Before the Independent Commissioner Hearing Panel

Under	the Resource Management Act 1991 (**RMA**)
In the matter of	an application by **Dunedin City Council** to develop a landfill at Smooth Hill, Dunedin.

Statement of evidence of Richard Mark Coombe

29 April 2022

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Qualifications and experience

1 My name is **Richard Mark Coombe**.

2 I am currently semi-retired and retained as a casual employee of GHD Limited as a Senior Project Manager specialising in solid waste, contaminated land remediation and construction management.

3 I have the following qualifications:

(a) NZCLS (Land Surveying) 1977; and

(b) NZCE (Civil), 1986.

4 I am a Chartered Professional Engineer, (CPEng) continuous since 2006 and have current practice areas in construction engineering management of civil infrastructure, engineering design of landfills and contaminated land remediation

5 I am experienced in all aspects of the design and construction of land development and progressed into landfill design in 2001. I have prepared preliminary design for consents and in some cases detailed design of municipal solid waste landfills in Sri Lanka, Philippines, New Plymouth, and Huntly; managed fill in Pokeno; biosolids monofills in Auckland, Morrinsville and Te Awamutu; construction and demolition waste in Christchurch; and cleanfill in West Auckland. I have also prepared concept and detailed designs for a number of waste transfer stations.

6 I have read the Code of Conduct for Expert Witnesses in the Environment Court Practice Note 2014. This evidence has been prepared in accordance with it and I agree to comply with it. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

Scope of evidence

7 I have been asked to provide a summary of the concept design for the proposed Smooth Hill landfill in relation to landfill engineering, and address any matters which have arisen since lodgement of the consent applications. I have also addressed matters raised by Otago Regional Council (ORC)'s peer reviewers, the s42A report, and submissions on the resource consent application that were not otherwise addressed in the Design Report. This includes:

(a) The location and siting of the landfill in relation to current best practice;

(b) Risk of leachate runoff by-passing the attenuation basin and contaminating downstream surface water;

(c) Proposed measures to avoid and mitigate adverse effects of leachate and other contaminants due to natural disasters;

(d) Potential for adverse effects due to heavy rainfall and potential for leachate release;

(e) Landfill liner construction quality assurance (CQA) - erodibility and containment;

(f) Liner installation defects and deterioration;

(g) The use of a geosynthetic clay liner (GCL) on the base of the liner;

(h) Flow capacity in leachate longitudinal drainage - drain lengths for cleaning and spacing;

(i) Adequacy of leachate tank storage;

(j) Establishment of a peer review panel;

(k) Litter control; and

(l) Fire management.

Executive summary

8 The landfill concept design prepared in support of this consent application for the Smooth Hill landfill meets the recommendations set out in the WasteMINZ (2018) *Technical Guidelines for Disposal to Land* deemed to be current best practice for landfill engineering in New Zealand. The basis of design is discussed in detail in the Report GHD (May 2021) *Waste Futures Phase 2 - Workstream 3 Smooth Hill Landfill: Landfill Concept Design Report.*

9 The Smooth Hill site was identified through a site selection process, resulting in the selected land being designated for the purpose of a regional landfill to replace the Green Island landfill. At the time of the designation, there were few dwellings in the vicinity and the surrounding land use was a mixture of forestry and pastural land.

10 During the concept design process the proposed landfill has been through two iterations ultimately resulting in a smaller project. This reflects the likely projected reduction in waste volumes due to initiatives proposed by the

Dunedin City Council. The current design also avoids directly impacting the wetland at the base of the landfill.

11 The existing landform is an amphitheatre shaped series of gullies located at the top of the surface water catchment. This is beneficial as it largely avoids surface water flowing though the site and the landform minimizes the amount of necessary earthworks.

12 Landfill engineering incorporates robust environmental controls to avoid and mitigate adverse environmental impacts and minimise social impacts from the activity. In all cases, potential adverse effects of possible major environmental occurrences (such as rainfall from a 1 in 100 year storm event and very low occurrence seismic events) are managed through design.

13 This evidence provides additional commentary on matters relating to landfill engineering raised by submitters and technical review by the ORC.

Landfill Design

14 The Smooth Hill landfill concept is designed to meet New Zealand standards in municipal solid waste landfill engineering for a Class 1 landfill as set out in the WasteMINZ (2018) Technical Guidelines for Disposal to Land.

