ATTACHMENT A
to
SUBMISSION ON A PROPOSED NATIONAL POLICY STATEMENT FOR HIGHLY PRODUCTIVE LAND

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Key paragraphs relevant to identification of highly productive land, excerpted from evidence of Dr. Douglas Laidlaw Hicks (transcript Env-2016-Akl-304-000199)

Throughout these paragraphs the abbreviation AUPOiP denotes Auckland Unitary Plan (Operative in Part).

5 MATTERS RELEVANT TO DETERMINING WHETHER SOILS WOULD BE CLASSIFIED AS ELITE, PRIME AND OTHER

5.1 The AUPOiP defines land containing elite soil as:

Land classified as Land Use Capability Class 1 (LUC1). This land is the most highly versatile and productive land in Auckland. It is:

- well-drained, friable and has well-structured soils;
- flat or gently undulating; and
- capable of continuous cultivation.

Includes:

- LUC1 land as mapped by the New Zealand Land Resource Inventory (NZLRI);
- other lands identified as LUC1 by more detailed site mapping;
- land with other unique location or climatic features, such as the frost-free slopes of Bombay Hill;
- Bombay clay loam;
- Patumahoe clay loam;
- Patumahoe sandy clay loam; and
- Whatitiri soils.

5.2 The AUPOiP defines land containing prime soil as:

Land identified as land use capability classes two and three (LUC2, LUC3) with slight to moderate physical limitations for arable use. Factors contributing to this classification are:

- readily available water;
- favourable climate;
- favourable topography;
- good drainage; and
- versatile soils easily adapted to a wide range of agricultural uses.

5.3 These definitions were uplifted and modified from the former Auckland Regional Policy Statement 1999. Other land is not defined, though by default it is any land which does not meet the criteria for elite or prime.

5.4 I consider that some parts of each definition make it difficult for a soil scientist to state clearly whether a soil is elite, prime or other in terms of the AUPOiP wording. These include, but are not limited to the following issues:

(a) "unique location or climatic features" are unspecified (apart from one locality which is certainly not unique);
(b) several highly versatile and productive soils are not listed;
(c) some of the factors contributing to classification of land as LUC 2 or LUC 3 are vaguely worded;
(d) whether LUC 1, 2 & 3 land as mapped by the NZLRI at 1:50,000, or LUC 1, 2 & 3 land as identified by more detailed site mapping, should be equated with land containing elite and prime soil;
(e) where LUC 1, 2 or 3 land contains a mix of soils, whether it fits the definition of land containing elite soil (where there is some elite) or prime soil (where there is more prime than elite) or neither (where other soil occupies a larger part of the land's area).

5.5 From a soil scientist's perspective, the land in the appeal area would be assessed as highly versatile (generally corresponding to 'elite') soil or versatile (generally corresponding to 'prime') soil depending on factors more specific than those listed in the AUPOiP definitions for land containing elite and prime soils. The properties of a highly versatile soil are well summarised by the New Zealand Society of Soil Science's publication Soils in the New Zealand Landscape (Molloy 1988):

- occurs on flat land or very gentle slopes (<5o),
- has a potential rooting depth of at least 0.75 m,
- offers little resistance to root penetration,
- suffers very few days of soil water deficit,
- suffers very few days of waterlogging,
- has enough large, interconnected pores to ensure good drainage and aeration,
- has a low content of stones,
- is capable of being cultivated by machines through most of the spring period,
- has high structural stability, and
- is not likely to suffer from erosion, flooding or salt contamination.

5.6 The above criteria are accepted and used by professional soil scientists throughout New

Zealand.

5.7 A highly versatile soil meets all the criteria. A versatile soil meets most, but falls short on one or more. The limitation - greater slope, shallower rooting depth, etc. - necessitates an adjustment to how the soil is managed. Where field examination of its soil (and other site characteristics) indicates all physical limitations are absent or negligible, a site is classed as LUC 1, defined as the most versatile multiple-use land with minimal physical limitations for arable use (Land Use Capability Handbook, Lynn et al 2009). Where field examination indicates a limitation is present but slight, the site is classed as LUC 2, defined as very good land with slight physical limitations to arable use, readily overcome by management and soil conservation practices. Where field examination indicates a limitation is moderate the site is classed as LUC 3, defined as land (which) has moderate physical limitations to arable use. These limitations restrict the choice of crops and the intensity of cultivation, and/or make special soil conservation practices necessary.

6 METHOD FOR DETAILED SOIL INVESTIGATIONS

6.1 Soils of the Mangere area are shown on published and unpublished DSIR Soil Bureau maps (listed in Attachment B) at scales ranging from 1:253,840 to 1:10,000. At these scales each soil polygon (map area) shows the main soil within its boundary, and its label may indicate that other soils are present but undifferentiated. A map scale greater than 1:10,000 is usually needed to depict detailed soil patterns on individual properties.

