Before the Hearings Commissioners at Christchurch City Council

under: the Resource Management Act 1991

in the matter of: an application by Ryman Healthcare Limited for resource consent to establish and operate a comprehensive care retirement village at 100-104 Park Terrace and 20 Dorset Street, and 78 Park Terrace, Christchurch

between: **Ryman Healthcare Limited**
Applicant

and: **Christchurch City Council**
Consent Authority

Statement of evidence of **Pierre John Malan** on behalf of Ryman Healthcare Limited

Dated: 6 January 2021

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STATEMENT OF EVIDENCE OF PIERRE JOHN MALAN ON BEHALF OF RYMAN HEALTHCARE LIMITED

INTRODUCTION

1 My full name is Pierre John Malan. I am a Senior Geotechnical Engineer with Tonkin & Taylor Limited.

2 I have a Masters of Engineering (Civil) and a Bachelor of Engineering (Civil) with Honours from the University of Canterbury. I am a Chartered Professional Engineer, an International Professional Engineer and a Member of the Institution of Professional Engineers New Zealand. I have over 20 years' experience in geotechnical engineering consultancy, primarily in New Zealand and the United Kingdom.

3 I have specialised skills in the field of geotechnical engineering. My experience includes leading geotechnical and multidisciplinary teams on projects. These include a team assessing aspects of natural hazards for the Earthquake Commission in Christchurch, supporting the geotechnical hazard assessment for construction of part of Transpower's North Island Grid Upgrade Project, assessing geotechnical aspects of various sites during the construction of the Northern Gateway Toll Road, as well as the development of various commercial, industrial and residential sites around Auckland.

4 Particularly relevant projects with which I have been associated in my capacity as a geotechnical engineering expert include the development of more than twenty retirement village sites. I have worked on other sites around Christchurch that are in similar geotechnical conditions including work on characterising liquefaction effects around metropolitan Christchurch, as well as the Ryman Healthcare Limited's (*Ryman*) sites at Mairehau (Diana Isaac Retirement Village), Riccarton (currently under construction) and Northwood (recently consented). In 2010, I lived and worked in Christchurch providing post-quake geotechnical inputs, and have been actively providing support to a number of projects in Canterbury since that time.

5 I directed and led the geotechnical team providing inputs to Ryman's Bob Scott Retirement Village in Petone, Wellington. This village has a very similar design concept to the current project, comprising multi-storey, base isolated buildings constructed over an artesian aquifer with high seismic loadings.

6 I am familiar with Ryman's resource consent application to construct and operate a comprehensive care retirement village (*Proposed Village*) at 100-104 Park Terrace and 20 Dorset Street and 78 Park Terrace, Christchurch (*Site*). In this statement of evidence, I describe the parcel of land at 78 Park Terrace as the "Peterborough Site" and the parcel of land at 100-104 Park

Terrace and 20 Dorset Street as the "Bishopspark Site". I refer to the Peterborough Site and Bishopspark Site together as the "Sites".

7 I directed the geotechnical site investigations, and supervised the preparation of the Geotechnical Engineering Assessment of Environmental Effects dated March 2020 (*Geotechnical Report*). I also supervised the preparation of the geotechnical aspects of the section 92 responses dated 18 May, 13 July and 17 November 2020 (*Further Information Responses*).

8 I have visited the Site and its surroundings on a number of occasions, including in May and October 2019. My most recent visit was on 27 October 2020.

CODE OF CONDUCT

9 Although these proceedings are not before the Environment Court, I have read the Code of Conduct for Expert Witnesses in the Environment Court Practice Note (2014), and I agree to comply with it as if these proceedings were before the Court. My qualifications as an expert are set out above. This evidence is within my area of expertise, except where I state that I am relying upon the specified evidence of another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

SCOPE OF EVIDENCE

10 My evidence sets out the following:

10.1 A summary of the Geotechnical Report and the Further Information Response;

10.2 My response to the geotechnical issues raised in submissions;

10.3 My response to geotechnical issues raised in the Council Officer's Report, and particularly the Earthworks and Construction Report prepared by Ms Yvonne McDonald;

10.4 My comments on the draft conditions; and

10.5 My conclusions.

11 My evidence focuses on the resource consent requirements relevant to the Christchurch District Plan (*District Plan*). I have provided some information on matters relevant to the regional consent requirements in order to respond to submissions, even though those matters are outside the scope of this process.

