

Otago Regional Council
Private Bag 1954
Dunedin 9054

Attention: Hilary Lennox

Dear Hilary

Technical Review: Smooth Hill Landfill
Appendix 5 - Geotechnical Interpretative Report
Appendix 6 - Geotechnical Factual Report

Introduction

- 1 Dunedin City Council (DCC) proposes to establish a new Class 1 landfill, to be located at Smooth Hill to the south of Dunedin Airport. DCC has applied to Otago Regional Council (ORC) for a range of resource consents required for the establishment and operation of the proposed landfill.
- 2 Tonkin & Taylor Limited (T+T) has been engaged by ORC to undertake a technical review of the geotechnical assessment lodged by DCC in support of its resource consent applications.
- 3 This report presents a Technical Review of the Geotechnical Interpretative Report, and also of the Geotechnical Factual Report which is essentially a supporting document giving the factual geotechnical information used for the geotechnical interpretative assessment.
- 4 The purpose of this Technical Report is to set out the findings of our technical review of DCC's geotechnical assessment, so as to inform a decision to be made by ORC regarding notification of the resource consent applications.
- 5 The following documents have been considered as part of this technical review:
 - **Appendix 5 – Geotechnical Interpretative Report:** *GHD August 2020. Waste Futures – Smooth Hill Geotechnical Interpretative Report. Report prepared by GHD Limited for Dunedin City Council* (herein referred to as the 'Geotechnical Interpretative Report').
 - **Appendix 6 – Geotechnical Factual Report:** *GHD August 2020. Waste Futures – Smooth Hill Geotechnical Interpretative Report. Report prepared by GHD Limited for Dunedin City Council* (herein referred to as the 'Geotechnical Factual Report').
 - **Dunedin City Council - proposed Smooth Hill Landfill: Section 92 review - requests for further information:** *Report prepared for ORC by T+T, September 2020* (herein referred to as 'the s92 request')
 - **Revised Appendix 5 – Geotechnical Interpretative Report:** *GHD May 2021. Waste Futures – Smooth Hill Geotechnical Interpretative Report. Revised (updated) Report*

- prepared by GHD Limited for Dunedin City Council; (herein referred to as the 'Final Geotechnical Interpretative Report').*
- **Revised Appendix 6 – Geotechnical Factual Report:** *GHD May 2021. Waste Futures – Smooth Hill Geotechnical Interpretative Report. Revised (updated) Report prepared by GHD Limited for Dunedin City Council; (herein referred to as the 'Final Geotechnical Factual Report').*
 - **Smooth Hill Landfill –s92 Question Responses – Geotechnical Interpretative and Factual Reports:** *Provided to ORC, and containing responses from GHD, as part of ORC's s92 request to DCC, May 2021; (herein referred to as the 's92 response')*
 - **Dunedin City Council - proposed Smooth Hill Landfill: Section 92 review - requests for further information:** *Report prepared for ORC by T+T, June 2021; (herein referred to as 'the further s92 request')*
 - **Smooth Hill Landfill –Further s92 Question Responses – Geotechnical Interpretative and Factual Reports:** *Provided to ORC, and containing responses from GHD, as part of ORC's s92 further request to DCC, August 2021; (herein referred to as the 'further s92 response')*
 - **Smooth Hill Landfill – Geotechnical Interpretative Report – Updated Appendix A plans and Appendix B ground model sketches (cross-sections) :** *Provided to ORC, and containing responses from GHD, as part of ORC's s92 further request to DCC, August 2021; (herein referred to as the 'further s92 Appendix A/B response')*
 - **Smooth Hill Landfill Draft Consent Conditions.** *Provided by ORC as part of its further s92 response of 4 August 2021; (herein referred to as the 'draft consent conditions')*
 - **Smooth Hill Landfill – Phase 3 Ground Investigation:** *GHD 24 August 2021. Technical Memorandum including borehole log BH301 and core photos*
 - **Smooth Hill Landfill – additional information provided by the applicant on 18 March 2022 comprising "Cross Section C";** *DCC's responses to ORC questions; and DCC's proposed amended consent conditions; (herein referred to as the 'amended draft consent conditions')*
- 6 On-line meetings were held between Andrew Stiles (T+T Geotechnical Consultant) and the applicant's geotechnical expert (Samantha Webb – GHD Technical Director Engineering Geology) on 7 July and 29 July 2021 to discuss the Geotechnical Interpretative and Factual Reports and s92 responses. The meetings satisfactorily clarified a number of matters.
- 7 This technical review has been undertaken by Andrew Stiles, Geotechnical Consultant at T+T. It has been prepared in accordance with T+T's letter of engagement with ORC dated 12 November 2019.

