REPORT ON:

STAGE 7 & 8, LYNDHURST ROAD SUBDIVISION FRIMLEY, HASTINGS

STAGE 7 LOTS 64 TO 91 &
STAGE 8 LOTS 104 TO 117

PROJECT:
GEOTECHNICAL ASSESSMENT

CLIENT: GREENSTONE LAND DEVELOPMENTS LTD.

GREENSTONE LAND DEVELOPMENTS LTD.
P O BOX 1200
HASTINGS 4122

RDCL

EXECUTIVE SUMMARY

Greenstone Land Developments Ltd. (GLDL) engaged Resource Development Consultants Ltd (RDCL) to undertake a geotechnical assessment for Stages 7 &8 Lyndhurst Road, Frimley in Hastings.

The information contained in this report:

- May be relied on for Building Consent only for lightweight timber-framed, single level, residential buildings and foundations as prescribed.
- Any change to building or foundation type will require re-assessment which may include additional site testing and geotechnical analyses.

Stage 7 of the development covers twenty-eight (28) residential lots (Lots 64 – 91) and Stage 8 covers fifteen (15) residential lots (Lot 104 to 117).

Investigations comprise both shallow (hand auger and Dynamic Cone Penetrometer) and deep (Cone Penetrometer Testing) in accordance with Hastings District Council (HDC) guidelines for the assessment of liquefaction prone land.

Based on the liquefaction assessment, the site is considered susceptible to:

- High to very high risk of liquefaction during a ULS event; with
  - Minor to moderate surface expression; and
  - 15mm to 125mm vertical (free field) settlement indicated.
- Low risk of liquefaction during an SLS earthquake event; with
  - Little to no surface expression; and
  - Up to 2mm to 15mm vertical (free field) settlement

In accordance with MBIE (2015) Technical Guidance, Part C, V3a guidelines for lightweight timber-framed buildings:

- The site is classified Technical Category TC2/TC3 Hybrid; where
- Vertical settlement due to liquefaction governs design.

For TC2/TC3 hybrid foundation recommendations are, indicative foundation recommendations are for:

- A 0.6m deep gravel raft foundation; with
  - Geofabric placed in the base; and
  - Two (2) layers of geogrid reinforcement; with
- MBIE Part A, (December 2012) option 2 enhanced raft; or option 4 waffle slab foundation.

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APPENDICES

1 OVERVIEW

Greenstone Land Developments Ltd. (GLDL) engaged Resource Development Consultants Ltd (RDCL) to undertake a geotechnical investigation and assessment report for Stages 7 & 8 of the Greenstone Subdivision on Lyndhurst Road in Hastings.

1.1 PURPOSE OF THIS REPORT

The purpose of this report is to provide geotechnical information to support subdivision and building consent at individual Lot level for Stages 7 & 8, Lyndhurst Subdivision.

The information contained in this report may be relied on for Building Consent for the foundations recommended in this document. Any change to foundation type may require re-assessment of the geotechnical design and may involve additional site testing and geotechnical analyses.

1.2 UNDERSTANDING THE PROJECT

- This report includes the following stages as indicated on the Zorn Surveying Proposed Subdivision Plan (Job No: 16-EQH; Plan No: V22a, dated 10 August 2018);
- Stage 7 comprising twenty-eight (28) residential lots (Lots 64 to 91); and
- Stage 8 comprising fifteen (15) residential lots (Lots 104 to 117).

1.2.1 EXISTING REPORTS

RDCL has previously completed geotechnical investigation and reporting including:

- Lyndhurst Subdivision Development Reports:
  - Stages 2-6 comprising 67 residential lots between Arbuckle & Lyndhurst Road (RDCL reports R170602050_02, R170602050_03, R181090602_01, and R183970602_01); and
  - Stage 9 (183970602A- 02), dated 30 July 2019.

1.3 SCOPE OF WORK

Work was undertaken in general accordance with RDCL proposal 183970602, dated 4 October 2018.

2 SITE DESCRIPTION

Stages 7 & 8 are part of the 12 Stage Lyndhurst Road Residential Subdivision located in Frimley Hastings, bordered by Lyndhurst Road, Arbuckle Road and the Napier Expressway.

The subdivision comprises generally flat land with original levels altered by minor cut and fill.

The subdivision includes new road access and service installation which is outside of this scope of work.

2.1 REGIONAL GEOLOGY

Regional geology maps indicate the site is underlain by Holocene river deposits; comprising poorly consolidated alluvial gravel, sand, and mud (GNS Science, 2011).

These materials are further described in the Hawkes Bay Emergency Management Group Portal (HBEMGP) as being finely to moderately interlayered silt and fine sand; derived as a complex system of aggrading alluvial river and delta plain deposits (overbank flood deposits).

The depositional environment results in variable ground conditions where silt, sand and gravel deposits overly each to form non-continuous layers and lenses. This variation can be seen in the modern, braided river systems where coarse cobbles may be found in the river bed, with fine silt in the river margins.