15 My work on the landfill design included preparation of the design of physical aspects of the proposed landfill including: the landfill location within the designation, shape and void, bulk earthworks, staging, liner and capping details and leachate management. I prepared the basis of the landfill operation and support facilities, cell development, and staging providing for the practical construction and operation of the landfill. In preparing this landfill design, I received and relied upon specific design inputs and advice from geotechnical engineers, hydrological engineers, hydrogeologists, landfill gas engineers, roading engineers, ecologists and landscape planners in regard to ecological and landscape/visual amenity constraints.

16 The proposed Smooth Hill landfill is located in a rural area located approximately 3km southeast of SH1, 2.7km from the Pacific coast, 28km by road from Dunedin CBD, and 9km from Brighton beach. The land has been used for exotic forestry for at least the last 30 years.

17 The topography is rolling hills and gullies of slopes generally up to 1 vertical to 5 horizontal. The eastern extent of the proposed landfill is a ridgeline on which Big Stone Road is located. The ridge line represents a local watershed and to the south east of the ridge surface water flows to the

Pacific Ocean. The site area is to the northwest of this ridge and surface water flows north/northwest across the site in two gullies that contribute to the headwaters of Ōtokia Creek.

18 The siting of the landfill at the head of a gully and watershed means there is no upstream catchment water of any significance to convey past or through the landfill. Surface water from the landfill is collected in swale drains and treated in sediment retention ponds and/or the water attenuation basin before discharging to the downstream tributary of Ōtokia Creek.

19 Site development works for the landfill prior to any waste importation will include screen planting; bulk earthworks and associated sediment controls; road upgrades; installation of services and site facilities; and installation of stormwater, landfill liner, and leachate collection management systems.

20 While the natural amphitheatre landform lends itself to development of the landfill, bulk earthworks will be required to develop the site as a landfill. The loess layer and any underlying weak soils will be removed from the entire landfill liner footprint, the facilities area will be cut, and the toe embankment filled. Topsoil will be stockpiled to apply to the final capping, the excess cut materials will be stockpiled for daily cover, and the loess will be stockpiled for the progressively constructed low permeability liner and capping.

21 Landfill liner sufficient for the following 2 years waste volume will be installed at commencement of waste placement to reduce the extent of liner that will catch rainfall and produce leachate; allow undeveloped areas to drain to the stormwater system; and avoid landfill liner exposure to the elements for longer than is necessary. The toe bund will however be constructed to the full extent at the outset to provide structural containment of waste along with the full leachate sump at the base of the landfill, complete with leachate pumps and conveyance pipework.

22 The toe bund will be 10 meters high and the liner system will be installed on the upstream face. Once the waste is filled to that level, the perimeter swale drain, including the first bench in the landfill liner will be installed to manage surface water from up slope areas. Intermediate capping will be installed where areas of waste will not be overlaid with fresh waste for more than 3 months, followed by the progressive completion of final capping as the waste is placed to finished level.

23 The landfill is designed to accept municipal solid waste that will produce leachate. As the nearest point of connection to the Dunedin City Council sewerage system is at Brighton, leachate will be collected and removed off site to the Green Island wastewater treatment plant by tanker trucks until

such time as it is economically feasible to install a sewerage pipe system to Brighton for disposal of leachate into the existing wastewater system.

24 Leachate generation will be minimised by keeping uncapped areas of waste as small as reasonably possible. Intermediate and final cap will be installed where possible allowing runoff from clean areas to the stormwater system. Any stormwater that is in contact with waste will be considered leachate and diverted to the leachate collection system for disposal as such.

25 Type 1 or Type 2 liners (as defined in section 5.7 of the WasteMINZ (2018) Technical Guidelines for Disposal to Land (2018)) meet the requirements for leachate containment for a Class 1 landfill. The Type 1 liner includes a 1.5mm high-density polyethylene (HDPE) membrane over 600mm of compacted clay with permeability of less than 1×10^{-9} m/s. The Type 2 liner incudes a 1.5mm HDPE membrane over a GCL over 600mm of compacted clay with permeability less than 1×10^{-8} m/s.

26 As shown on the drawings, I recommend a Type 2 liner with a GCL is applied to the flatter base of the landfill where the depth of leachate is at risk of increase above the nominal 300mm during temporary storage in extreme storm events. Type 2 liner is also recommended for the leachate sump and for a vertical height of 1.2m up the sides of the inclined side liner from the nominal base grade of the liner.