Description of the proposal

- 8 The proposed Smooth Hill municipal landfill is intended to replace the existing Green Island landfill located in Dunedin. The Smooth Hill Landfill is reduced in scale from the original application as follows:
- a) A footprint of 18.6 ha instead of the original 44.5 ha.
 - b) A gross capacity reduced from 7.9 million m³ to 3.3 million m³
 - c) Net waste capacity of 6.2 million m³ to 2.9 million m³
 - d) The predicted landfill life reduced from 55 years to years
- 9 The landfill will be designed to accept municipal solid waste in accordance with acceptance criteria.

- 10 The landfill design proposes multi-bench cut slopes up to about 30 m high overall and 1V:4H or flatter, and fill slopes, formed of site-won materials, up to 10 m high at slopes of 1V:4H or flatter.

Receiving Environment

- 11 Sections 1 and 2 of the Geotechnical Interpretive and Factual Reports describe the existing environmental setting for the proposed landfill, identifying that it is :
- a) Approximately 23 km south-west of Dunedin City;
 - b) About 2.7 km north-east of the coast;
 - c) In an area of rugged terrain, with elevations typically between about RL 100 m and RL 150m, with well-defined ridges separated by stream gullies
 - d) Currently covered by mixture of scrub, bare earth, forestry waste and replanted pine but, until recently, was covered by a pine plantation
- 12 Within 3.5 kms of the Landfill, there are 12 No. residences and 3 No. commercial premises. Only two of these existing residences are within 1 km, with the closest being 380 m. T+T considers this is a low density of sensitive locations near to the proposed landfill.
- 13 The geotechnical aspects of the landfill development and operation are not expected to have any effects on those residences and premises
- 14 Overall, we agree with the Geotechnical Interpretive and Factual Reports' assessment of the receiving environment.

Assessment of geological setting

- 15 The applicant's investigations have shown the proposed landfill site is likely underlain by the Upper Cretaceous Henley Breccia. This unit is typically a relatively massive interbedded siltstone, sandstone and conglomerate. Discontinuities appear relatively limited, with rare bedding planes generally shallowly dipping at between about 15° and 30°.
- 16 While Recent Loess forms the surface cover over much of the existing slopes, with alluvial soils in the stream/gully bottoms, the proposed landfill construction will remove all those materials from within the landfill footprint.

Assessment of geotechnical investigations

- 17 The geotechnical investigations discussed in the Geotechnical Interpretive and Factual Reports covered the proposed landfill area identified in the original application. However, the Reports advised that portions of the proposed landfill site, in the south-east and along the western edge, were unable to be accessed due to existing tree cover and for environmental reasons. That meant that geotechnical investigation information was not available for about 40% of the originally proposed landfill area.
- 18 The subsequent reduction in the landfill area, as discussed in the Final Geotechnical Interpretive and Factual Reports, means that the area in the south-east, which was not able to be investigated, now comprises a larger proportion, i.e., about 50%, of the overall footprint.
- 19 The lack of geotechnical investigation for much of the proposed landfill application area, and how that information 'gap' would be addressed, was identified in the s92 request, the subsequent further s92 request and in the 29 July 2021 on-line meeting. At that meeting it was agreed that additional investigations would be carried out at Detailed Design stage to fill in any remaining information gaps and to ensure that there is adequate geotechnical information available for the landfill's design.