2.1.1 LIQUEFACTION VULNERABILITY

The site is located in a zone of "high liquefaction vulnerability", as mapped by Hawke's Bay Emergency Management Group (HBEMGP); requiring an assessment of liquefaction potential and likely ground settlements under seismic conditions.

2.1.2 ACTIVE FAULTS

The site is located approximately 2.5 km southeast of the active trace of the Awanui Fault, as identified in the GNS Science Active Faults Database (2016).

3 RELEVANT GUIDELINES

Geotechnical investigations and assessment have been undertaken in accordance with relevant guidelines:

- Hastings District Council (June 2019). Geotechnical Site Investigations Guidelines. Residential Building Consents.
- MBIE Guidance Version 3 (Dec 2012) Revised issue of Repairing and Rebuilding Houses Affected by the Canterbury Earthquakes. Part A: Technical Guidance (TC1 and TC2).
- MBIE Guidance Version 3a (April 2015) Part C: Assessing, Repairing and Rebuilding foundations in TC3.

4 SUBSOIL INVESTIGATION

4.1.1 GENERAL

Geotechnical testing completed comprised site-specific testing at each Lot for Stages 7 & 8 comprising:

- Shallow investigation testing at each Lot comprising :
  - One (1) Hand auger investigation
  - Four (4) dynamic cone penetrometer (DCP) tests.
- Deep Testing at Subdivision Level:
  - Twenty-one (21) Cone Penetration Tests (CPT101 to 113 & CPT 201 to 208) tested to between 2.5m (refusal) and 20 m bgl.

Hand Auger and DCP testing locations are located on the Site Investigation Layout plan as Figure 1 (Stage 7), & Figure 2 (Stage 8) and Figure 3 for CPT tests.

Hand Auger and DCP logs are presented in Appendix A (Stage 7) & Appendix B (Stage 8). CPT Logs for the Subdivision are presented in Appendix C.

Soil samples recovered in hand augers were recorded by an engineering geologist in accordance with NZGS (2005) guidelines for field description of soil and rock.

4.1.2 SHALLOW REFUSAL

Shallow refusal of both nhad-augers and CPT has occurred at some locations within the development. In both cases, this is due to natural, coarse materials which in the geological context of the site (Section 2.1) may be expected and is considered normal.

Some shallow auger holes were unable to be completed (Lots 70 to 75 and Lot 91), due to penetration resistance of engineered granular fill and which has been certified as part of this report (Form 6 certification).

Several CPT's were terminated at shallow depth (~2.5m to ~5m) which is at a level below known engineered fill and is anticipated to be dense sands and gravels associated with naturally occurring geological conditions.

4.2 SUBSOIL CONDITIONS

4.2.1 STAGE 7 RESULTS

The results of shallow subsoil conditions at the locations tested in Stage 7 suggest:

- Imported TOPSOIL (Fill); comprising silt with some gravel, dark brown between 0.2 and 0.5 m thick; overlying
- Engineered FILL to between 0.5m and 1.2m bgl comprising Sandy / gravelly SILT, stiff, non-plastic, with a trace of topsoil;
- Natural Silty SAND & Sandy SILT, with occasional clay lenses, loose to medium dense or firm to termination depth consistent with anticipated overbank flood deposits in this region.

Hand auger investigations were terminated between 0.6m and 2.1m bgl.

Hand augers were unable to be completed at Lots 70 to 75 and 91 due to the density of compacted engineered fill comprising gravelly sands. These materials were monitored during placement and assessed suitable for subdivision development.

4.2.2 STAGE 8 RESULTS

The results of shallow subsoil conditions at the locations tested in Stage 8 suggest:

- Imported TOPSOIL (Fill); comprising silt with some gravel, dark brown between 0.3 and 0.7 m thick; overlying
- Engineered FILL (Isolated to Lots 111 to 117) to between 0.6m and 0.8m bgl comprising Sandy / gravelly SILT, stiff, non-plastic, with a trace of topsoil;
- Natural Silty SAND & Sandy SILT, with occasional clay lenses, loose to medium dense or firm, consistent with anticipated overbank flood deposits in this region.

Hand Auger investigations terminated between 1.2m and 2m depth due to hole collapse.

4.2.3 DEEP TESTING (CPT TESTS)

CPT outputs (Appendix C) indicate the subsoil profile comprises:

- Layer 1; Silt and clay dominated mixtures:
  - ~2m to 3.5m thick,
  - soft to firm and loose; overlying
- Layer 2; Sand with gravel dominated mixtures:
  - to ~11m bgl,
  - medium dense to dense; overlying
- Layer 3; Silt and clay dominated mixtures
  - to ~15m bgl,
  - firm to stiff; overlying
- Layer 4; Sand and gravel dominated mixtures:
  - to ~17m depth,
  - medium dense to dense; overlying;
- Layer 5; Silt and clay dominated mixtures to:
  - >20m depth,
  - firm to stiff.

