REPORT ON THE

GEOTECHNICAL INVESTIGATION

FOR THE

REDCLIFF VALLEYVIEW

HOUSING DEVELOPMENT

VERULAM

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EXECUTIVE SUMMARY

A Phase 1 detailed geotechnical investigation has been performed for the Redcliff Valleyview housing Development in accordance with the national Department of Housing requirements for Greenfield Site geotechnical investigations (GFSH - 2 Document). The site has been divided into residential site class designations based on subsoil structures. Areas not recommended for development and areas deemed costly to develop have also been highlighted. In general, the vast majority of the site is suitable for single storey residential development, provided the recommendations outlined in this report are adhered to. Few “red flag” areas not recommended for development; or deemed very costly to develop; include seepage zones, steep slopes and the potentially unstable shale slope area highlighted in Figure 2.

1. INTRODUCTION AND TERMS OF REFERENCE

Drennan Maud and Partners was appointed by the eThekwini Municipality to conduct a detailed geotechnical investigation for the Redcliff Valleyview Housing Development consisting of approximately 833 sites. The investigation is performed in accordance with the National Department of Housing Requirements for Phase 1 Detailed Site Investigations pertaining to Greenfield sites (GFSH - 2 Document). Slight reporting deviations were necessary relative to the nature of this investigation. A preliminary geotechnical investigation and report was produced in December 2003 by Drennan Maud and Partners.

2. INFORMATION USED IN THE STUDY

Information supplied by the eThekwini Municipality to assist in the study included site locality plans and air-photos highlighting and co-ordinating the site boundaries. The contoured topography of the site was obtained from the eThekwini Municipality Geographic Information System (GIS). The site was not surveyed at the time of the geotechnical investigation.

Relevant information held by Drennan Maud and Partners (i.e. geological and topographical maps) were also reviewed together with an old report (1997) of previous work performed in the area by Knight Hall Hendry and Associates.
3. SITE DESCRIPTION

The site comprises some 44 hectares and is located in the Redcliff area to the immediate west of Verulam. The location and geomorphology of the site is shown in Figure 1. The area may generally be divided into a northern hillside and a southern hillside draining toward a central west-east flowing stream.

Access is via the tarred Valleyview Drive paralleling this stream in the valley base and a district road (Buffels Drive - D521) running along the northern ridge. North south trending high voltage powerlines pass through the western portion of the site.

Drainage of the area follows the topography with the positions of seepage zones highlighted in Figure 2. Seepage zones are generally narrow, well defined areas with exception to the north-south trending seepage zone in the southern site portion which is essentially broad and difficult to accurately define.

Slope gradients generally range from moderate (1 in 10) to very steep (1 in 2.8) with steeply incised narrow dongas following prominent seepage paths. Vegetation is mainly in the form of grasses with scattered trees and shrubs increasing in density in the vicinity of seepage zones.

Numerous existing formal and informal settlements may be found in the eastern half of the southern portion of the site.

4. NATURE OF INVESTIGATION

The geotechnical investigation comprised the excavations/profiling/sampling of inspection pits together with Dynamic Cone Penetrometer (DCP) testing to provide indication of soil consistency between inspection pits. Inspection pits were excavated by TLB backactor and profiled/sampled by an engineering geologist. Geotechnical mapping and logging of existing cuttings/exposures was also performed where available.

The inspection pit positions are shown in Figure 1 and have been positioned by GPS as the survey of the site was not available at the time of investigation. Laboratory analysis includes Mod AASHTO, CBR, Foundation Indicator, PH and Conductivity testing. No soft compressible clays were encountered and hence consolidometer sampling / testing was not deemed necessary.

The inspection pit profiles are included as Appendix 1, DCP test results as Appendix 2 and Laboratory analysis results as Appendix 3.
5. SITE GEOLOGY, GROUNDWATER CONDITIONS AND LABORATORY ANALYSIS

5.1 General

The 1:250 000 geological map Durban 2930 shows the regional geology of the area to consist of Pietermaritzburg Formation Shale, Dwyka Tillite, Natal Group Sandstone separated by faulted contacts and intruded by dolerite dykes and sills of Jurassic age. The regional dip of these sedimentary formations is generally seaward at 10 - 15° dip.