SUMMARY OF EVIDENCE

12 In my opinion, the Site is suitable in geotechnical terms for the Proposed Village, provided the recommendations in the Geotechnical Report are considered and implemented in the detailed design.

13 The subsurface geological conditions at the Site are similar, and typical of Christchurch. The geological profile consists of fill overlying alluvial deposits including silts, sands, gravels and peat materials that extend to gravels at around 20 m depth.

14 My evidence addresses the key geotechnical risks that I have identified at the Site, relating to the potential for: liquefaction effects under seismic loading, consolidation settlement / subsidence effects, and effects relating to the proposed basement including mechanical deformation in the temporary (during construction) and permanent (during operation) cases.

15 The currently proposed foundation and retention system comprises a continuously supported stiff perimeter wall, rigid elements/piles beneath the building footprint, and a rigid (metre thick) concrete floor slab. I consider this foundation and retention system will address the potential geotechnical risks at the Site. Any residual effects on structures located near the boundaries will be addressed by conditions requiring Ryman to offer pre and post construction condition surveys of nearby structures, and 'make good' any damage that is attributable to excavation and construction activities.

SUBSURFACE CONDITIONS

Geological conditions

16 The general geological profiles at both the Bishopspark Site and the Peterborough Sites are similar, and typical of most of urban Christchurch.

17 In summary, the geological profile at the Site typically comprises:

17.1 Silty topsoil or fill comprising up to 6 m of demolition rubble (Peterborough) or imported materials (Bishopspark); overlying

17.2 Alluvial sands, silts and peats/organic silt (of the Springston Formation), which are variable and can be loose or soft (to around 10 m depth); overlying

17.3 Alluvial sand or silt of the Christchurch Formation (to around 20 m depth); overlying

17.4 The artesian dense Riccarton Gravels (extending below investigation depth).

18 There is a layer of peat/organic silt deposits present at the Site, around 3-6 m below ground level. This layer is typically 2-4 m thick, and consistently thicker at the Bishopspark Site than at the Peterborough Site.

19 An existing basement at the Peterborough Site has been filled with demolition rubble from the old structure that was present at this Site. In addition, there are approximately 330 driven precast concrete piles beneath the old building footprint. Figure 1.2 in the Geotechnical Report shows approximate locations of the precast concrete piles.

20 A possible spring on the boundary of the Site with the Dorset Street flats was mentioned by submitters.[1] A member of my team inspected this area on 4 November 2020, and did not identify any evidence of a spring. This inspection was reported in the 18 November 2020 Further Information Response.

ASSESSMENT OF GEOTECHNICAL EFFECTS

21 The key geotechnical risks I have identified at the Site relate to the potential for:

21.1 Liquefaction effects under seismic loading;

21.2 Consolidation settlement / subsidence effects; and

21.3 Effects related to the proposed basements, including mechanical deformation in the temporary (during construction) and permanent (during operation) cases.

Seismic and liquefaction assessment

22 I assessed the seismic performance of the Site in terms of the shaking hazard assessed for the Site set out by the Ministry of Business, Innovation and Employment in 2014. I assessed the potential for liquefaction using the Boulanger and Idriss (2014) method, which includes in its database case studies from the Canterbury Earthquake Sequence. Post-liquefaction settlement risks were calculated using the approach set out in Zhang (2002). The approach I adopted and specific parameters and results, as well as full reference citations, are set out in more detail in section 5.2 of the Geotechnical Report.

[1] Dorset Street Flats Owners Group and C. Garlick.

23 The geotechnical seismic performance of both the Bishopspark Site and the Peterborough Site are comparable, and so I discuss them as the Site from now on.

24 Under seismic shaking, some of the subsurface materials at the Sites are at risk of liquefaction related strength loss and settlement. Some materials in the upper 10 m or so (Springston Formation) are at high risk of liquefying, with occasional lenses or pockets possibly affected in the Christchurch Formation (the 10 m or so below that). The Riccarton Gravels are too dense and permeable to liquefy.

25 The calculation method set out above shows liquefaction first occurring under frequent (25 year return period) levels of seismic loading, with the intensity and extent of liquefaction increasing up to infrequent (200-300 year return period) loading. Without mitigation, I assess the effects to include liquefaction strength loss of materials, post-liquefaction settlements up to 300 mm, and lateral spreading towards the Avon River.