Dense sandy gravels at shallow depth are indicated due to shallow refusal in CPT tests (CPT 101, 102, 103, 105, 201, & 205) where Cone Resistance (qt) was recorded in excess of 30MPa.

4.3 GROUNDWATER

Groundwater was not encountered during the site investigations.

5 EARTHWORKS

5.1 GENERAL CUT & FILL

Stages 7 & 8 was subjected to minor filling up to ~700mm thick in places comprising localised silts and sands with traces of topsoil excavated from service installations and imported granular fill derived offsite. Traces of topsoil observed in engineered fill is acceptable in low proportions (<5%).

Fill placement was observed during periodic site construction monitoring activities to be in accordance with NZS4431:1989 Earthworks for Residential Development.

Cut excavations were undertaken to form the road access and for service installation.

5.2 SEPTIC TANK REINSTATEMENT

A Septic Tank was removed from Lot 66 (2m x 2m x 1.5m deep excavation) and backfilled with “river run”granular fill and compacted with a heavy plate compactor in 150mm lifts. Verification testing was by NDM Compaction testing method by an Independent Laboratory.The results of the compaction test achieved target density of:

- > 100% MDD at two locations.

The Site plan showing the Septic Tank Plan and Compaction Test results are attached in Appendix D

6 GEOTECHNICAL ASSESSMENT

6.1 LIQUEFACTION ASSESSMENT

The liquefacftion assessment was undertaken at subdivision-wide level due to the geological variability encountered during deep testing. Further assessment may be undertaken at individual lot level to confirm specific testing results.

The liquefaction assessment utilised 21 CPT tests (CPT 101 to 113 and CPT 201 to 208) and was assessed using CLiq v.2.1.6.7 Liquefaction Assessment Software. The liquefaction output results are presented in Appendix E.

In accordance with the CPT testing across the site, the Lyndhurst Subdivision is assessed to be:

- For SLS earthquake event:
  - Low risk of liquefaction, with
  - Little to no surface expression;
  - Up to 15mm vertical settlement predicted (Free-field).
- For ULS earthquake event:
  - High to very high risk of liquefaction; with
  - Minor to moderate surface expression; and
  - ~15mm to ~125mm of estimated vertical settlement (Free-field).

Liquefaction potential and induced settlement results are summarised in Table 3; lateral displacements are not expected due to the generally flat relief across the site and surrounding area.

The results of the liquefaction assessment are summarised in Table 1 below.

TABLE 1: CPT ASSESSED LPI, LSN AND VERTICAL SETTLEMENT FOR SLS AND ULS

Development Stage	Test ID	Liquefaction Potential Index	Liquefaction Severity Number	Estimated Vertical Settlement (mm)	Termination Depth (m)
7 - 12	CPT101 to 113 & CPT201 to 208	Low Risk	Little to no expression	2 - 15	See below
Development Stage	**Test ID**	**Liquefaction Potential Index**	**Liquefaction Severity Number**	**Estimated Vertical Settlement (mm)**	**Termination Depth (m)**
7	CPT106	Very High	Moderate	125	13.5
7	CPT107	Low Risk	Little to none	11	3.4
7	CPT108	Very High	Moderate	127	16
7	CPT206	Very High	Moderate	119	20
7	CPT208	High Risk	Minor	71	6.9
8	CPT113	Very High	Moderate	121	17
8	CPT203	Very High	Moderate	117	14.2
8	CPT204	Very High	Minor	102	14.4
8	CPT205	Very High	Minor	99	10.6
9	CPT109	Very High	Moderate	120	20
9	CPT110	Very High	Moderate	115	20
9	CPT201	Low	Little to None	7	3.3
9	CPT202	Very High	MInor	103	20.1
10	CPT111	Very High	Minor	96	9
10	CPT112	Very High	Moderate	123	20
11	CPT101	Low	Little to none	15	4.9
12	CPT102	Low	Little to none	3	2.4
12	CPT103	High Risk	Minor	49	4.9
12	CPT104	Very High	Moderate	117	13.8
12	CPT105	High Risk	Minor	86	8.2
12	CPT207	Low	Little to None	5	2.6

6.1.1 SEISMIC SOIL CLASSIFICATION

The site is classified as site subsoil "Class D – Deep or Soft Soil Site" in accordance with NZS1170.5:2004, part 5: Earthquake Actions – New Zealand.

The site subsoil class was determined based on conservative review of the Hawkes Bay well database.

The Hawkes Bay well database indicates ground conditions are variable in the area, such that the site can be expected to be underlain by deep soils, specifically:

- Well 2008;
- Well 5554;
- Well 671;
- Well 10847; and
- Well 8474.

6.1.2 BASIS OF ASSESSMENT

The liquefaction assessment for the site was assessed using CLiq, accepted industry software package (Geoligismiki, 2014), CPT data of current ground conditions, soil logs from Test Pit investigations and the following input parameters (GNS Consultancy Report (2015/185), October 2015):

- PGA = 0.12g (SLS) & 0.42g (ULS), with:
  - Magnitude (M) = 6.2 (SLS) & 6.5 (ULS)
  - C=1.12 (Class D Soil), and
  - R=0.25 (SLS) & 1.0 (ULS).
- Groundwater table 2.0 m bgl based on our knowledge of the area.