27 A GCL is a 5mm thickness of swelling clay laid between two geotextiles. This is a common product used for landfill liners and water retaining structures as an alternative to low permeability clays or similar.

28 A GCL has been adopted on the base liner for two reasons:

(a) The leachate sump will be regularly subjected to leachate depths exceeding 300mm and the inclined liner base will also have leachate depths that exceed 300mm under extreme rainfall events; and

(b) The landfill base is relatively small and filling the base with waste will occur relatively quickly, providing confining pressure needed for the GCL.

29 I have recommended a Type 1 liner for the side slopes of the landfill for two primary reasons:

(a) As noted above, GCLs have limitations where confining pressures are required to control swelling and this is harder to achieve on the side slopes; and

(b) The GCL's internal shear strength is limited to cross threading of the geotextile fibres. If during detailed design a GCL is ultimately selected for the inclined liner batter slopes, design will carefully assess and test interface shear strength between the individual and composite liner layers to prove internal stability in shear.

30 It should be noted that the Type 2 liner is stated as being adopted in the Design Report for both the base and side of the landfill. However, as described above, the drawings show a Type 2 liner over the flatter base of the landfill and a Type 1 liner on the side batters. The drawings and my evidence reflect my recommendations and I note the hydrogeological modelling presented in Mr Kirk's evidence also reflects my recommended design. Nonetheless, both Type 1 and Type 2 liners are acceptable alternatives in WasteMINZ's Technical Guidelines for Disposal to Land (2018) and could be adopted during detailed design.

31 HDPE liners are used for both Type 1 and Type 2 composite liners. These liners are susceptible to degradation through sunlight and temperature variations. This will be managed by keeping liner installation to between 1 and 2 years of liner development and covering the liner with waste or other materials as quickly as possible. Bulk earthworks to advance the liner subgrade will be completed on a larger scale than needed at that time to allow flexibility in the landfill liner development.

32 The site facilities will be installed at the commencement of the landfill operation. This provides support for the landfill operation, leachate management, and capability to attend to emergencies.

33 Landfill gas bores, pipes and flares will be installed when there is sufficient waste to produce enough gas for flaring. Horizontal gas pipes will be installed until there is sufficient waste depth to install vertical wells. Landfill gas will be flared until such time that the landfill operator considers gas to electricity generation is viable. Mr Welsh's evidence provides a more detailed discussion on the generation and capture of landfill gas.

34 It is proposed that the landfill will be progressively filled and final cap applied over portions of the landfill where the design levels have been achieved. The benching of the landfill side walls allows controlled raising of the landfill waste with surface water controls at iterative levels. Mr Ingles provides a more detailed discussion on surface water management in his evidence.

35 Particular issues addressed in this design to resolve potential adverse effects include the following:

(a) Minimising the landfill footprint and maximising waste depth to increase void efficiency. The landfill was first designed to accommodate over 6 million cubic metres of waste that would be at capacity after 55 years allowing for 90,000 tonnes per annum. Following the gazettal of the National Environmental Standards for Freshwater 2020, and re-assessment and reduction of the potential imported waste volumes, the applicant decided to reduce the extent of the proposed landfill and avoid the wetland at the base of the landfill embankment. The updated design provides for around 3 million cubic metres of waste that would have a life span of around 40 years, allowing for the placement of 60,000 tonnes per annum - the assumed revised likely future waste disposal rate;

(b) Utilising the natural landform at the head of two minor gullies to minimise surface water impacts and minimise earthworks, while providing sufficient soils to undertake the required earthworks during both construction and operation of the landfill. The slope of the natural gullies approximates the proposed liner slopes of 1 vertical to 4 horizontal. Allowing the perimeter of the landfill to marry into the existing landform permits screen planting and surface water controls to be installed early without the need for large scale earthworks in those locations;

(c) Providing a stable structure to retain the waste will also address shallow failure of the loess layer that overlies the Henley Breccia. This is achieved by generally cutting the existing slopes 5m below existing ground surface and the removal of the loess completely. Any filling required will be with engineered fill. Loess will be reused in the base liner construction and be modified to increase its potential erosional stability and reduce its permeability;