26 During the Canterbury Earthquake Sequence, lateral spreading cracks of up to 50 mm and settlement were observed adjacent to the Sites.

27 I consider these liquefaction effects can be appropriately mitigated by an appropriately designed foundation system, which I discuss now.

Proposed foundation/retention system

28 The proposed foundation/retention system has been refined with further analysis since the Geotechnical Report was finalised. The currently proposed system comprises the following elements:

28.1 The basement perimeter will be retained by driven circular steel tubes, 'clutched' to each other like sheet piles, and filled with concrete for stiffness. These are stiff elements that control deformations, and also restrict groundwater flow through the clutches;

28.2 Once these piles are installed, they will be propped and the single level basement will be excavated in stages. As they are exposed, the steel clutches will be welded to provide an impermeable permanent perimeter wall. Temporary water flows through the basement floor are anticipated and will be controlled by pumping. The rate of flow will depend on the nature of the materials and size of the exposed surface. During the excavation, the perimeter walls will be supported to maintain wall deformations at acceptable levels;

28.3 Prior to excavation, rigid concrete elements (similar to piles) will be drilled through the floor extending to the dense

sands between 10 m and 20 m below ground level. In combination with the slab, the rigid elements will stiffen the soil and carry the load of the building into non-liquefying layers and mitigate settlement; and

28.4 An approximately 1 m thick, rigid concrete slab will then be cast onto the basement floor, providing a permanent prop to the steel perimeter walls. The basement foundation system will be waterproof, and a base isolated structure constructed in dry, controlled conditions above the foundation slab.

29 Once completed, I consider the system will provide a stable foundation for the Proposed Village buildings. In summary, the potential geotechnical effects and the mitigation provided by the foundation/retention system are:

29.1 Liquefaction strength loss and settlement effects on the buildings will be mitigated by the installation of the concrete rigid elements into dense layers, combined with the basement slab and the base isolated structure above;

29.2 Settlement, both primary consolidation and secondary (creep) settlements, will be mitigated by the same mechanism;

29.3 Deformation effects associated with the single level basement excavation will be mitigated by installing stiff perimeter walls and propping them off internal building elements;

29.4 Permanent groundwater effects will be mitigated by a fully waterproofed building basement; and

29.5 Temporary groundwater effects (during basement construction) will either be mitigated by an impermeable wall (for lateral flows) or will be staged and not consequential (for flows through the basement floor).

30 The design approach I set out is very similar to that adopted at Ryman's Bob Scott Retirement Village in Petone, Wellington. The Bob Scott Retirement Village has been designed and constructed, and has operated as expected through the recent Seddon and Kaikoura earthquakes with moderate (PGA 0.16-0.20g) shaking.

Subsidence (settlement) and stability assessment

31 The soils at the Site are potentially compressible. Under the static building loadings, the proposed buildings could experience settlement due to both primary (compression due to load) and secondary (organic/creep) consolidations. If not mitigated, the magnitude of the static settlements will exceed normal Building

Code tolerances (and are calculated to potentially be up to 250 mm-400 mm in places over a 50 year period).

32 The primary consolidation settlement will be partially compensated by the excavation of the basements. This excavation approach balances the weight (load) of removed soil weight, replacing it with the weight of the new buildings. This load compensation provides partial mitigation to the primary consolidation settlement risks at the Site.

33 The rigid basement slab will be founded on board, cast *in situ* rigid concrete inclusions extending to (effectively) non-compressible soils beneath the Site. This system effectively stiffens and improves the subsurface conditions, which will mitigate both settlement and instability/bearing capacity risks.

34 In my opinion, the foundation system can be designed using these normal approaches so that the Proposed Village is not at risk of consequential subsidence or potential instability.

35 The foundation system will support the Proposed Village in a manner that will not transfer significant load to the adjacent sites. Combined with the load compensation from the basement excavation, I am satisfied that the risk of subsidence affecting adjacent sites due to the construction of the Proposed Village is negligible.

Basement deformation effects - permanent case

36 Once the basement construction is completed, it will be waterproofed and the rigid foundation slab will prop the perimeter retaining wall. This design approach is a very stable and stiff geometry that avoids deformation effects outside of the Site. As the basement is waterproof, I expect no drawdown of groundwater.