The design earthquake was chosen on the basis of the probability of recurrence. The probability is based on historical earthquakes assuming a 50-year design life and Importance Level 2 (IL2) structure.

A 6.5 magnitude earthquake correlates with 500 year return period (ULS) and 6.2 magnitude for a 25 year return period (SLS) and was assigned.

6.2 INFERRED BEARING CAPACITY

DCP test results have been correlated with Ultimate Bearing Capacity (UBC) in accordance with M.J. Stockwell 1977. Inferred UBC for each site is presented in Appendix F.

Inferred Bearing capacity varied between 200mm and 300kPa between 0.2m and 0.5m depth across the site.

For foundation design, Liquefaction risk governs bearing capacity and therefore the foundation recommendations are based on the results of the Liquefaction Assessment.

7 GEOTECHNICAL RECOMMENDATIONS

7.1 FOUNDATION RECOMMENDATIONS

Based on the results of these investigations, we consider Stages 7 & 8 to be suitable for the proposed residential development provided:

- Foundations meet TC2/TC3 Hybrid type foundation requirements in accordance with MBIE (April 2015) TC3 Technical Guidance, V3a; where
- A gravel raft foundation and enhanced slab or waffle slab in general accordance with MBIE Technical Guidance, Part A, December 2012 is used.

7.1.1 GRAVEL RAFT FOUNDATION

The gravel raft foundation is presented as a schematic section in Figure 4. The gravel raft specification requires:

- Undercut to 0.6m bgl and 1m horizontal distance outside the building footprint;
- Placement of geotextile filter cloth (Strength Class C) in the base and wrapped up the sides;
- Placement of two (2) layers of Cirtex geogrid SS30 or equivalent, where the first layer is placed in the base with a second layer separated by ~150mm gravel fill.
- Placement of compacted, well-graded gravels with maximum particle size of 70mm and less than 15% fines, free of topsoil or deleterious materials; and
- Compacted to 95% MDD at optimum water content;
- Tested by NDM testing by an independent laboratory.

7.1.2 FLOOR SLAB

The Floor slab should incorporate from MBIE Part A, December 2012, either:

- Option 2 (300mm – 400mm thick) enhanced raft; or
- Option 4 Waffle Slab

7.2 SUITABILITY FOR USE

7.2.1 FOUNDATION SOLUTIONS; THIS REPORT

Foundation solutions given in this report are considered suitable for use to support a Building Consent provided:

- The proposed structure generally meets the description of Lightweight, single-level timber-framed buildings of "simple shape"; and the
- Proposed foundations meet the requirements of TC2/TC3 hybrid category solutions.

Alternative solutions require specific geotechnical testing and design to confirm.

The depth to bearing is indicative based on-site testing on the day. Experience shows that depth may vary with excavation, particularly in wet conditions.

7.2.2 ALTERNATIVE FOUNDATION SOLUTIONS; SPECIFIC DESIGN

Alternative, acceptable foundation solutions may be possible based on additional geotechnical testing, or structural design.

8 GEOTECHNICAL VERIFICATION

Geotechnical inspections required for verification include:

- Excavation Inspection (Geotechnical Engineer);
- Inspection of geotextile and geogrid components;
- Granular backfill confirmation;
- Independent compaction testing (NDM);
- Verification of Compaction tests (Geotechnical Engineer); and
- Issue of Producer Statement (PS4); Geotechnical Engineer.

9 STATEMENT OF PROFESSIONAL OPINION - FORM 6 (224C)

A statement of professional opinion as to the suitability of land for building development is presented in Appendix G.

10 REFERENCES

GNS Science. (2004). Active Faults Database. *Institute of Geological and Nuclear Sciences*. GNS Science.

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M.J. Stockwell, Determination of allowable bearing pressure under small structures, 15 June 1977, New Zealand Engineering, 32,6 p 132-135

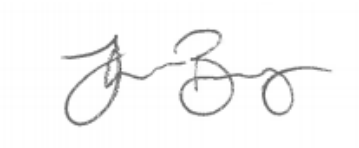
11 LIMITATIONS

- This report has been prepared for the particular purpose outlined in the project scope and no responsibility is accepted for the use of any part in other contexts or any other purpose.
- Ground conditions assessed in this report are inferred from published sources, site inspection and the investigation described. Variations from the interpreted conditions may occur, and special conditions relating to the site may not have been revealed by this investigation, and which are therefore not taken into account. No warranty is included either expressed or implied that the actual conditions will conform to the interpretation contained in this report.
- No responsibility is accepted by Resource Development Consultants Ltd for inaccuracies in data supplied by others. Where data has been supplied by others, it has been assumed that this information is correct.
- Groundwater conditions can vary with season or due to other events. Any comments on groundwater conditions are based on observation at the time.
- This report is provided for use by the client, section owners, and Hastings District Council and is confidential to the client and their professional advisors. No responsibility whatsoever for the contents of this report shall be accepted for any person other than the client.