- 20 GHD advised in the 29 July 2021 meeting, on behalf of the applicant, that a further borehole was in the process of being drilled in the previously uninvestigated area, and the results of that additional BH301 were subsequently provided to T+T. Whilst providing additional geological information for that uninvestigated area, the level of investigation coverage remains less than for the remainder of the proposed landfill area, and additional investigations are still considered necessary.
- 21 T+T considers the agreed approach, of additional investigations at Detailed Design stage, is acceptable and that the proposed condition in the 'amended draft consent conditions' reflects that agreement.

Assessment of seismicity

- 22 The Smooth Hill landfill site is bounded to the north-west and south-east by the Titri Fault and Akatore Fault respectively, both faults trending approximately north-east to south-west and parallel to the general coastline.
- 23 The Factual Geotechnical Report lists "*.....known faults in close proximity to the landfill site....*" with both the Titri and Akatore Faults listed. However, the report defines "active faults" as those with recurrence periods less than 2,000 years. That definition means that the applicant has ignored the Akatore Fault (with a recurrence of 3,000 years and responsible for known recent local seismic events such as the 1974 "Dunedin Earthquake") in favour of the main Alpine Fault 240 km north-west of the site.
- 24 The Final Factual Geotechnical Report updates the earlier comments and notes that "*.....whilst the Alpine Fault is the closest "active fault" there has been recent research on the recurrence intervals of the Titri and Akatore faults. This new data will be included in the seismic hazard assessment of the site.....*". Although not noted in the Final Factual Geotechnical Report we infer that new data includes recent research by Stirling et al (University of Otago), and which has been widely reported.
- 25 The Geotechnical Interpretative Report assumed the proposed landfill to have an Importance Level 2 (IL2) for the purposes of seismic design, i.e., its ability to resist earthquake loadings. The s92 request noted that it is more usual to assign an IL3 rating or higher for the immediate post-construction phase of a landfill when the completed landfill contains significant leachate which could potentially be released as a result of a seismically induced breach of the containment system.
- 26 After review, the applicant, in the s92 response and Final Geotechnical Interpretative Report revised the Importance Level rating to IL3, and then to the more appropriate IL4 in their 'amended draft consent conditions'.
- 27 Site-specific assessment of seismicity is a key consideration in landfill design, bearing in mind New Zealand's overall level of seismic risk, and the potential hazards, including liner rupture and possible leachate release. The relatively long design life of the facility is a further concern, in particular the lengthy post-closure period when, for example, leachate may continue to be present for many years. In view of those risks and concerns, T+T considers that a Site Specific Seismic Hazard Assessment (SSSHA) should be carried out as part of the landfill's Detailed Design. Such an approach is seen as a standard procedure for a project such as this and will give reassurance that the landfill is adequately designed for seismic risk, in particular the hazards of possible liner rupture and leachate release.
- 28 The Geotechnical Interpretative Report was unclear as to whether the applicant proposed to carry out a Site Specific Seismic Hazard Assessment (SSSHA) and that was queried in the s92 request. The issue continued to be unclear in the subsequent Final Geotechnical Interpretative Report, with T+T considering that a SSSHA should be carried out, but was

resolved as part of the on-line meeting held between Andrew Stiles and the applicant's geotechnical expert (Samantha Webb) on 29 July 2021.

- 29 In that meeting GHD advised, on behalf of the applicant, that a SSSHA would be carried out at the detailed design stage to confirm appropriate seismic design parameters are being used.
- 30 T+T considers that the proposed condition in the 'amended draft consent conditions', (with the last sentence modified as discussed below), is appropriate to address seismicity issues.

Assessment of geotechnical design parameters

- 31 Geotechnical design parameters were proposed in the Geotechnical Interpretative Report and a number of queries on the proposed values, and their derivation, were raised in the s92 request.
- 32 Clarification by the applicant was provided in the s92 response and the Final Geotechnical Interpretative Report. Following a further round of queries and responses, i.e., the further s92 request and further s92 response, T+T generally agrees with the proposed geotechnical design parameters and overall approach.