(d) The landfill toe embankment will be constructed as engineered fill from breccia excavated from cut areas to allow for a steep down-side embankment thereby reducing the footprint size of the embankment and avoiding the wetland. This requires the stormwater attenuation basin to be constructed off-line from the main gully;

(e) The attenuation basin will be constructed in the gully south of the proposed landfill where there are no wetlands. Surface water will flow under gravity from the landfill to the attenuation basin. This will be achieved by inclining the longitudinal gradient of the top surface of the toe embankment towards the attenuation basin. The landfill perimeter swale drains continuously from the full perimeter of the landfill and across the top of the toe bund to the basin. In accordance with best practice, the drainage grades provide surface water management for more than a 1 in 100 year storm event (including allowance for climate change);

(f) Access for waste transport trucks from the public road to the landfill will be incorporated into the facilities area that is graded at 4%. This will allow for checking of incoming loads; a turning area for large trucks and leachate tankers; a weighbridge; a wheel wash; and offices. The wide entrance on the outside corner of Big Stone Road provides for good sight lines by trucks exiting the site and also allows for landscaping of the main entrance;

(g) The incorporation of areas for earthworks soil storage into the design. This may include excavated soils and loess materials scheduled for later use on the landfill construction and rehabilitation;

(h) Location of the landfill gas flare to reduce the visibility of the flare is achieved by developing a maintenance area containing the flare separate from, and 10m lower in elevation than, the upper facilities area;

(i) Provision of sufficient flat areas for landfill administration and support facilities primarily at the entrance from Big Stone Road is achieved by the early removal of the ridge line over that location. An additional facilities area related more to the waste placement and compaction is located on a lower platform closer to the landfill itself, thereby reducing impacts to the more administrative operations at the higher elevation; and

(j) Stable waste placement is achieved through both the construction of the toe embankment at commencement, and the relatively small size landfill base. This allows waste to be placed in the “bowl’ of the landfill with the waste supported on all sides as early as possible. Additionally, the leachate system will be installed in its entirety early and the “bowl” will provide emergency leachate storage, should this be required.

Response issues in ORC peer review

36 I have responded to matters raised in the document: Tonkin & Taylor (2 September 2021): Technical Review to Inform Notification Decision:

Smooth Hill Landfill - Appendix 3 - Landfill Concept Design and further queries Tonkin and Taylor (22 February 2022).

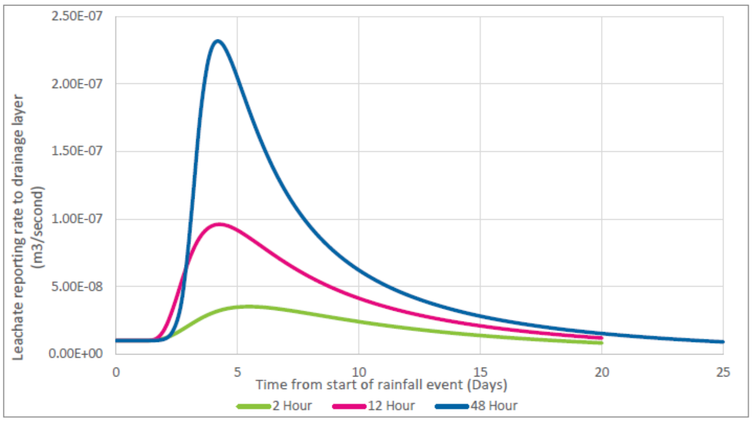
Flow capacity in leachate longitudinal drainage - leachate drainage on benches and drain lengths for cleaning and spacing (Clause 15)

37 Tonkin & Taylor have queried the capacity of the leachate drainage pipework, and have suggested that each bench on the liner side batters could accommodate an additional leachate drain to reduce the load on the drainage pipes at the base of the landfill. Tonkin & Taylor also recommended that leachate drainage extends to the locations where this drainage can be accessed for jetting. I believe the concerns raised are adequately addressed in the design and elaborate as follows.

38 For the leachate drainage pipework, I have chosen two 200mm diameter perforated HDPE pipes, being more resistant to crushing for a given pipe wall thickness than one larger pipe, and reducing potential build-up of leachate on the landfill liner should one pipe block. Note that if there is a localised blockage in one pipe, leachate will flow out of the blocked pipe through the perforations, flow through the drainage aggregate and/or the second pipe and return into the blocked pipe perforations down slope of the blockage. The leachate drainage aggregate is protected from blockage by installation of a geotextile (filter cloth) as shown on drawing 12506381-01-C207. The 200mm pipe flow capacity at 4% gradient is 75 l/s and two pipes will convey 150 l/s. I have calculated the required capacity for the leachate collection on two scenarios set out below.