12 CLOSURE

We trust this meets your current needs. Should you wish to discuss any aspect of the contents of this document please contact the undersigned on 06 877-1652.

Prepared by:



T Bunny
BSc, PG Dip EngGeol
Senior Engineering Geologist

Reviewed by:

CA Wylie
MSc; MIPENZ, CPEng
Principal

FIGURES

FIGURE 1 – STAGE 7 SITE INVESTIGATION LAYOUT

5607850.0 5607900.0 5607950.0 5608000.0

1928365.0 1928415.0 1928465.0 1928615.0 1928665.0 1928715.0

Lot 81 Lot 82 Lot 83 Lot 84 Lot 85 Lot 86 Lot 87 Lot 88 Lot 89 Lot 90 Lot 91

DCP7.58 DCP7.59 DCP7.63 DCP7.66 DCP7.67 DCP7.70 DCP7.71 DCP7.74 DCP7.75 DCP7.78 DCP7.79 DCP7.83 DCP7.86 DCP7.87 DCP7.90 DCP7.91 DCP7.94 DCP7.95 DCP7.98 DCP7.99
HA7.08 DCP7.62 HA7.09 HA7.10 HA7.11 HA7.12 HA7.13 DCP7.82 HA7.14 HA7.15 HA7.16 HA7.17
DCP7.57 DCP7.60 DCP7.64 DCP7.65 DCP7.68 DCP7.69 DCP7.73 DCP7.76 DCP7.80 DCP7.81 DCP7.84 DCP7.85 DCP7.88 DCP7.89 DCP7.92 DCP7.93 DCP7.96 DCP7.97 DCP7.100
DCP7.61 DCP7.72 DCP7.77

STAGE 7

DCP7.56 DCP7.52 DCP7.49 DCP7.45 DCP7.44 DCP7.41 DCP7.40 DCP 7.37 DCP7.36 DCP 7.32 DCP7.24 DCP7.21 DCP7.20 DCP7.17 DCP 7.16 DCP7.13 DCP7.12 DCP7.11
DCP7.53 DCP7.48 DCP7.29 DCP7.28 DCP7.25 DCP7.09 DCP7.10
HA7.07 HA7.06 HA7.05 HA7.04 HA7.03 DCP 7.33 DCP7.07
DCP7.55 DCP7.54 DCP7.51 DCP7.50 DCP7.46 DCP7.43 DCP7.42 DCP7.08
DCP7.47 DCP7.46 DCP7.39 DCP9.38 DCP7.35 DCP 7.34 DCP7.30 DCP7.26 DCP7.23 DCP7.22 DCP7.19 DCP7.18 DCP 7.14 DCP7.05 HA7.18 DCP7.06
DCP7.31 DCP7.27 DCP 7.15
DCP7.04 DCP7.01
HA7.02
DCP7.03 DCP7.02
DCP7.101 DCP7.102
HA7.01
DCP7.104 DCP7.103
DCP7.105 DCP7.106
HA7.19
DCP7.108 DCP7.107

Lot 80 Lot 79 Lot 78 Lot 77 Lot 76 Lot 75 Lot 74 Lot 73 Lot 72 Lot 71 Lot 70 Lot 68 Lot 67 Lot 66 Lot 64 Lot 65

Legend

- DCP Tests
- Hand Auger

Fill Thikness

- 0.0 - 0.05m
- 0.05 - 0.1m
- 0.1 - 0.15m
- 0.15 - 0.2m
- 0.2 - 0.25m
- 0.25 - 0.3m
- 0.3 - 0.35m
- 0.35 - 0.4m
- 0.4 - 0.45m
- 0.45 - 0.5m
- 0.5 - 0.55m
- 0.55 - 0.6m
- 0.6 - 0.65m
- 0.65 - 0.7m
- 0.7 - 0.75m
- Stage 7 Lot Boundaries

10 0 10 20 30 40 50 m

RDCL

RDCL
PO Box 28057 | 8/308 Queen St East Hastings NZ
Tel: +64 6 8771652 | Fax: +64 6 877 5015
Email: info@rdcl.co.nz www.rdcl.co.nz

Title	Site Investigation Layout	Drawn By	BB	Date	06/08/19
Project	Stage 7 - Lyndhurst Rd Subdivision	Checked By	TB	Date	06/08/19
Client	Greenstone Land Development Ltd	Approved By	TB	Date	06/08/19