37 On this basis, I assess the effects of the basement on settlement in the permanent case to be negligible.

Basement deformation effects – temporary case

38 Ryman propose to construct a stiff, continuously supported retaining wall around the basement perimeter. That approach minimises the deformation on adjacent land and limits settlements around the Site. In this section, I present:

38.1 Information on the proposed retention system;

38.2 My methodology for modelling potential deformation; and

38.3 My assessment of the potential deformation effects and mitigation measures.

39 Since the Geotechnical Report was written in March 2020, we have continued to assist Ryman to develop options for their preferred retention system. Their currently preferred retaining system will comprise a continuously propped wall of stiff steel piles. This will be installed in the following sequence:

39.1 Installation of steel clutched tubes from the ground surface, and construction of a concrete capping beam;

39.2 Excavation of a temporary bund in front of the wall, and construction of a metre thick basement slab inside the bunds;

39.3 Installation of temporary props to the top of the clutched tubes, propped off the basement slab (or occasionally the opposite basement wall);

39.4 Excavation of the bund, placement of granular hardfill, and then construction of the permanent basement slab propping the wall; and

39.5 Removal of the top props.

40 Excavation, even for a single level basement, inevitably leads to some deformation of the surrounding soil. Therefore, as the soils are removed from inside the basement area, there is the potential for these soils to deform (mechanically) and affect adjacent sites. The proposed retention system has been designed to minimise these effects, and the proposed system means that at no stage will the basement wall be left unsupported.

41 I have assessed the effects on adjacent sites by carrying out retaining wall analyses using the computer retaining wall analysis programme WALLAP. This programme both assesses the stability of walls, and calculates the deformation of the wall face. I use the deformation outputs of that analysis to estimate the deformation profile that may occur behind the wall based on the semi-empirical method set out in Ciria 760 (2018). Following this assessment, I consider the land use and the consequence of deformation due to the construction.

42 Ryman have experience with a similar wall retention system at its Bob Scott Retirement Village in Petone. During construction, typical deformations of the walls were significantly less than the analysis calculated. I attribute this difference to a number of beneficial soil mechanics effects that are not relied upon in modelling, particularly around the small strain stiffness of soils, the stiffness of the structural elements, soil/structure interaction, three dimensional effects and the duration of loading. These factors can be hard to capture in a design model, but mean that actual deformations in the field are often lower than calculated. I

expect similar effects to be present here, but have not relied on them in my assessment.

43 I have carried out deformation assessments for a variety of soil conditions and geometries around the Site. That assessment shows characteristic settlements of less than 10 mm outside the Site (relating to less than 20 mm maximum pile deformation). If adverse conditions occur in some locations (higher excavation, worse soil conditions, difficult construction), then I calculated that settlements of up to 10 -15 mm could occur.

44 Around the Site, I therefore expect that at almost every location there will be little to no consequential effects as a result of the proposed excavations. Dwellings around the Site are set back sufficiently far from the excavation that deformation effects are expected to be negligible.

45 Around the Site, there are limited structures (garages and a pool) located on boundaries. In these locations, it is possible the garages may experience some low levels of deformation (less than 10 mm). However, if deformations occur at the upper end of the assessed range (i.e. 10 -15 mm) and depending on the nature of the structure, there is potential for some cosmetic effects on these garages. Deformations of this level are not reasonably expected to adversely affect the amenity or utility of the garages, and are below levels that are normally expected to compromise structural performance. I discuss the potential effects on the Pool in paragraph 63 below.

46 Ryman are mitigating the risks associated with the deformation by adopting an unusually stiff retention system, offering pre and post construction condition surveys of nearby structures, and offering to 'make good' any damage that is attributable to excavation and construction activities. The proposed retention system is unusually stiff, and will minimise deformations. In my experience, there are no other normally constructed systems available (including anchored walls) that would generate significantly lower levels of deformation.

Permanent and temporary groundwater effects

47 Potential groundwater effects are addressed in section 5.4 of the Geotechnical Report in relation to the regional consent requirements. As set out above, I consider permanent groundwater effects will be mitigated by a fully waterproofed building basement. I consider temporary groundwater effects (during basement construction) will be mitigated by an impermeable wall (for lateral flows) or will be staged and not consequential (for flows through the basement floor). I comment further on groundwater effects in response to submitters below.