39 The first and more important scenario is when half the landfill is practically full and a catchment of 93,000 m^2 reports to two leachate pipes (note that the areas of each side of the landfill are approximately equal). To calculate the flow of rainfall that will report to the leachate collection system, consideration is required of the time it takes for rainfall to flow through the waste. Snowfall contributing to leachate production is allowed for in the overall precipitation rates used in the leachate modelling. The infiltration time is discussed in Section 5.1 of the Design Report. For visual representation I have referred to Figure 3 below that is copied from the report GHD (Aug 2020): *Assessment of Effects to Groundwater* and depicts the flow rate of rainfall through 14 metres of landfill waste with various cover.

Figure 3: Leachate reporting rate to drainage layer following 10 Year ARI rainfall event



40 This figure shows that rainfall through the waste takes up to 20 hours to report to the leachate collection system. It follows that the flow rate is attenuated as it flows through the waste. In calculating the required capacity for the leachate drainage collection pipes, I have assumed a 4 hour storm followed by a 4 day period for percolation of rain water through the waste. I also assessed flows to the leachate drainage for a 4 hour storm where the waste is thinner and the percolation rate is faster. This gives a range of flows that the leachate pipework needs to accommodate. I have used the average infiltration rates derived through *Hydrological Evaluation of Landfill Performance* (HELP) modelling prepared by Anthony Kirk. HELP allows for calculation of leachate that is generated through water percolation through a landfill. It allows for a range of factors including evaporation, absorption, capping layers and rainfall rates.

41 The HELP model allows for various landfill covers from open HDPE to final cover. This average infiltration for areas of different cover types is 35% of rainfall. For the 4 hour duration the calculated flow rate is 130 l/s - less than the capacity of the two proposed leachate pipes. Where the 4 hour storm takes 4 days to percolate, the flow rate reporting to the leachate pipework is 22 l/s. The actual flow will vary between these two numbers as the landfill is in different stages of filling. The conservative flow rate of 130 l/s demonstrates that the leachate pipe system as designed is adequate. This will however be re-visited at detailed design.

42 The second scenario is when new landfill liner has been placed and there is no waste over that portion of the liner to attenuate the flows and the rainfall is not attenuated. This scenario allows for 10,000 m^2 HDPE liner to receive a 10 minute rainfall event that will produce 260 l/s reporting to the two leachate pipes. Although this exceeds the capacity of the two leachate

pipes by 75%, additional flow will occur in the drainage blanket to accommodate the additional flow.

43 The submitted design provides for the leachate pipes to extend to the surface at the top of the landfill toe embankment and adjacent to the leachate pump risers. This therefore will permit jetting of the leachate pipes. This is shown on Drawing 12506381-01-C402 although the detail is slightly obscured on the drawing by the pump riser pipes.

44 I previously considered placing leachate pipes on the inclined liner benches as suggested by Tonkin & Taylor. The benches have a 2% longitudinal gradient, however the detail to return the leachate pipes with multiple bends across the 10m wide bench leading to the leachate sump at the base of the landfill, and still allow for water jetting was complicated. I considered the less complicated system with pipes at the base of the landfill batter appropriate. The detail on Drawing 12506381-01-C207 shows the benches, however does not show the proposed placement of low permeability clay fill over the bench, and the HDPE liner when the landfill liner is extended up the slope. This fill will provide a gradient for the leachate to flow from the upper slope and across the bench to the lower slope such that the leachate depth will not exceed 300mm. This detail will be confirmed at detailed design.

45 I have not shown the placement of intermediate leachate drains across the base of the landfill. Such drains are not required to convey the anticipated leachate volumes discussed above, however will be required to regulate depth of the leachate on the base of the landfill to 300mm. It is not expected that leachate would develop to 300mm on the 1 vertical : 4 horizontal side slopes. This aspect will however be confirmed at detailed design and where necessary, intermediate drains will be installed.