Drawing Size- A3
Project No.: 183970602
Figure Number: 1

5607700.0 5607750.0 5607800.0 5607850.0

FIGURE 2 - STAGE 8 SITE INVESTIGATION LAYOUT

5607975 5607950 5607925 5607900 5607875 5607850

1928300 1928275 1928250 1928425 1928450 1928400 1928375

1927000 1928000 1929000 1930000 1931000

5605000 5606000 5607000 5608000 5609000

HASTINGS

Lot 112 Lot 113 Lot 114 Lot 115 Lot 116 Lot 117

Lot 114 Lot 110 Lot 171 Lot 109 Lot 108 Lot 107 Lot 106 Lot 105 Lot 104

DCP8.14 DCP8.15 DCP8.18 DCP8.19 DCP8.22 DCP8.23 DCP8.26 DCP8.27 DCP8.30 DCP8.31 DCP8.33 DCP8.36

HA8.04 HA8.05 HA8.06 HA8.07 HA8.08 HA8.09

DCP8.13 DCP8.16 DCP8.12 DCP8.11 DCP8.17 DCP8.20 DCP8.24 DCP8.21 DCP8.25 DCP8.28 DCP8.32 DCP8.34 DCP8.35

HA8.03 DCP8.09 DCP8.10 DCP8.29

STAGE 8

DCP8.07 DCP8.08 HA8.02 DCP8.06 DCP8.05

DCP8.56 DCP8.53 DCP8.52 DCP8.49 DCP8.48 DCP8.45 DCP8.44 DCP8.42 DCP8.40 DCP8.37

DCP8.60 DCP8.57 HA8.15 HA8.14 HA8.13 HA8.12 HA8.11 HA8.10

DCP8.02 DCP8.03 DCP8.59 DCP8.58 DCP8.55 DCP8.54 DCP8.50 DCP8.51 DCP8.46 DCP8.47 DCP8.43 DCP8.41 DCP8.39 DCP8.38

HA8.01 DCP8.01 DCP8.04

Legend

- DCP
- HA
- Lot boundaries (Stage 8)

Legend for Fill Thickness

- 0.0 - 0.05 m
- 0.05 - 0.1 m
- 0.1 - 0.15 m
- 0.15 - 0.2 m
- 0.2 - 0.25 m
- 0.25 - 0.3 m
- 0.3 - 0.35 m
- 0.35 - 0.4 m
- 0.4 - 0.45 m
- 0.45 - 0.5 m
- 0.5 - 0.55 m
- 0.55 - 0.6 m

Notes:
New Zealand Topo50 Map and Hawke's Bay 0.3 m Rural Aerial Imagery (2014-2015) obtained from https://data.linz.govt.nz/layer/