RESPONSE TO SUBMISSIONS

48 I have reviewed all of the submissions, and note the following geotechnical issues raised by submitters:

48.1 The geotechnical nature of the land and the suitability for the Proposed Village buildings, particularly in regard to the liquefaction risks;

48.2 The potential for ongoing settlement issues from the construction of the Proposed Village;

48.3 The effects of the proposed basements, particularly relating to:

(a) Instability of adjacent land;

(b) Mechanical deformation at the Site boundaries due to the retaining systems;

(c) Drawdown of groundwater leading to settlement;

(d) Management of groundwater during construction, particularly based on local experience;

(e) Liquefaction-inducing vibration from sheet piling installation around the proposed excavations; and

(f) The management or removal of existing foundations (concrete piles at Peterborough Street).

48.4 Concerns regarding potential discrepancies in the AEE and Geotechnical Report;

48.5 Concerns that there has not been sufficient geotechnical investigation or analysis, and inadequate integration with other disciplines; and

48.6 The potential for the condition of adjacent structures to be changed by the construction of the Proposed Village.

49 I consider each of these issues below.

Geotechnical suitability of the land

50 A number of submitters[2] have raised concerns about the construction of the Proposed Village, particularly in light of the Site

[2] Including B. & M. Logan; Dorset Street Flats Owners Group; R. & M. Lucas; V. Zanetti; M. Pascuzzi; and P. Wells.

either being classified as, or located adjacent to land classified as, "TC3"[3] land.

51 The Site and land adjacent to it are known to have experienced liquefaction through the Canterbury Earthquake Sequence. The specific foundation design responds to the nature of the subsurface conditions. This foundation design is described in more detail in paragraph 28.

52 I understand the previous tower block with basement at the Peterborough Site did not experience consequential foundation damage or failure during the September 2010 earthquake, although it was structurally damaged in the February 2011 earthquake. I consider this is a strong indicator that the subsurface conditions are not intrinsically unsuitable for development.

53 While the Site has challenging geological conditions, I am satisfied that it is geotechnically suitable for the Proposed Village, provided an appropriate foundation system (such as that proposed by Ryman) is designed and constructed.

Settlement of adjacent land

54 A submitter has concerns about the potential for ongoing settlement issues caused by the construction of the Proposed Village.[4]

55 In order to satisfy the Building Code, the design for the foundations for the Proposed Village must address any risks associated with ongoing settlement issues. The foundation design concept for the Proposed Village is described at paragraph 28 above and will be confirmed through the detailed design of the Proposed Village. Based on the proposed design, I consider the land around the Proposed Village will not be at risk of ongoing settlement.

Effects of the proposed basement

56 Submitters have raised a number of concerns regarding the proposed basement design for the Proposed Village.[5]

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[3] Technical Category 3 (TC3) is Christchurch residential land assessed in 2011 as being potentially affected by liquefaction and requiring specific foundation design.

[4] Including J. Stratford & G. Waddy (18 Salisbury Street).

[5] Including G. Dewe; D. Turner; P. Wells; Dorset Street Flats Owners Group; J. Stratford & G. Waddy; P. & L. Trustuum; M. Pascuzzi; V. Zanetti; Heritage New Zealand; Dr J. Roper-Lindsay; R & M Lucas; M. Rinaldo; L. Goodland; C. Garlick; and P. Wells.

57 I address each of the concerns identified below, in light of the proposed foundation/retention system described in paragraph 28 above.

Instability of adjacent land

58 A number of submitters[6] are concerned that construction of the Proposed Village will cause instability of adjacent land. As outlined in my evidence above, the potential for instability of adjacent land caused by the Proposed Village will be mitigated by the design of the retention system. The presence of continuous propping in both the temporary and permanent cases will provide a very stable and robust system that in my opinion does not have a credible risk of causing instability of adjacent land.

Mechanical deformation at the Sites' boundaries

59 A number of submitters[7] have raised concerns that the excavation at the Sites' boundaries will cause mechanical deformation of the soil and cause adverse effects on adjacent properties. I have addressed this in paragraphs 36 to 46 of my evidence above. The proposed continuous and stiff propping system means the soils around the Sites will never be unsupported. As a result, the potential for deformation will be minimised. As noted in paragraph 46, Ryman have offered a condition that provides for pre and post construction condition surveys of adjacent structures and rectification of any damage attributable to excavation.