The geology of the site is rather complex. The profiling of trial pits/cuttings together with surface mapping of any rock outcrop was combined to produce the geological map shown in Figure 1. The following is a general description of the materials and their variations encountered on site and should be read in conjunction with Figure 1. It must be noted that this is a general description of the various materials encountered. For more detailed information pertaining to particular areas (i.e horizon description and thicknesses, bedrock depths, variations in bedding/jointing trends etc) reference must be made to the appended trial pit profiles.

5.2 Subsoil Profiles

5.2.1 Transported Cover

a) Hillwash

The *Hillwash* varies in relation to the underlying bedrock type as follows:

*Hillwash* overlying *shale* areas is generally less than 0,5m thick cohesive, firm/stiff/very stiff, fissured and ranges from a sandy clay to a clayey silt. Shale gravels are common.

A thin (<0.5m) *hillwash* also overlies *tillite* and is generally described as firm through to stiff, sandy clay/clayey sand with tillite gravels.

A loose silty sand *hillwash* overlies *sandstone* with cobbles to boulders encountered in the hillwash in areas shown in Figure1. The hillwash overlying sandstone is generally thin (<0.5m) with occasional localised areas increasing to 1,0 - 1,5m thickness.

*Hillwash* overlying *dolerite* is generally thin (<0.5m) slightly shattered/slickensided, firm/stiff, and variable in composition from clayey sand to sandy clay to sandy silt.
b) Alluvium and Colluvium

A wide range of alluvial and colluvial soils are found in valley bases ranging from soft through to stiff, clays/sandy clays to loose through dense clayey sands and sands.

Other less prominent, transported material types include a thin gravelly pebble marker horizon separating the transported cover from the residuum.

5.2.2 Bedrock and Residuum

a) Shale

The shale bedrock is described as blue grey to olive green weathered orange brown, fine grained (argillaceous), subhorizontally bedded/laminated, soft to medium hard rock with depth. The bedding of the shale is generally seaward (ie dipping at 5 - 15° in a North easterly and South Easterly direction), however numerous localised variations in dip appear to result from the faulting episode and fault drag near faulted contacts (ie dips as steep as 45° we recorded). Subvertical and subhorizontal jointing is fairly intense and variable in trend resulting in the material being excavated in angular shale fragments generally <0.3m in size. Joint planes are essentially smooth with orange/black staining and thin clay gouge ingress. Variations in bedding/jointing trends and dips are noted in the appended trial pit profiles.

The shale residuum is generally described as firm/stiff through to very stiff, silty clay/clayey silt with variable amounts of angular shale gravels to cobbles up to 40% by volume. Shattering/slickensiding in the residuum is common indicating the material to have a heave potential.

The shale residuum is usually thinly developed with only two thick residual shale horizons found in the vicinity of TP2A and TP17A.

b) Tillite

Tillite bedrock is described as grey to mustard, soft becoming hard rock with depth, intensely subhorizontally and subvertically jointed resulting in the soft rock tillite being excavated as angular fragments generally <0.2m in size. Joint planes are generally smooth to medium rough, stained black and open.
Tillite bedrock rarely develops a residual profile with bedrock usually encountered at shallow depth. Of all the trial pits excavated to tillite bedrock, only TP14 and TP 24 possessed a thin tillite residuum described as a stiff clayey silt with tillite gravels to cobbles.

c) Sandstone

The sandstone usually occurs at shallow depth beneath a thin hillwash with sandstone cobbles to boulders (especially on the steeper slopes). The sandstone bedrock is pink weathered brown/orange, medium hard becoming hard rock rapidly with depth. Numerous, often open, subvertical joint trends result in subangular boulders up to 2.0m in size occurring on the steep slopes. The following main subvertical trends were noted in outcropping rock: 10°N-S / 65°NE-SW / 100 E-W / 140°NW-SE.

On slopes the standstone residuum is either thinly developed or absent and described as loose with dense patches, medium to coarse sand with few sandstone cobbles to boulders.

d) Dolerite Intrusions

The dolerite bedrock is described as blue grey weathered brown, highly jointed with numerous subhorizontal and subvertical joint set trends, commonly hard to very hard rock at depths <3,0m. Joint planes range from smooth to medium rough, open to closed with orange staining and clay gouge ingress. An area of softer friable dolerite bedrock (sugar dolerite) was identified in the vicinity of TP5A and TP6.

The residual dolerite is generally described as a fissured / slickensided, stiff / very stiff, silty clay/sandy clay. The slickensided nature of the residual dolerite does indicate a heave potential. Dolerite corestones are often present.