5 0 5 10 15 20 25 30 35 40 m

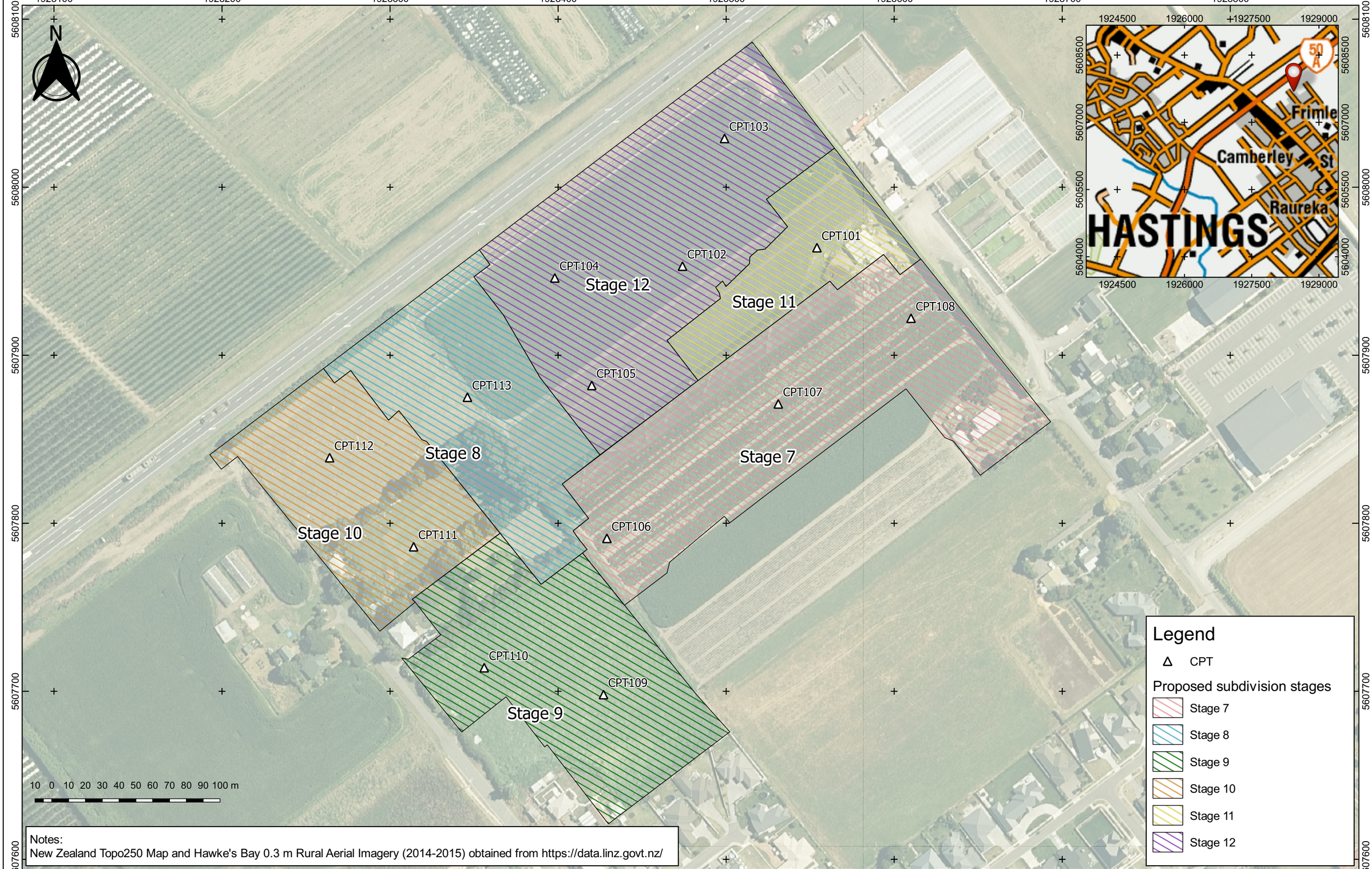
RDCL

RDCL
PO Box 28057 | 8/308 Queen St East Hastings NZ
Tel: +64 6 8771652 | Fax: +64 6 877 5015
Email: info@rdcl.co.nz www.rdcl.co.nz

Title	Site Investigation Layout	Drawn By SD	Date 09/08/19	Drawing Size- A3
Project	183970602 - Stage 8: Lyndhurst Rd Subdivision	Checked By TB	Date 09/08/19	File Name
Client	Greenstone Land Developments Ltd	Approved By TB	Date 14/08/19	Figure Number: 2

5607875 5607850 5607825 5607800 5607775 5607750

FIGURE 3 - STAGES 7 TO 12 CPT INVESTIGATION LAYOUT



Notes:
New Zealand Topo250 Map and Hawke's Bay 0.3 m Rural Aerial Imagery (2014-2015) obtained from https://data.linz.govt.nz/

RDCL
PO Box 28057 | 8/308 Queen St East Hastings NZ
Tel: +64 6 8771652 | Fax: +64 6 877 5015
Email: info@rdcl.co.nz www.rdcl.co.nz

Title	CPT Test Locations	Drawn By SD	Date 28/05/19	Drawing Size- A3	
Project	Stage 9 - Lyndhurst Rd Subdivision	Checked By BB	Date 28/05/19	Project No.: 183970602	
Client	Greenstone Land Development Ltd	Approved By TB	Date 28/05/19	Figure Number: 2	

FIGURE 4 - SCHEMATIC FOUNDATION RECOMMENDATIONS

NOTES:

1. For recommended foundation type, refer to RDCL geotechnical report.

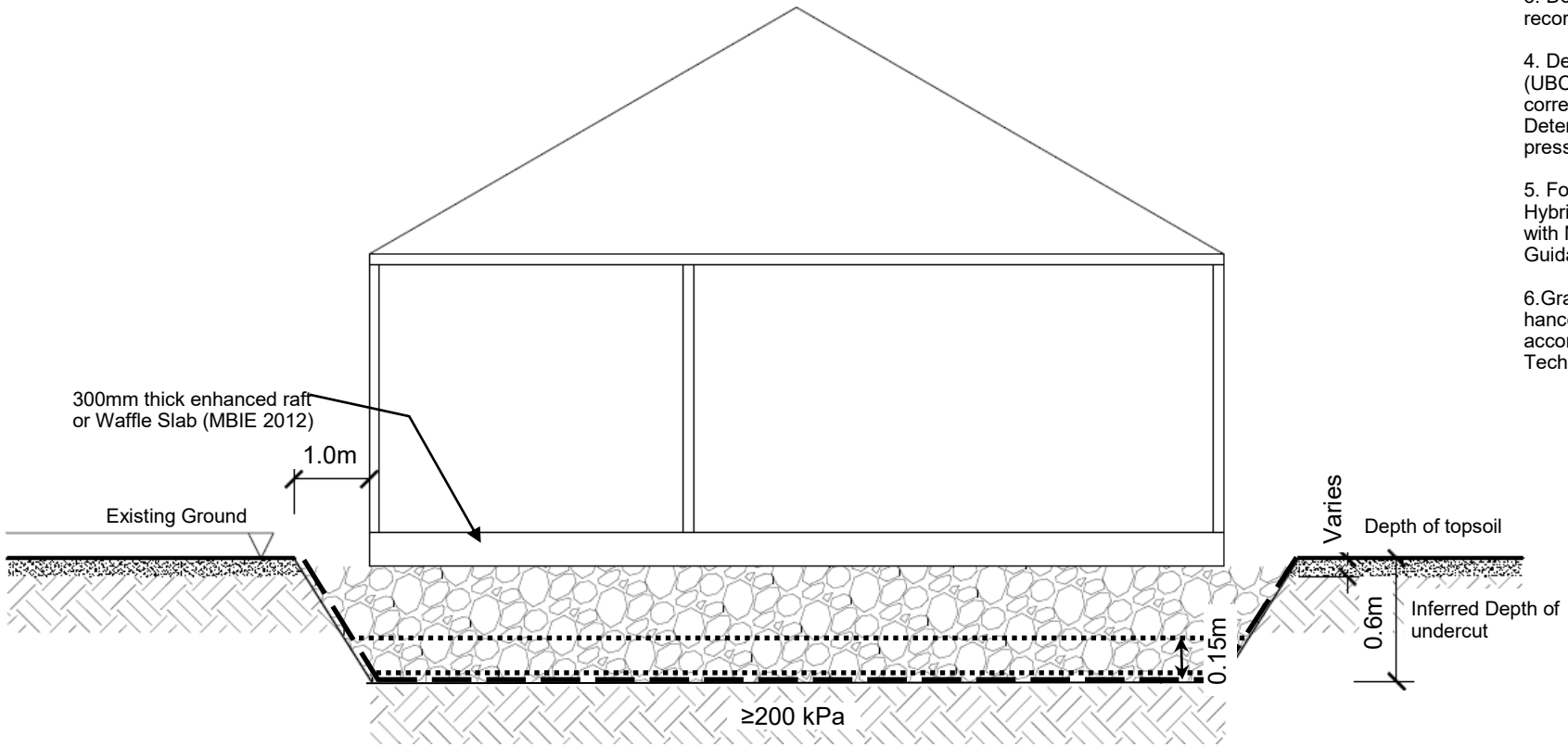
2. Depth of undercut is referenced from existing ground level

