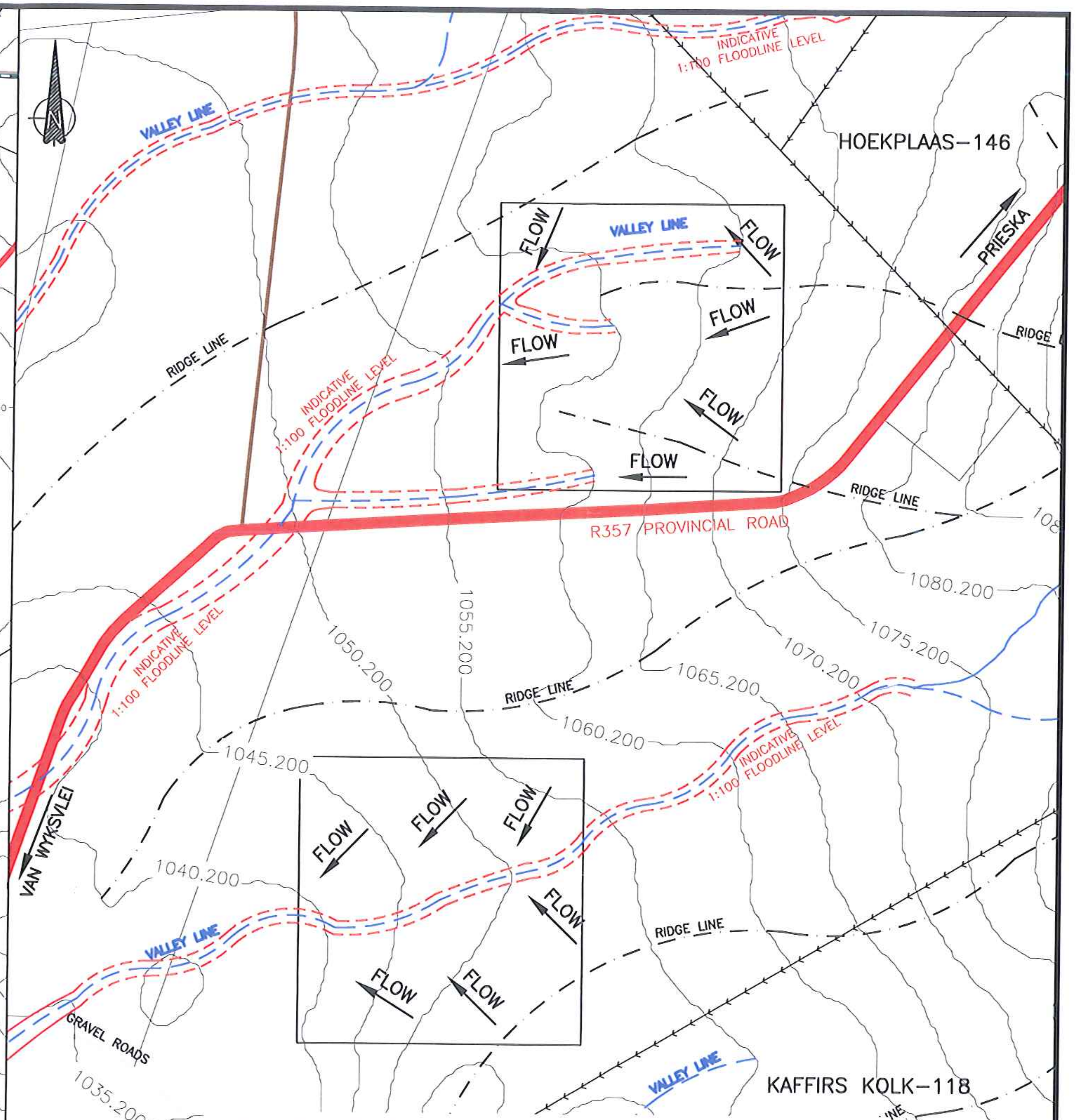

PRE-DEVELOPMENT OVERLAND FLOW DIRECTION

SCALE 1:25000

REV	DATE	BY	DESCRIPTION
A	02.12.11	GPK	ISSUED FOR INFORMATION

PROJECT KLIPGATS PAN PV PLANT	SiVEST ENGINEERING DIVISION 51 Wessel Road Rivonia 2128 South Africa P.O. Box 2921 Rivonia 2128 Phone: (+27 11) 798 0600 Fax: (+27 11) 803 7272 e-mail: info@sivest.co.za www.sivest.co.za	DWG. TITLE INDICATIVE PV LAYOUT AND PROPOSED STORMWATER	DRAWN: GPK, DATE 02.12.11; DESIGNED: MLM, DATE 01.12.11 APPROVED ENGINEER: RICHARD HIRST Pr Eng No: 200430110 SIGNATURE	SCALE VERTICAL: * HORIZONTAL: AS SHOWN	DRG. No. 11134/305 REV. A