5.2.3 Structural Geology

The geological sequence of the rock types encountered on site consists of Pietermaritzburg Formation Shale, overlying Dwyka Tillite, overlying Natal Group Sandstone. Over both the northern and southern portions of the site, this sequence is shown to be in reverse and thus numerous faults are believed to intersect the site at approximate positions shown in Figure 1. It must be noted that faulted and natural contacts between formations are inferred and may vary slightly in position and trend. Trial pit 16A was excavated in such a fault zone intersecting fault breccia as described
in the appended logs. Joint trend evidence indicates that the west-east trending faults found in the southern site area dip steeply (± 45 - 60°) to the NE on a 20-50° dip direction.

5.3 Water Table

Drainage follows the natural topography. Geotechnical mapping and test pitting revealed that seepage water (at < 1.5m depth) and associated shallow seasonal/permanent water tables are generally defined to lower valley depressions as delineated in Figure 2.

5.4 Laboratory Analysis

5.4.1 Foundation Indicator / Mod AASHTO / CBR Testing

Samples taken during testpitting were subject to foundation indicator/ mod AASHTO/CBR testing to determine:

- The presence of potentially problematic soils i.e. heaving profiles
- The materials suitability for re-use as engineered fill or pavement layerworks

Table 1 of Appendix 3 summarises the laboratory soil test results from which the following is concluded relative to the main material types encountered on site:

a) Shale Areas

*Hillwash Overlying Shale* (Sample TP12)

The material has a low potential expansiveness (although fissuring in testpits revealed a heave potential) and classifies as CL/OL according to the Unified Classification, as A-6 according to the AASHTO Classification and as worse than G10 after TRH 14 (1985). The material is thus not recommended for use as engineered or subgrade fill.

*Residual Shale* (Sample TP9 and TP18a)

The material has a low potential expansiveness (although fissuring/slickensiding in testpits revealed a heave potential) and classifies as CL/OL/MH/OH according to the Unified Classification, as A-6 to A-7-5 according to the AASHTO Classification, and as worse than G10 after TRH 14 (1985). The material is thus not recommended for use as engineered or subgrade fill.
**Soft Rock Shale** (Sample TP17)
The material has a low potential expansiveness and classifies as GW according to the Unified Classification, as A-2-4 according to the AASHTO Classification, and as G8 after TRH 14 (1985). The material is thus deemed suitable as engineered fill and suitable up to lower selected layer level in road layerworks.

**b) Tillite Areas**

*Hillwash Overlying Tillite* (Sample TP7)
The material has a low potential expansiveness and classifies as CL/OL according to the Unified Classification, as A-6 according to the AASHTO Classification and as G9 after TRH 14 (1985). The material is thus deemed suitable as engineered fill and suitable up to subgrade level in road layerworks.

*Soft Rock Tillite* (Sample TP5)
The material has a low potential expansiveness and classifies as GM according to the Unified Classification, as A-1-b according to the AASHTO Classification, and as G9 after TRH 14 (1985). The material is thus deemed suitable as engineered fill and suitable up to lower selected layer level in road layerworks.

**c) Sandstone Areas**

*Hillwash Overlying Sandstone* (Sample TP11 0-0,4m)
The material has a low potential expansiveness and classifies as SM according to the Unified Classification, as A-2-4 according to the AASHTO Classification and as G7 after TRH 14 (1985). The material is thus deemed suitable as engineered fill and suitable up to upper selected layer level in road layerworks.

*Soft Rock Sandstone* (Sample TP11 0,4-0,9m)
The material has a low potential expansiveness and classifies as SP/SM according to the Unified Classification, as A-1-b according to the AASHTO Classification, and as G8 after TRH 14 (1985). The material is thus deemed suitable as engineered fill and suitable up to lower selected layer level in road layerworks.

**d) Dolerite Areas**

*Hillwash Overlying Dolerite* (Sample TP19)
The material has a low potential expansiveness (although fissuring in testpits revealed a heave potential) and classifies as CL/OL according to the Unified Classification, as A-7-6 according to the AASHTO Classification and as G10 after TRH 14 (1985). The material is thus deemed suitable as engineered fill and suitable up to subgrade level in road layerworks.
Residual Dolerite (Sample TP1)
The material has a high potential expansiveness (fissuring/slickensiding in testpits also revealed a heave potential) and classifies as SM according to the Unified Classification, as A-7-5 according to the AASHTO Classification, and as worse than G10 after TRH 14 (1985). The material is thus not recommended for use as engineered or subgrade fill.