Adequacy of leachate tank storage (Clause 16)

46 I agree that the storage capacity of the leachate tank storage will need to be reviewed at detailed design. The concept design submitted provides for the bunded area to contain the volume of one storage tank of leachate should it rupture as well as using that same bunded area for emergency storage should the storage tanks reach capacity in a storm event. The three storage tanks will accommodate a 10 year rainfall event and the tanks plus bund will accommodate flows from a 100 year event with no tankering off site for 2 days. The volume of leachate storage is set out in the Draft Consent Conditions. This requires the leachate tank storage to be based on a calculated volume for the first 2 years and thereafter to be 150% of the

actual leachate flows recorded. It is expected that the volume of storage will increase as the extent of the landfill increases.

Establishment of a peer review panel (Clause 25)

47 I agree that the appointment of a peer review panel is appropriate to provide third party review of the design, development and operation of the landfill and provide transparency to stakeholders and the public. I also agree that the independent CQA should be provided and each portion of landfill liner inspected, tested and certified by an independent party experienced in liner installation.

Response to matters raised in submissions

Site Selection (Submitter S Laing and S&A Ramsey)

48 The submitters query if the site selection leading to Smooth Hill as the preferred location has been reviewed since the initial selection in the report by Beca Steven (16 January 1992): *Dunedin City Council Refuse Landfill: Site Selection Report*. The submitter notes "Under current best practice, the site would not be chosen as a good site for a class 1 landfill. There have been advances in understanding the environmental risks like siting landfills away from valleys and waterbodies, given how fragile waterways and wetlands are."

49 I have reviewed the assessment criteria applied in the Beca Steven (1992) report and confirm that criteria in the 1992 assessment covers the same matters as the current WasteMINZ (2018) landfill design guidelines. Additionally, the site is located at the head of the Ōtokia catchment and I have noted previously the benefits with respect to storm water management and environmental protection of having a site with very little up gradient catchment and no permanent flowing water bodies crossing the site. The applicant has also specifically avoided encroachment in the wetland at the toe of the proposed landfill thereby meeting the requirements of the recently redefined National Policy Statement for Freshwater Management 2020.

Risk of leachate runoff including pipework failure by-passing the attenuation basin and contaminating downstream surface water (Submitter Big Stone Forest Ltd, S & A Ramsey)

50 The attenuation basin is designed to regulate the flow of runoff from the landfill surface and the support facilities areas, such that the flow rates to the downstream watercourse are similar to the flows before the landfill existed. At the time of this application, the catchment that currently flows to the attenuation basin and the wetland downstream of the proposed landfill

is felled pine and is replanted in pine seedlings. The proposed attenuation basin will receive surface water from the entire final landfill capping when the landfill is completed as well as most of the operations and facilities areas supporting the landfill. Surface waters from the landfill capping are directed to the attenuation basin by a perimeter swale drain.

51 The submitters are concerned that burst leachate pipes may not flow to the attenuation basin where leachate can be controlled through the attenuation basin. The leachate riser pipe route and the leachate storage tanks and associated load-out-bay all drain to the attenuation basin. (Ref Drawing 12506381-01-C202). Note that the upper facilities area has cross fall from the north towards the perimeter swale drain and this is the same for the crest of the landfill toe embankment that also drains to the swale drains that gravitate to the attenuation basin.

52 The only exception to the direction of all surface water to the attenuation basin is prior to the landfill being filled up to and above the crest level of the landfill toe embankment, surface water will be piped (and initially a small quantity pumped) from a sediment retention pond (SRP) constructed within the landfill footprint to the wetlands at the base of the landfill toe embankment. I reiterate that surface water that is contaminated with leachate will be treated as leachate and the surface waters discussed are not contaminated with leachate. Once the landfill surface reaches the first (lowest) bench in the landfill liner profile, surface water is gravity fed to the attenuation basin. As the stage 1 SRP poses a risk of transmission of leachate directly to the watercourse (i.e. not through the attenuation pond), water from the SRP will be continuously monitored to confirm the water is suitable to be released (the testing is discussed in the evidence from Mr Allen Ingles). If it is not suitable to be released, portable pumps will discharge the pond water to the leachate management system and ultimately to the Dunedin wastewater treatment system.

53 The only catchments associated with the landfill development that do not flow to the attenuation basin are the topsoil and general fill stockpiles to the north of the facilities area and the face of the landfill toe embankment. These earthworks will be provided with separate erosion and sediment controls that will drain to the gully to the north of the landfill and ultimately to Ōtokia Creek. No waste will be stored in this area and sediment control measures will be in place to manage the stockpiles.