APPENDIX 'C'

User selection has the following criteria:
Coordinates: Latitude: 30 degrees 1 minutes; Longitude: 22 degreess 18 minutes
Durations requested: 1 h
Return Periods requested: 5 yr, 20 yr, 50 yr, 100 yr
Block Size requested: 3 minutes

Data extracted from Daily Rainfall Estimate Database File
The six closest stations are listed

Station	Name Number	SAWS (km)	Distance (Years)	Record (−)	Latitude (')	Longitude (−)	MAP (')	Altitude (mm)	Duration (m)	Return (m/h/d)	Period (years) 5	5L	5U	20	20L	20U	50	50L	50U	100	100L	100U

Gridded values of all points within the specified block
Latitude Longitude MAP Altitude Duration Return Period (years)

(−)	(')	(−)	(')	(mm)	(m)	(m/h/d)	5	5L	5U	20	20L	20U	50	50L	50U	100	100L	100U
29	58	22	19	177	1097	1 h	28.9	21.3	36.4	42.5	31.1	54.6	52.1	37.6	67.8	59.8	42.6	78.7
29	58	22	20	172	1097	1 h	28.9	21.4	36.4	42.5	31.1	54.5	52.1	37.6	67.7	59.8	42.7	78.6
29	58	22	21	178	1097	1 h	28.9	21.5	36.3	42.5	31.3	54.4	52.1	37.8	67.6	59.8	42.9	78.4
29	59	22	21	172	1097	1 h	28.9	21.4	36.3	42.5	31.2	54.5	52.1	37.7	67.6	59.8	42.8	78.5
30	0	22	19	195	1074	1 h	28.9	21.3	36.4	42.5	31	54.6	52.1	37.5	67.8	59.8	42.6	78.7
30	0	22	20	196	1082	1 h	28.9	21.4	36.4	42.5	31.1	54.6	52.1	37.6	67.7	59.8	42.7	78.6