Soft Rock Dolerite - Sugar Dolerite (Sample TP6)
The material has a low potential expansiveness and classifies as SM according to the Unified Classification, as A-2-4 according to the AASHTO Classification and as G7 after TRH 14 (1985). The material is thus deemed suitable as engineered fill and suitable up to upper selected layer level in road layerworks.

5.4.2 PH and Conductivity Testing

Table 1 of Appendix 3 also summarises the results of the PH and Conductivity testing on the main hillwash and residual soil types, together with a sample of the stream water flowing through the center of the site. Using the Global Assessment method (DIN 50929), to determine the corrosivity of the soils and water on site, reveal that they generally fall into the range of “borderline corrosivity” on a scale where:

- > 0 is non corrosive
- 1 to -4 is fair
- -5 to -8 is borderline
- < -8 is unsatisfactory
- < -10 is corrosive

6. GEOTECHNICAL EVALUATION

6.1 Excavatability

The following excavatability assessment should be read in conjunction with the site geology map Figure 1.

Areas underlain by Shale and Tillite are generally excavatable to between 2 - 3m depth by Soft excavation (after SANS 1200D) below which Intermediate and Hard excavation is to be expected. Areas underlain by sandstone are generally excavatable to between 0,5 - 1,5m by Soft excavation (after SANS 1200D) below which Intermediate and Hard excavation is to be expected. Boulder excavation CLASS B is also to be expected in the
shallow soil profile overlying sandstone on the steeper slopes in the southern site portions. Although only a localised formation, areas underlain by dolerite vary considerably from deeply weathered profiles (>3.0m soft excavation) to localised shallow hard rock dolerite corestone areas. Dwyka Tillite formations are also known to have localised shallow hard rock corestone rich areas, although none were specifically encountered at this site.

Considerably shallower levels of Hand excavation are to be expected due to the shallow bedrock levels and stiff/very stiff cohesive soil profiles.

Exception to the above is toward valley bases where thicker alluvial/colluvial transported soil profiles prevail.

6.2 Material Suitability and General Earthworks

The majority of on-site soils and soft rock classify as G10 or better type material and may thus be used as subgrade fill in cut to fill housing/road platforms.

Exception to the above is:

- Hillwash and Residual soils overlying Shale and Dolerite (worse than G10)
- Hillwash, colluvial and Residual soils favouring valley bases (worse than G10)

The above soils are generally clayey (G10+); difficult to work/compact; and are expected to result in considerable settlement after compaction. It is not recommended that soils classifying as worse than G10 type material be used as subgrade fill in road/housing platforms and that granular material rather be imported from suitable on site sources. Sandwhich compaction can be employed (in Shale and Dolerite areas) to minimise costs and improve the fill subgrade condition (ie compacting with alternating layers of poor quality on site material and better quality imported material such as soft rock shale / tillite / dolerite or sandy hillwash over sandstone).

The upper 100mm root rich horizon should not be used as fill nor should it be left below fill platforms. Rock fragments which do not break down to less than \( \frac{3}{8} \) of compacted layer thickness should also not be used in fill platforms. The majority of soft rock Tillite and Shale is expected to breakdown to the required size during handling (ie excavating and recompacting). Compaction with a sheepfoot roller or impact roller will aid in this regard. Rock fragments derived from sandstone excavation are expected to be harder with numerous oversized boulders/ corestones requiring removal to spoil.
The soft rock dolerite (sugar dolerite) and the sandy Hillwash overlying Sandstone are deemed the best quality natural on-site material for re-use in road layerworks.

The fill material must be benched into the existing sideslopes for slopes steeper than 1 in 6 and compacted in maximum 300mm loose layer thickness to a minimum of 93% Mod AASHTO. It is recommended that cut and fill slope batters be limited to gradients of 1 in 1, 75. Embankments greater than 2,0m height should be inspected by a geotechnical professional.

6.3 Steep Slopes / Slope Stability

The majority of the site slopes at between 1 in 5 to 1 in 10, and hence will require terraced cut to fill platforms and additional founding expense. Some of the southern sandstone portion slopes steeper than 1 in 5, and even steeper than 1 in 3 in few places. Areas steeper than 1 in 3 (as highlighted in P2 in Figure 2) are not recommended for development as they are likely to require costly retaining structures to avoid cuts/fills from chasing slopes for considerable distance. The sandstone bedrock is also shallow in these areas with numerous boulders making them very costly to terrace (ie cut to fill). The delineation of the slopes steeper than 1 in 3 was visually estimated on site and will require confirmation from the pending site survey.