60 I have addressed the specific properties identified by the submitters below.

61 The properties at 5 Salisbury Street,[8] 13 Salisbury Street, 18 Salisbury Street[9] and 18 Dorset Street[10] have garages or appurtenant structures located adjacent to the boundary. They therefore have the highest risk of experiencing mechanical deformation effects. The property files for these properties show reinforced slab foundations typically founded a few hundred millimetres below ground level. The garage building at 18 Salisbury Street is likely to have been underpinned as part of the works for the previous basement at the Peterborough Site.

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6 Including ICON; Dorset Street Flats Owners Group; J. Stratford & G. Waddy; M. Rinaldo; L. Goodland; B. & M. Logan; M. Pascuzzi; and D. Cottle.

7 Including L. Goodland; B. and M. Logan; J. Stratford & G. Waddy; D. & A. McLean; Dorset Street Flats Owners Group; M. Rinaldo; D. Cottle; ICON; and M. Pascuzzi.

8 Including L. Goodland.

9 Including J. Stratford and G. Waddy; P. & J. Marshall; D. Bruce; D. & A. McLean; W. Davidson & G. Waddy.

10 Including B. & M. Logan.

62 As I discuss in paragraphs 43 to 45, I consider the most likely deformation will be at a level that is not readily observable in these structures (i.e. less than 10 mm), and therefore no effects are expected. Given the propping proposed (for both the temporary and permanent cases) and the limited nature of the deformation, I consider the potential for adverse structural effects to be negligible.

63 At 15 Salisbury Street, a pool is located approximately 2 m from the boundary. The pool is founded below ground level, and the property file shows it to comprise a fibreglass shell founded more than 1 m deep. Given the setback and founding depth, I consider less than 10-20 mm of potential deformation is likely to occur at the pool, using the method set out above. I do not consider this level of deformation is likely to cause consequential adverse effects. In the unlikely event the pool experiences damage, the proposed conditions require Ryman to offer to undertake pre and post construction surveys and repair any damage attributable to its works.

64 The Dorset Street Flats, located at 16 Dorset Street, are set back more than 7 m from the boundary. For the reasons set out above, I do not consider there is any credible risk of mechanical deformation affecting the Flats. If the proposed Stables building at 4A Dorset Street is constructed prior to the basement, the effects and proposed mitigation are as set out in paragraph 58.

65 P and L Trustuum are concerned about the effect that the excavation required for the Proposed Village will have on their property at 18 Peterborough Street. This property is set back more than 25 m from the excavation. Given this geometry, I do not consider there is any credible risk of the Proposed Village excavation affecting that property.

Drawdown of groundwater

66 P and J Marshall have raised concerns regarding the potential for ground settlement to occur due to dewatering. The potential for drawdown of groundwater leading to settlement will be mitigated by the proposed perimeter retention system. As the steel clutches are exposed by excavation, they will be welded to make the system watertight. The welding will typically extend to the low permeability silty peat that underlies the Sites, which will prevent consequential local drawdown. In my opinion, the risk of ground settlement occurring on adjacent sites from groundwater drawdown is negligible.

Groundwater management

67 Some submitters[11] raised concerns about difficulties others have experienced with groundwater management.

68 Groundwater management has been considered during the design of the Proposed Village, and we are aware of the high local inflows that have occurred in other excavations. While groundwater extraction falls outside the scope of this resource consent application, I comment on geotechnical aspects here in response to the submissions.

69 The rate of lateral groundwater inflow will be mitigated by the use of watertight perimeter walls. During construction groundwater, flows through the floor of the excavation will be captured, treated and discharged into the stormwater system. I understand that other excavations in the area have typically comprised open excavations with batters. This excavation approach does not provide any mitigation to groundwater inflows. Therefore, high and problematic rates of groundwater flow for that (different) situation are not unexpected. The perimeter system proposed here is adopted in light of the ground conditions and previous experience to mitigate the rate of groundwater inflow.

70 Accordingly, I consider the proposed groundwater approach will address the submitters' concerns.

Liquefaction risk during construction

71 The submitters from 1-8 18 Salisbury Street raised the potential for vibrations from sheet piling to cause liquefaction.[12] Vibratory techniques cannot typically cause consequential liquefaction effects as the energy levels are low compared with seismic shaking. I note that the Christchurch Ground Improvement Trials carried out by MBIE and the Earthquake Commission after the Earthquake Sequence required explosives to generate widespread liquefaction at the test sites. Therefore, I do not consider that there is the potential for consequential liquefaction as a result of the construction methods for the Proposed Village.