30	0	22	21	198	1082	1 h	28.9	21.4	36.3	42.5	31.2	54.5	52.1	37.7	67.6	59.8	42.8	78.5
30	1	22	20	195	1073	1 h	28.9	21.3	36.4	42.5	31	54.6	52.1	37.5	67.8	59.8	42.6	78.7
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29	58	22	15	179	1066	1 h	28.9	21.2	36.5	42.5	30.9	54.8	52.1	37.4	68	59.8	42.4	78.9
29	58	22	16	183	1072	1 h	28.9	21.3	36.5	42.5	31	54.7	52.1	37.4	67.9	59.8	42.5	78.9
29	58	22	18	174	1091	1 h	28.9	21.3	36.5	42.5	31	54.7	52.1	37.4	67.9	59.8	42.5	78.9
29	59	22	18	186	1112	1 h	28.9	21.3	36.5	42.5	31	54.7	52.1	37.4	67.9	59.8	42.5	78.8
29	59	22	19	172	1097	1 h	28.9	21.2	36.5	42.5	30.9	54.8	52.1	37.4	68	59.8	42.4	78.9
29	59	22	20	170	1097	1 h	28.9	21.3	36.4	42.5	31	54.6	52.1	37.5	67.8	59.8	42.6	78.7
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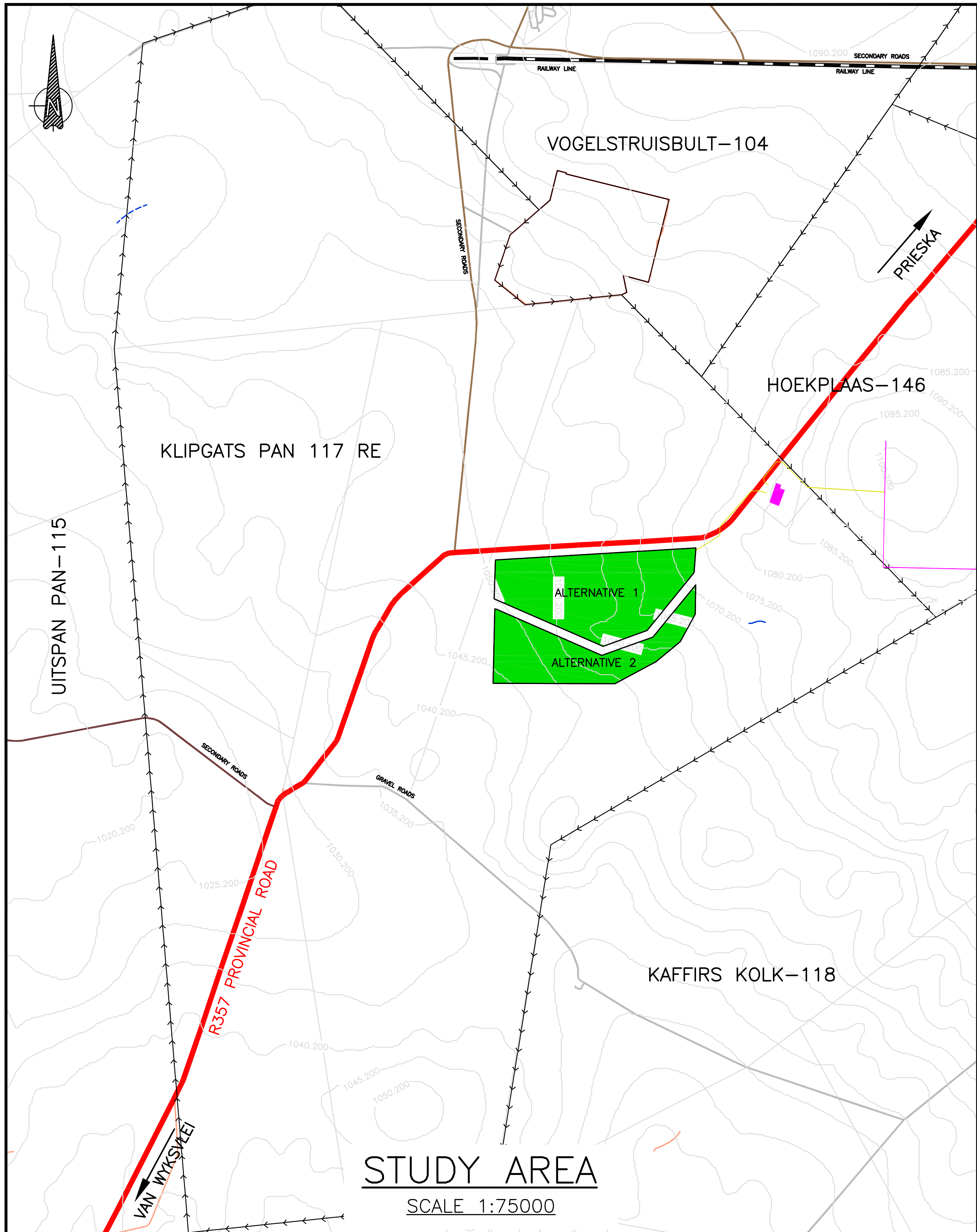
30	3	22	17	184	1038	1 h	28.9	21.2	36.5	42.5	30.9	54.8	52.1	37.3	68.1	59.8	42.4	79
30	3	22	18	186	1040	1 h	28.9	21.2	36.5	42.5	30.9	54.8	52.1	37.3	68.1	59.8	42.4	79
30	4	22	17	186	1031	1 h	28.9	21.2	36.5	42.5	30.9	54.8	52.1	37.3	68.1	59.8	42.4	79
30	4	22	18	185	1039	1 h	28.9	21.2	36.5	42.5	30.9	54.8	52.1	37.3	68.1	59.8	42.4	79
30	4	22	19	184	1048	1 h	28.9	21.2	36.5	42.5	30.9	54.8	52.1	37.3	68.1	59.8	42.4	79
29	59	22	15	170	1066	1 h	28.9	21.1	36.6	42.5	30.8	54.9	52.1	37.2	68.2	59.8	42.2	79.2