Assessment of geotechnical hazards

- 33 The Geotechnical Interpretative Report identified a number of existing slope failures across the proposed landfill site. The s92 request queried their extent, particularly depth and whether they only affected the superficial loess deposits. The s92 response and Final Geotechnical Interpretative Report identified such features to be shallow seated, within the loess, and all would therefore be removed as the loess was progressively stripped from the site during construction of the landfill.
- 34 Compressible soils within the landfill footprint were identified in the Geotechnical Interpretative Report, e.g., alluvial deposits in the base of stream gullies, historic fill, topsoil and some loess. The Geotechnical Interpretative Report noted that all such potentially compressible soil would be removed from under the proposed landfill footprint and from beneath any areas on which engineered fill is to be placed.
- 35 Groundwater seepages were identified in the Geotechnical Interpretative Report as having been noted in a number of locations around the site. There is also the potential for further such seepages to be encountered if construction excavation works intersect groundwater. This potential geotechnical hazard is discussed in T+T's Technical Review – Appendix 8 – Groundwater Report
- 36 The Geotechnical Interpretative Report identifies that, although in theory saturated fine grained alluvium in the base of stream gullies could liquefy during a seismic event, the potential hazard will be eliminated as a result of the proposed removal of all such stream alluvium as part of the landfill development work.
- 37 T+T considers that the application has appropriately addressed the above potential geotechnical hazards.

Assessment of proposed cut and fill slopes

- 38 The Geotechnical Interpretative Report discussed the assessed stability of the cut and fill slopes necessary to form the proposed landfill subgrade geometry. The s92 request queried the appropriateness of some of the analyses, in particular whether translational failure modes in the Henley Breccia materials were more appropriate than the circular failure mechanisms analysed. The s92 request also queried why the potential for refuse (MSW) to slide over the lining system, either of temporary internal refuse slopes during construction or of the completed waste mass, had not been addressed.

- 39 Clarification by the applicant was provided in the s92 response and Final Geotechnical Interpretative Report. Following a further round of queries and responses, i.e., the further s92 request and further s92 response, T+T generally agrees with the applicant's proposed approach, and that the proposed cut and fill slope stability assessment is considered appropriate for consent application but will be reviewed, and revised as necessary, during Detailed Design.
- 40 In the 29 July 2021 on-line meeting (Andrew Stiles and Samantha Webb) T+T expressed concern that the lack of geotechnical investigation could result in unrealistic cross-sections for stability analyses. In T+T's view that was a particular reason why additional investigations were considered necessary as part of Detailed Design.
- 41 With respect to T+T's queries on the potential for refuse (MSW) to slide over the liner system, this has now been addressed in the proposed consent conditions.
- 42 T+T considers that the proposed conditions in the 'amended draft consent conditions', are appropriate to address slope stability issues.

Mitigation

- 43 The paucity of investigations in the revised proposed landfill area will be addressed by the further borehole recently completed, and the additional investigations agreed to be carried out at the Detailed Design stage.
- 44 Appropriate seismic design parameters will be confirmed by a Site Specific Seismic Hazard Assessment (SSSHA) to be carried out at the Detailed Design stage.
- 45 The proposed cut and fill slope stability assessment will be reviewed, and revised as necessary at the Detailed Design stage.