Tillite and sandstone bedrock are generally stable founding mediums. The main stability concern regarding this site is the presence of shale bedrock. As mentioned, areas with shale bedding planes dipping out of the slope at 10 - 20° are known to have potentially unstable slopes, especially when associated with seepage zones and dolerite intrusions. Development on these slopes often promotes failure by:

- Loading i.e. dwellings / fills.
- Steepening / under cutting of slopes.
- Concentrating the drainage i.e. soakpits, paved area overflows, leaky pipes or taps.

The NE site portion (delineated as P3 in Figure 2) is not recommended for development as there is considerable evidence indicating this to be a “high risk”, potentially unstable area. This evidence comprises a combination of:

- Shale bedding planes and clay lenses / infills dipping out of the slope.
- A “humocky topography” potentially representative of past slope failures.
- Numerous Dolerite intrusions and seepage zones.
It is recommended that the area delineated as P3 rather be left open as parks, gardens, cultivated lands, cemetery sites, etc. The remainder of the site is generally deemed stable provided the recommendations outlined in this report are adhered to. However, small scale folding and fault drag may produce localized variations in the bedrock dip. It is thus important that a geotechnical professional inspect all cut slopes.

6.4 Seepage Zones, Site Drainage and Erosion

The majority of the Hillwash and Colluvial soils throughout the site are deemed erosive. The sandy hillwash overlying sandstone areas are deemed highly erosive. The dongas on site are evidence of an erosive potential.

Stormwater runoff must be controlled by piping or, carrying in surface drains to be discharged into the natural drainage paths in the valley bottoms. Erosion protection measures must be implemented at all outlets.

Surface and subsurface seepage zones are expected throughout the site at general positions highlighted as P1 in Figure 2. These seepage zones are not recommended for development and should be allocated as open park areas or land available for cultivation. However, should it be necessary to develop these areas then surface and subsoil cut-off drainage will be necessary for both road and housing platforms to avoid seepage from softening soils beneath housing platforms or, in road layer works.

Few localized minor perched seepage zones (not highlighted in Figure 2) might be encountered especially in areas associated with dolerite intrusions. These will also likely require cut-off drainage for road/housing platforms should they be identified during the earthworks phase.

Platforms must be graded to ensure positive drainage away from structures. Exposed slopes must be vegetated as soon as possible to reduce erosion. The design flood level of the central stream needs to be determined and avoided.
7. RESIDENTIAL SITE CLASS DESIGNATIONS AND FOUNDING RECOMMENDATIONS

7.1 Site Class Designations

The National Department of Housing requires that sites be classified in accordance with the Residential Site Class Designation set out in the NHBRC standards and guidelines. Relevant Tables 1 and Tables 5-7 of Part 1, Section 2 of the NHBRC document have been included in Figure 2 and Appendix 4.

The residential site class designation allocated in Figure 2 takes account of bedrock depths and the thickness of any problematic horizons (i.e. heaving / collapsible / compressible). Given the difficulty of inferring information between testpits / exposures, the site class designations shown in Figure 2 are deemed broadly representative and subject to confirmation and minor alteration during the “Phase 2” inspection.

7.2 Founding Recommendations

From the residential site class designations shown in Figure 2, a range of suitable foundation designs are given in Part 1, Section 2, Tables 5-7 of the NHBRC standards and guidelines (refer Appendix 4). The developer may choose the most feasible foundation design taking account of the worst case condition where composite site class designations are given. In addition to the residential site class designation, the developer must take into account the effects of sloping ground where cut to fill platforms will result in competent founding at shallow depth in the cut portion, becoming deeper to competent founding progressing into the fill portions of platforms (i.e. foundations must be taken down to similar competent founding material throughout the platform). When founding on steeper sloping ground where the bedrock depth and the filling in front of the units combines to exceed +/- 2,0m below platform level, the following is recommended to reduce differential settlement:

- Found wholly in cut, or
- Found in a stiffened raft capable of accommodating the expected differential settlement, or
- Found on rafts / groundbeams supported by mini piles or pad columns taken through the fill and insitu soils to found onto competent weathered rock.