STUDY AREA

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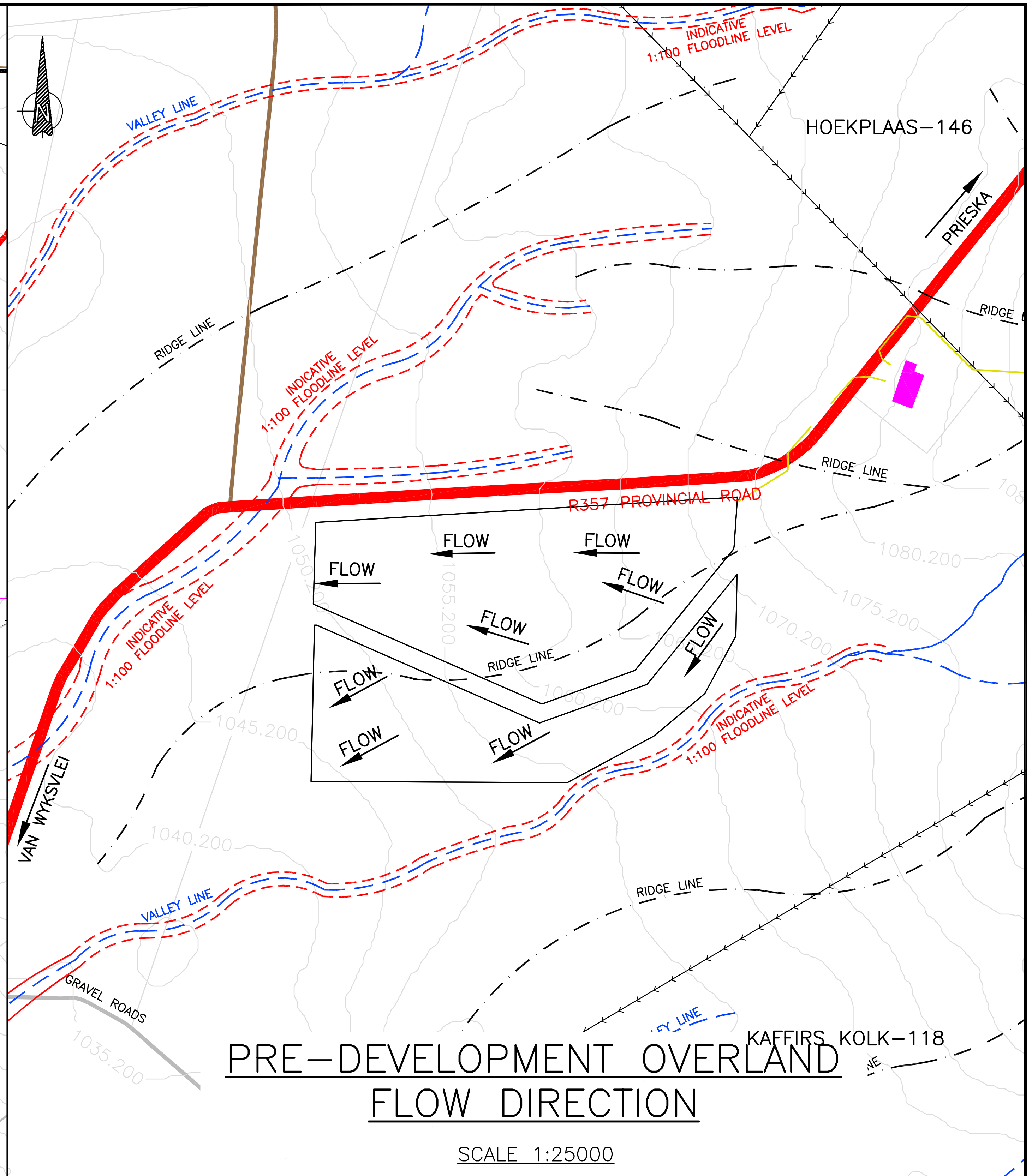

PRE-DEVELOPMENT OVERLAND FLOW DIRECTION

SCALE 1:25000

REV	DATE	BY	DESCRIPTION
C	28.09.12	GPK	LAYOUT REVISED
B	11.09.12	RDH	LAYOUT REVISED
A	02.12.11	GPK	ISSUED FOR INFORMATION