6.2 Land use capability of the soils at Mangere appears on 1:63,360 and 1:50,000 New Zealand Land Resource Inventory (NZLRI) maps (listed in Attachment B) which are used for indicative regional-scale planning by Auckland Council, and by other local authorities nationwide. Each NZLRI polygon (map area) indicates LUC class for the majority of land within its boundary. To support planning applications for individual properties, NZLRI LUC usually needs to be re-mapped in greater detail and at a larger scale, to ascertain where better (or worse) LUC classes are present on parts of the polygons.

6.3 I have identified soils by field investigation of all land in the appeal area, except for several small properties on the Pukaki Peninsula which are either subject to Special Purpose - Maori Purpose Zoning or are existing house lots; and except for parts of Crater Hill which are either quarried or back-filled or flooded. Field investigations were undertaken at Pukaki Peninsula on 16 - 17 March 2017, followed by a return visit on the morning of 27 March 2017 to check the positions of several soil boundaries. Field investigations were undertaken at Crater Hill on 2 - 3 May 2017, followed by a return visit on the morning of 9 June 2017 to check the identities of several soils.

6.4 At both sites, soil identifications were made by digging holes with auger or spade close to field boundaries where changes were visible in cultivated soil, or close to landform boundaries where changes were likely in vegetated soil, and also at intermediate positions.

6.5 Soil properties - topsoil depth; topsoil and subsoil colour; texture, structure, consistence and moisture retention in topsoil and upper subsoil - were visually observed and recorded at each hole i.e. standard procedure as described in the Soil Description Handbook (Milne et al 1995). To assist land use capability classification of the soils, landform boundaries were mapped. Underlying geology, surface soil, and other relevant physical features - slope, site wetness, and erosion or deposition (if any) - were noted for each landform i.e. standard procedure as described in the Land Use Capability Handbook (Lynn et al 2009).

7 DETAILED SOIL INVESTIGATIONS

7.1 Figure 1 in Attachment C (Pukaki Peninsula) and Figure 1 in Attachment D (Crater Hill) are the resulting maps. They depict the soil pattern at 1:5,000 which is a scale appropriate for small horticultural land holdings (refer to paragraph 6.1). Table 1 in each Attachment summarises the match between soil, other physical features, and land use capability.

7.2 In terms of the matters referred to in the AUPOiP definitions, Weymouth and Waitomokia soils, on sites labelled as LUC class 1 sub-class c, are elite soils. Weymouth and Waitomokia soils, on sites labelled as LUC class 2 subclass c+w, or as LUC class 2 subclass c+t, are prime soils. Waitomokia, Puketutu and McLaughlin soils, on sites labelled as LUC class 3 subclass t, or as LUC class 3 subclass r, are also prime soils.

The balance of Section 7 paragraphs express elite, prime and other soils as areas and percentages of land subject to appeal at the two sites. Details about each soil's properties, together with explanations of why it does - or doesn't - meet the criteria, are contained in evidential Attachments C and D. The soil and land use capability maps in these attachments (accepted by the Court) are scans of hand-drawn and hand-labelled overlays on colour aerial photographs. Similar maps - such as I have recently supplied for several applicants' resource consent applications in the Auckland region - should be equally acceptable to local authorities without any expectation that applicants go to the expense of digital maps produced by geographic information systems (GIS) software. Although the latter may be warranted from an applicant's viewpoint, if soil or land use capability maps are to be registered with subdivision and site development plans already stored on a GIS.

Section 8 paragraphs contain other points relevant to the proposed NPS - HPL. Paragraph 8.1 in particular may shed light on questions in the discussion document such as :

* Can soil names or soil locations be used to identify highly productive land, without reference to soil versatility criteria?

* Do soil versatility criteria (highly versatile = elite; versatile = prime, non-versatile = other) need to be taken into account when identifying highly productive land?

* Does highly productive land correspond to LUC Classes 1, 2 and 3? Or to Classes 1 and 2? Or just to Class 1?

* Is there some LUC Class 4 & lower land which can be rendered highly productive for specific crops if the right management is applied?

8 WHETHER THE SOILS AT PUKAKI PENINSULA AND CRATER HILL ARE PHYSICALLY SUITABLE FOR HORTICULTURE

8.1 Land containing elite soil and land containing prime soil often have exactly the same soil. The difference, designated by transition from LUC class 1 to LUC class 2, is that the soil is designated prime on areas where it needs a little extra management to overcome limitations such as slight winter wetness or slight erosion risk. The transition from LUC class 2 to LUC

class 3 denotes areas of prime soil which need somewhat more management where limitations become moderate.