3. Depth of topsoil is based on depth recorded at the locations tested.

4. Depth to Ultimate Bearing Capacity (UBC) is inferred from DCP tests in correlation with M.J.Stockwell (1977); Determination of allowable bearing pressures under small structures.

5. Foundations to meet TC2/TC3 Hybrid trype foundations in accordance with MBIE (April 2015) TC3 Technical Guidance, V3a.

6.Gravel Raft foundation and enhanced slab or Waffle slab in general accordance with MBIE (2012) Technical Guidance, Part A



One layer of TNZ F7: Strength Class C Geotextile placed in base and wrapped up the sides of excavation

One/Two layers of Cirtex 30/30 Secugrid laid in the base and separated with ~200mm of granular fill.

REFERENCE:

MBIE (2012) Part A Technical Guidance Version 3

MBIE (2015) Part C Technical Guidance Version 3a.

RDCL	TITLE	Schematic Foundation Recommendations	PROJECT	183970602B		
	PROJECT	Lyndhurst Subdivision Stage 7 & 8	DRAWN BY	TB	DATE	30/8/19	APPX
	CLIENT	Greenstone Land Development Ltd	CHECKED BY	CAW	DATE	30/8/19	G

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, clients can benefit from a lowered exposure to the subsurface problems that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed below, contact your GBA-member geotechnical engineer. Active involvement in the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Geotechnical-Engineering Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. *Those who rely on a geotechnical-engineering report prepared for a different client can be seriously misled*. No one except authorized client representatives should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one – not even you – should apply this report for any purpose or project except the one originally contemplated.*

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read it *in its entirety*. Do not rely on an executive summary. Do not read selected elements only. *Read this report in full.*

You Need to Inform Your Geotechnical Engineer about Change

Your geotechnical engineer considered unique, project-specific factors when designing the study behind this report and developing the confirmation-dependent recommendations the report conveys. A few typical factors include:

- the client's goals, objectives, budget, schedule, and risk-management preferences;
- the general nature of the structure involved, its size, configuration, and performance criteria;
- the structure's location and orientation on the site; and
- other planned or existing site improvements, such as retaining walls, access roads, parking lots, and underground utilities.

Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

This Report May Not Be Reliable

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, that it could be unwise to rely on a geotechnical-engineering report whose reliability may have been affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If your geotechnical engineer has not indicated an "apply-by" date on the report, ask what it should be*, and, in general, *if you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying it. A minor amount of additional testing or analysis – if any is required at all – could prevent major problems.

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface through various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing were performed*. The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgment to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team from project start to project finish, so the individual can provide informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, *they are not final*, because the geotechnical engineer who developed them relied heavily on judgment and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* revealed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a full-time member of the design team, to:

- confer with other design-team members,
- help develop specifications,
- review pertinent elements of other design professionals' plans and specifications, and
- be on hand quickly whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction observation.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for informational purposes only*. To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report, but they may rely on the factual data relative to the specific times, locations, and depths/elevations referenced. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely*. Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures*. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. As a general rule, *do not rely on an environmental report prepared for a different client, site, or project, or that is more than six months old.*

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, none of the engineer's services were designed, conducted, or intended to prevent uncontrolled migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration.*** Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

Telephone: 301/565-2733
e-mail: info@geoprofessional.org www.geoprofessional.org