PROJECT

KLIPGATS PAN PV PLANT

SiVEST ENGINEERING DIVISION

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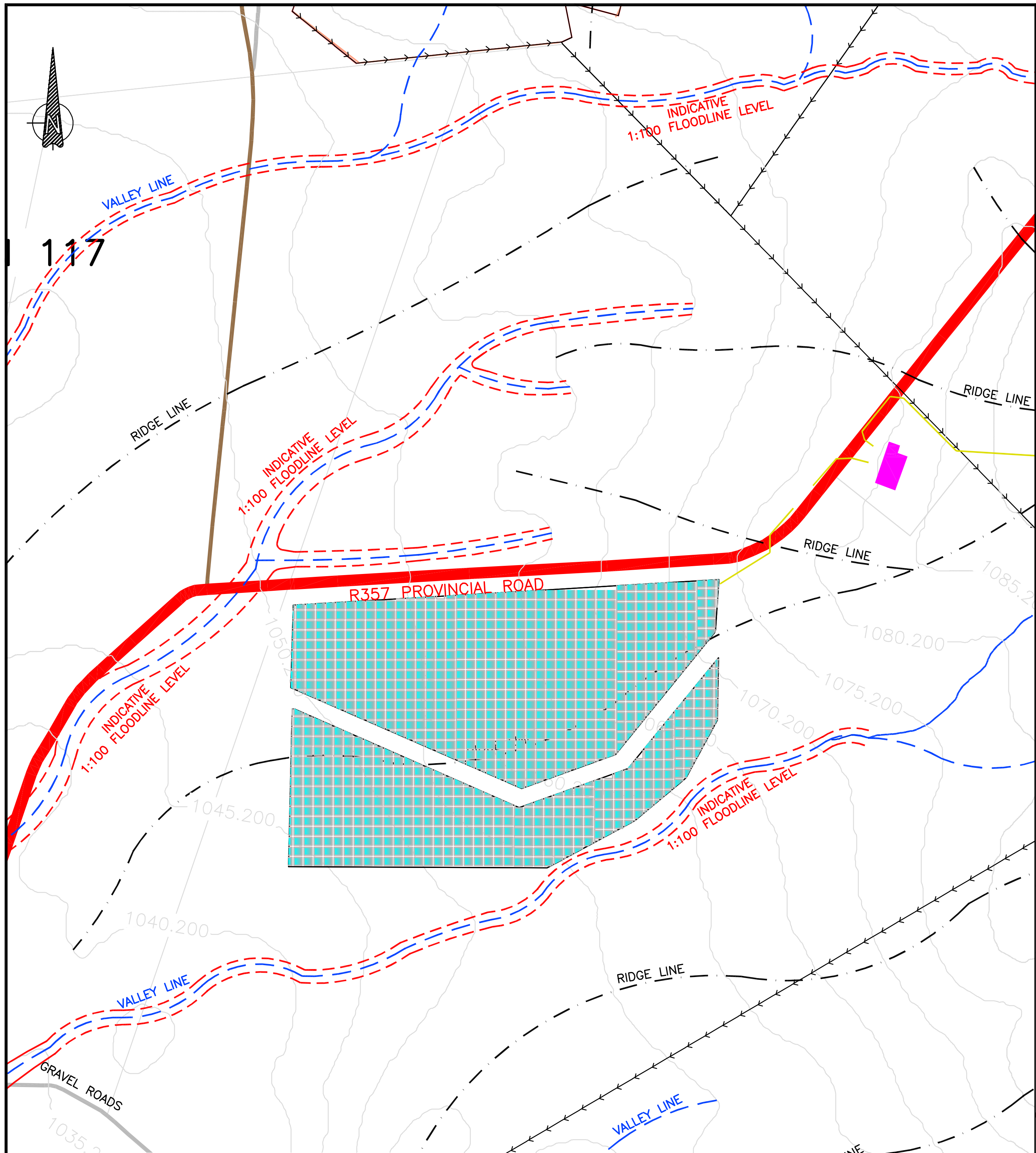
DWG. TITLE