8.2 As previously stated (paragraph 7.2), in terms of the matters referred to in the AUPOiP definitions, Weymouth and Waitomokia soils, on sites labelled as LUC class 1 sub-class c, are elite soils. Weymouth and Waitomokia soils, on sites labelled as LUC class 2 subclass c+w, or as LUC class 2 subclass c+t, are prime soils. Waitomokia, Puketutu and McLaughlin soils, on sites labelled as LUC class 3 subclass t, or as LUC class 3 subclass r, are also prime soils.

8.3 My opinion, after investigating these areas of soil in the field, is that they are physically suitable for many horticultural crops:

* above-ground vine crops such as tomato, squash and pumpkin;
* shallow-rooting salad greens;
* deeper-rooting brassicas;
* tuber and bulb crops such as potato, kumara and onion;
* grape vines and kiwifruit vines;
* pip, stone, and citrus fruit trees.

8.4 To grow any of these crops successfully, there is an increasing need for soil and site management moving from elite soil (LUC 1) through prime soil (LUC 2) to prime soil (LUC 3). At Pukaki Peninsula and Crater Hill, this is demonstrated by the landowners' past and present management practices, for instance:

* fertiliser to maintain soil nutrients on any LUC class;
* cultivation techniques which maintain soil structure on any LUC class;
* irrigation to overcome seasonal dryness on any LUC class;
* shelter plantings which protect against wind stress on any LUC class;
* deep ripping or subsoil drainage to overcome slight seasonal wetness on LUC 2 c+w;
* cross-slope cultivation to mitigate slight topsoil sheetwash on LUC 2 c+t;
* de-stoning to overcome moderate topsoil stoniness on LUC 3 r;
* reduced cultivation to mitigate moderate topsoil sheetwash on LUC 3 t.

8.5 The management practices may constrain frequency of cropping and annual crop yield per hectare. They certainly impose additional time requirements and production costs on growers. My opinion remains that they do not prevent the growth of productive horticultural crops on these soils.

8.6 My opinions stated in paragraphs 8.3, 8.4 and 8.5 are supported not just by assessing soil and site characteristics or observing what was growing at the time of site investigations, but also by the following facts:

* Most areas of elite & prime soil (if reference is made to the finer grained 1:5,000 soil and LUC map) at Pukaki Peninsula have been in continuous market gardening for decades;
* Some areas of elite & prime soil (if reference is made to the finer grained 1:5,000 soil and LUC map) at Crater Hill have been intermittently used for market gardening & orchards (kiwifruit);
* They are the same soils as used for market gardening in the past, at sites elsewhere in Mangere now urbanized;
* They are similar to elite and prime soils used for market gardens and orchards, elsewhere in the Auckland region (soils such as Karaka, Pukekohe, Patumahoe, Hamilton,

Hobsonville, and Otao soils).

My observations and opinions expressed in paragraphs 8.1 to 8.6 for a specific site in 2017, now lead me to add an additional opinion about identification of highly productive land elsewhere:

* Land mapped as LUC 1 and 2 at 1:50,000 (NZLRI LUC or converted to equivalent FARM LUC) will be predominantly LUC 1 and 2, and will contain a proportion of lower LUC classes (3 or lower) if re-mapped at 1:10,000 - 1:5,000. Most of the re-mapped LUC 1 and 2 would be identified as highly productive land, if evaluated in terms of soil versatility and climate suitability criteria. Some - but not all - of any remapped LUC 3 and 4 would be similarly identified, at the level of individual LUC units.

* Land mapped as LUC 3 and 4 at 1:50,000 (NZLRI LUC or converted to equivalent FARM LUC) may contain some LUC 1 or 2, will be predominantly LUC 3 and 4, and will contain a proportion of lower LUC classes (5 or lower) if re-mapped at 1:10,000 - 1:5,000. Most of the re-mapped LUC 1 and 2 would be identified as highly productive land, if evaluated in terms of soil versatility and climate suitability criteria. Some - but not all - the re-mapped LUC 3 and 4 would be similarly identified, at the level of individual LUC units.

* Land mapped as LUC 5 or lower at 1:50,000 (NZLRI LUC or converted to equivalent FARM LUC) is unlikely to contain much LUC 1 and 2 if re-mapped at 1:10,000 - 1:5,000. If evaluated in terms of soil versatility and climate suitability criteria, some re-mapped LUC 3 and 4 would be identified as highly productive land, at the level of individual LUC units. It is even possible that a little of the re-mapped LUC 5 and lower classes might be identified as highly productive for specified vine and tree crops if appropriate management were to be applied. These would need to be identified at the level of individual LUC units.

It is hoped that Paragraphs 8.1 to 8.6 together with the additional opinion expressed, may shed some light on reasons for changes to the Policy 1 mapping procedure for highly productive land which are recommended in Section 5 of my submission; together with reasons for changes to the Appendix 1 identification criteria for highly productive land which are recommended in Section 6.