Proposed conditions

- 46 The earlier 'draft consent conditions' included requirements to assess the stability of the proposed cut and fill slopes, and also of the potential movement of the waste mass over the landfill liner system. Considering these in turn :
- 46.1 The applicant has proposed the following 'amended draft consent condition' for addressing the stability of the proposed cut and fill slopes :
- ".....The detailed design of the landfill shall demonstrate the short (construction and operation) and long-term (closure to post closure) stability of all cut and fill slopes of the landform. This will be achieved by undertaking quantitative limit equilibrium slope stability assessment of the design landform and earth fill retaining bund to demonstrate a factor of safety for cut and fill slopes in the static load case of >1.5, and for slopes where the factor of safety is <1 in the pseudo-static seismic load case, the displacement method shall be considered as per Section 6.3.2 of the Waka Kotahi NZTA Bridge Manual (3rd Edition Oct 2018)....."*
- 46.2 The applicant has not provided any amendments to the earlier 'draft consent condition' for the potential movement of the waste mass over the landfill liner system, (other than a suggested minor amendment to refer to the independent peer review panel).
- It is considered that the proposed 'amended draft consent conditions' are appropriate to ensure that stability assessment issues are appropriately addressed
- 47 To ensure seismic design issues are satisfactorily addressed, the applicant has proposed the following 'amended draft consent condition' :
- ".....A Site Specific Probabilistic Seismic Hazard Assessment (SSPSHA) shall be undertaken as part of Detailed Design of the landfill to ensure seismic risks are addressed so the landfills performance under seismic load is consistent with an IL4 structure as defined in Table 3.2 NZS"*

1170.0.2004 Structural Design Actions - Part 0 General Principles ([facilities containing hazardous materials capable of causing hazardous conditions that extend beyond the property boundaries.]) and Table 3.3 for appropriate annual probability of exceedances based on design life. The detailed design of the landfill shall use the results of the SSPSHA as inputs into the slope stability modelling.....”.

While we consider the above proposed ‘amended draft consent condition’ is generally appropriate, we consider that the last sentence should be revised to be more general in terms of design inputs, namely changed to read “.....*The detailed design and construction of the landfill, in particular for temporary and permanent slopes, shall be modified as necessary to incorporate any changes in seismic design parameters identified by the SSPSHA.....”.*

It is considered that the above proposed ‘amended draft consent condition’, with the last sentence modified as shown, is appropriate to ensure that seismicity issues, and potential earthquake effects on the proposed landfill, are addressed.

- 48 To ensure that an adequate level of geotechnical investigation is carried out, the applicant has proposed the following ‘amended draft consent condition’ :

“.....Additional geotechnical investigations shall be carried out as necessary as part of the detailed design of the landfill to generate a robust site encompassing geotechnical ground model for the site. The performance of the in-situ Henley Breccia is critical to the cut slope stability; further investigation shall include verification of the dip and dip direction of the Henley Breccia and strength assessment of the contacts between units. The location of investigation points shall be determined during the initial stages of the detailed design process where specific confirmation is required.....”.

It is considered that the above proposed ‘amended draft consent condition’ is appropriate to ensure that an adequate level of geotechnical investigation is achieved.

- 49 The applicant’s ‘amended consent conditions’ also include additional conditions to establish an independent peer review panel to review the design, construction and operation of the landfill. We consider that such conditions, for an independent peer review panel, are appropriate, as they give additional confidence that design and construction issues, including geotechnical concerns, will be adequately addressed.
- 50 Other than the above, the proposed ‘amended draft consent conditions’ are considered appropriate to cover geotechnical design and construction issues for the proposed landfill.

Conclusion

- 51 We consider that the potential effects of the landfill development can be appropriately managed through the proposed conditions of consent and accordingly the potential geotechnical effects from construction and operation of the landfill have been addressed, subject to detailed design.

Applicability

52 This Report been prepared for the exclusive use of our client Otago Regional Council , with respect to the particular brief given to us, and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Tonkin & Taylor Ltd

Environmental and Engineering Consultants

Prepared by:

.....

Andrew Stiles
Geotechnical Consultant

Authorised for Tonkin & Taylor Ltd by:

.....

Tony Bryce
Project Director

29-Mar-22

\\ttgroup.local\corporate\christchurch\tt projects\1011469\workingmaterial\6. s42a adendum reports\5. geotechnical\210826_appendix 5 and appendix 6 - geotechnical factaul and interpretative report-technical review-updated-230322.docx