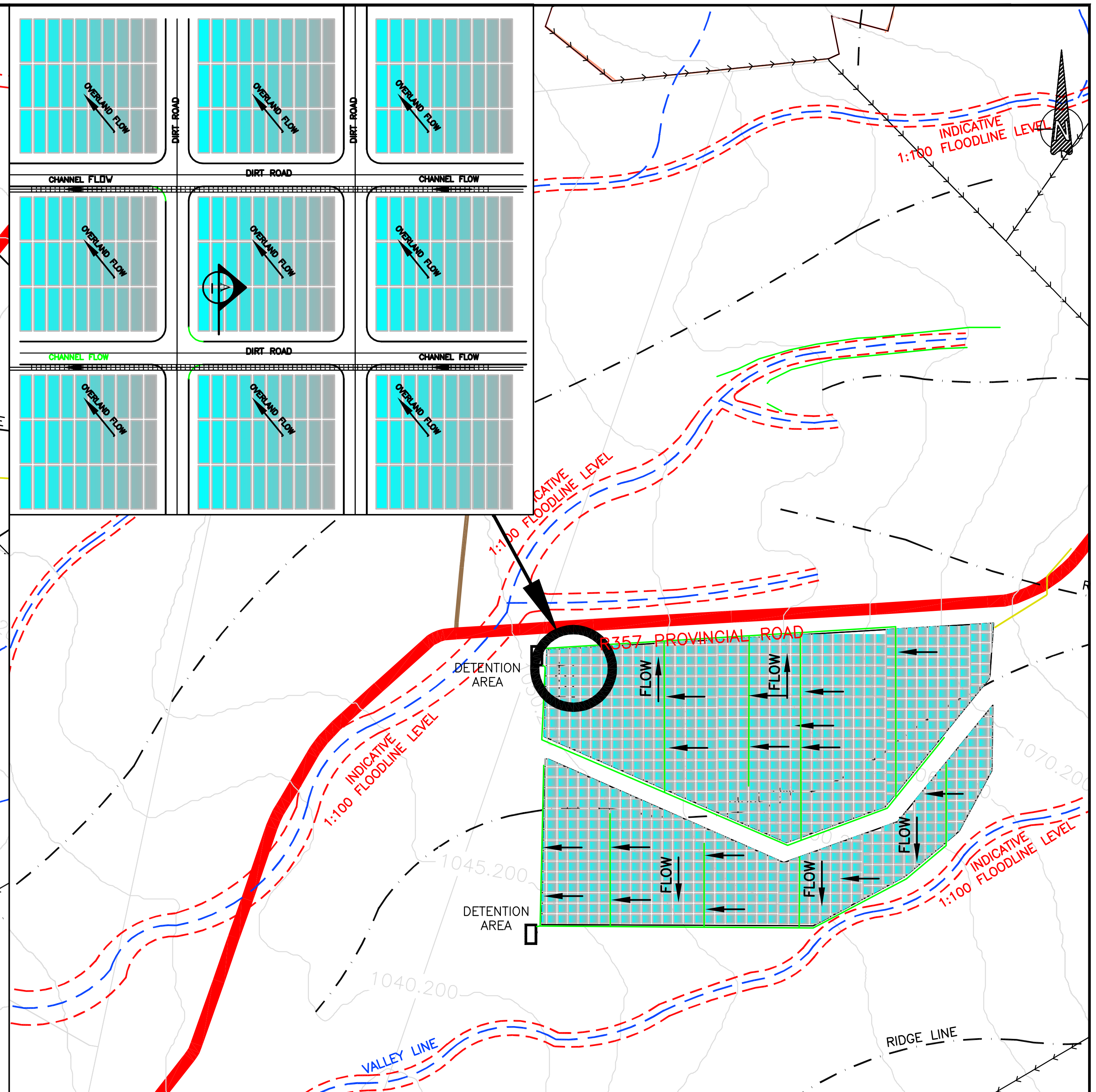
INDICATIVE PV LAYOUT AND PROPOSED STORMWATER

DRAWN	DATE	DESIGNED	DATE	SCALE	
GPK	02.12.11	MLM	01.12.11	VERTICAL	*
APPROVED				HORIZONTAL	AS SHOWN
ENGINEER	RICHARD HIRST			DRG. No.	REV.
Pr Eng No	200430110			11134/305	C
SIGNATURE					



PROPOSED SITE LAYOUT

SCALE 1:25000



POST-DEVELOPMENT CHANNELED FLOWS

SCALE 1:25000

REV	DATE	BY	DESCRIPTION
C	28.09.12	GPK	LAYOUT REVISED
B	11.09.12	RDH	LAYOUT REVISED
A	02.12.11	GPK	ISSUED FOR INFORMATION

PROJECT

KLIPGATS PAN PV PLANT

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DWG. TITLE

INDICATIVE PV LAYOUT AND PROPOSED STORMWATER

DRAWN	DATE	DESIGNED	DATE
GPK	2.12.11	MLM	30.11.11
APPROVED			
ENGINEER	RICHARD HIRST		
Pr Eng No	200430110		
SIGNATURE			

SCALE	
VERTICAL	*
HORIZONTAL	AS SHOWN

DRG. No.	REV.
11134/306	C