Table 1 overleaf provides recommended founding solutions relative to this site taking account of the Site Class designations shown in Figure 2 and anticipated slope gradients.
### TABLE 1: RECOMMENDED FOUNDING SOLUTIONS

<table>
<thead>
<tr>
<th>Site Class Description and Slope Condition</th>
<th>Construction Types (refer Tables 5-7 of Appendix 4)</th>
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<tbody>
<tr>
<td>R - H (Gentle slopes with &lt;2m to bedrock beneath fills)</td>
<td>Normal construction with good site drainage</td>
</tr>
</tbody>
</table>
| R - H (Steep slopes with >2m to bedrock beneath fills) | - Found wholly in cut, or  
- Stiffened raft, or  
- Rafts / groundbeams supported by mini-piles |
| R - C (Gentle slope with <2m to bedrock beneath fills) | Normal construction with good site drainage |
| R - C (Steep slopes with >2m to bedrock beneath fills) | - Found wholly in cut, or  
- Stiffened raft, or  
- Rafts / groundbeams supported by mini-piles |
| R - C (With boulders) | - Raft / groundbeam foundations |
| H1 (Gentle slopes and steep slopes) | - Modified normal (i.e. articulation and reinforcement) with foundations extending through fill into insitu.  
- Raft / groundbeam foundations |
| H2-S2 (only found in gentle slopes) | - Stiffened raft |
| P1, P2, P3 | - Not recommended for development |

Surface beds (where used) should be floating and underlain by a layer (200mm) of inert granular material to soften heave effects in “H” areas.

### 8. CONCLUSIONS AND SPECIAL PRECAUTIONARY MEASURES

The results from this geotechnical investigation confirm that the proposed development of the Redcliffe site is feasible, provided the recommendations given in this report are taken into consideration in the planning, design and development of the proposed site.

The geology of the site is rather complex and comprises Pietermaritzburg Shale, Dwyka Tillite and Natal Group Sandstone separated by faulted contacts. Numerous Jurassic age
Dolerite intrusions are also evident. Soil covers are generally thin and comprise cohesive clayey soils over Shale and Dolerite areas with granular "sandy" soils overlying Sandstone areas.

The site has been classified according to the NHBRC Residential Site Class designations which takes account of bedrock depths and the thickness of potentially problematic horizons. The recommended founding solutions given in this report take account of both the site class designation and slope condition (i.e. cut to fill platform requirements). On gentle slopes underlain by shallow soils normal (conventional strip footings) may be used. In areas with steeper slopes and thicker subsoils stiffened rafts / groundbeams with pads/piles extending down to competent like founding are generally recommended.

Seepage zones and slopes steeper than 1 in 3 have been delineated and are not recommended for development i.e. costly to develop. The NE site portion (delineated P3 in Figure 2) is also not recommended for development as there is considerable evidence indicating this to be a “high risk” potentially unstable shale area.

Stormwater must be controlled to prevent erosion and stability problems.

The majority of on-site soils and soft rock classify as G10 or better type material and may thus be used as subgrade fill in cut to fill housing/road platforms. Exception is the shale and Dolerite areas which are underlain by clayey transported and residual soils which are classified as worse than G10 type material and not recommended for use in the fill portions of cut to fill platforms. It would be economically unviable to import suitable material, for the entire platform in these areas, and hence it is recommended that sandwich compaction be employed (i.e. alternating the compacted on site clay with layers of better quality soft rock shale / soft rock dolerite / soft rock Tillite / Hillwash overlying sandstone). The earthworks could also be performed a considerable time before construction to allow the majority of fill settlement.

The weathered soft rock dolerite in the vicinity of IP5A/IP6 and the Hillwash overlying Sandstone, classifies as a G7 soil and is the best quality borrow pit material identified on site.

Areas underlain by Shale and Tillite are generally excavatable to between 2-3m depth by Soft excavation (after SANS 1200D). Areas underlain by sandstone are generally excavatable to between 0.5 - 1.5m depth by Soft excavation (after SANS 1200D). Considerably shallower levels of “hand excavation” are to be expected due to the shallow bedrock levels and stiff / very stiff cohesive soil profiles.
APPENDIX 1

INSPECTION PIT PROFILES
(IP 1 - IP 28)
APPENDIX 2

DYNAMIC CONE PENETROMETER
TEST RESULTS (DCP 1 - DCP 20)
APPENDIX 4

NHBRC STANDARDS AND GUIDELINES
FIGURE 2

NHBRC RESIDENTIAL SITE CLASS DESIGNATIONS