Removal of existing foundations

72 Some submitters[13] are concerned about the potential effects associated with the removal of the existing concrete pile foundations at the Peterborough Site. For clarity, the existing foundations will not be removed from the ground. The presence of these foundations has been actively considered in the development

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[11] Including M Rinaldo, G. Dewe; Dorset Street Flats Owners Group; C. Garlick; Dr J. Roper-Lindsay; J. Stratford & G. Waddy; and V. Zanetti.

[12] Including J. Stratford & G. Waddy.

[13] Including V. Zanetti; and M. Rinaldo.

of potential foundation solutions. The design of the proposed raft foundation system is sufficiently adaptable to allow foundation elements to be relocated if an obstruction is present.

Potential report discrepancy

73 J Roper-Lindsay has identified a potential discrepancy in the AEE (at section 2.1.1) and the Geotechnical Report (at page 9), and notes that the basement of the Proposed Village will not be setback.

74 I have reviewed both statements and do not consider there to be a discrepancy. The AEE notes that the basements will "*span almost the entire area of the Bishopspark Site*". The Geotechnical Report states that "*buildings will be setback from the property boundaries".*

75 The foundation drawings (.S02 .A0.040 and .S01 .A0-040) show the basement foundations are set back typically between 1.5 m and 2 m from the property boundaries. In the context of a single level excavation, this setback is meaningful as deformations reduce away from excavation faces. By comparison, other single level basements I have worked on are often built directly on the site boundaries. I consider the proposed geometry to both span almost the entire area of the Sites, and also be setback from the property boundaries.

Sufficiency of geotechnical analysis

76 Some submitters[14] consider there has not been sufficient geotechnical investigation or analysis, and integration with other disciplines.

77 My geotechnical investigations and analysis have been integrated with the wider design team throughout the process. I consider the level of investigation and analysis appropriate for this resource consent application, and am satisfied that the work is sufficiently integrated. The investigation includes more than 10 boreholes and 20 CPT on the Sites, as well as access to investigation data around the Sites.

Adjacent structures

78 Some submitters[15] are concerned about the potential for the condition of adjacent structures to be modified by the Proposed Village.

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[14] Including J. Stratford & G. Waddy; Dorset Street Flats Owners Group; Dr J. & Roper-Lindsay.

[15] Dorset Street Flats Owners Group; L. Goodland; L. Davies; C. Bennett; J. Stratford & G. Waddy; and B. & M. Logan.

79 I have addressed the potential effects throughout this evidence. I understand Ryman has offered a condition requiring pre and post-condition surveys offered to adjacent properties. This is to allow any potential effects that may occur during the construction of the Proposed Village to be identified. I consider this approach will address the submitters' concerns.

RESPONSE TO COUNCIL OFFICER'S REPORT

80 I have reviewed the Council Officer's Report dated 14 December 2020 and the Earthworks and Construction Report prepared by Ms Yvonne McDonald.[16]

81 Ms McDonald notes, and the Council Officer's Report accepts, that the foundation concepts presented in the Geotechnical Report comprise elements installed by displacement, rather than vibratory methods, and therefore vibration effects are not an issue.

82 Ms McDonald considers that settlement effects, including the potential for cross-boundary settlement, have been addressed by extending foundations below peat layers. She concludes that no damage to the neighbouring properties is anticipated.

83 Ms McDonald notes that groundwater effects will be negligible, particularly in light of seasonal variations.

84 I agree with those conclusions.

DRAFT CONDITIONS

85 The Council Officer's Report does not recommend any changes to the *Pre- and Post-Construction Building Condition Surveys* conditions proposed by Ryman (conditions 19-25). Nevertheless, I recommend one amendment to condition 19.

86 Condition 19 requires building consent for all retaining walls to be obtained before earthworks start. I consider this condition can be modified to allow minor earthworks (i.e. earthworks associated with shallow contaminated land removal) to be undertaken prior to building consent for retaining walls being obtained. Such earthworks will not have the potential to affect neighbouring land stability in my view. This approach also recognises different staging of the two discrete Sites. I consider minor earthworks are those involving up to a metre of excavation.

[16] Council Officer's Report, Appendix D – Earthworks and Construction Report.

CONCLUSIONS

87 I conclude that there is no geotechnical issue that would preclude the granting of consent for the Proposed Village on the basis of the conditions discussed in this evidence.

Pierre Malan
6 January 2021