54 Possible leachate spills that would flow to the attenuation basin could arise from:

(a) Rupture of leachate riser pipes from the pumps of the leachate collection system to the leachate storage tanks;

(b) Overfilling of the leachate storage tanks exceeding the storage capacity of the tanks and emergency storage;

(c) Spillage of leachate while filling leachate tanker trucks; and

(d) Leachate breakout at the landfill capping.

55 The landfill toe embankment will be constructed from engineered fill. The top of the embankment is 20m wide and the base is up to 90m wide. Although this fill is not specifically low permeability, the landfill liner will be applied to the landfill side (upgradient) of the embankment and there will be groundwater drainage at the upslope side of the embankment that will capture groundwater and convey this to the monitoring manhole on the downward face of the toe embankment.

56 Breakout of leachate from a leak in the inclined landfill liner to the down slope face of the toe embankment would have to firstly flow through the landfill liner and then flow through a wide engineered fill embankment. This is unlikely given that liquid will seek to flow vertically down, as opposed to horizontally. The natural geology of the breccia is low permeability and any leachate leakage through the liner would follow the path of least resistance to the under-liner groundwater drainage that reports to the monitoring manhole before discharge to the ephemeral stream. The manhole will be continually monitored for a range of parameters found in leachate

57 There is no subsoil drainage through the toe embankment apart from the one drain running parallel to the upper edge of the embankment fill and adjacent to the leachate sump in the landfill that drains to the groundwater monitoring manhole at the toe of the landfill. This groundwater drain is not required from a structural aspect (unless there are existing seeps to be drained), such a drain if installed could be routed to the monitoring manhole as for the formal perimeter sub-liner groundwater drains.

58 As stated above – all potential spillage of leachate to surface areas will be captured in the proposed drainage flowing to the attenuation basin. Leakage in the landfill liner is expected to preferentially flow to the groundwater collection drainage and to the monitoring manhole.

Proposed measures to avoid and mitigate adverse effects of leachate and other contaminants due to natural disasters (Submitter Mosgiel Taieri Community Board and South Coast Neighbourhood Society)

59 Hazards and contingent events and the management of these is discussed in detail in Section 8 of the GHD (2021) *Landfill Concept Design Report*. Natural disasters that could give rise to leachate discharges or waste exposure leading to odour are discussed as follows:

Flooding

60 The surface water drainage system including the swale drains and the attenuation basin are designed to accommodate a 1 in 100 year storm with additional allowance for increased rainfall due to climate change up to the year 2100. This provides for the conveyance of surface water safely around the landfill.

61 The biggest risk for leachate spillage associated with flooding is when the landfill filling commences and waste levels are below the level of the Stage 1 perimeter bench that gravitates to the attenuation basin; and when a temporary pipe conveys surface water from the unlined portion of Stage 1 (refer Drawing 12506381-01-C201). There is a risk that the stormwater pumps will not cope with the rainfall intensity and surface water builds up and flows into the waste void and is managed thereafter by the leachate collection system. Should this occur, the surface water pumps would be switched off and the combined surface water and leachate treated as leachate and pumped to the leachate storage tanks for removal off-site. The void in the waste is large and able to accommodate the overflow of rainfall into it.

Landslips

62 Landslips can be caused by a number of factors. I will not discuss these potential causes, however I will discuss the effects of a landslip in relation to leachate loss. The risks associated with seismic events are addressed in the evidence of Mark Stirling (which specifically covers the likelihood and scale of such an event), and in the evidence of Samantha Webb (which specifically covers the use of seismic accelerations defined by Mr Stirling, in confirming the seismic stability of the landfill earth structures).

63 Slips in the supporting soils of the landfill liner would cause the liner to tear where the extent of movement exceeds the elastic limits of the HDPE liner. In such cases, the compacted clay layer included in both Type 1 and 2 liner systems provides healing of the rupture up to the point that the clay layer itself ruptures and creates a pathway for leachate to flow to the underlying soils. Allowable elongation of HDPE varies on a number of factors and for different manufacturers provide service limits between 3% and 6% with a maximum elongation of around 20% resulting in tear in the liner. GCL membrane can withstand 10% to 30% elongation dependant on the

individual GCL properties. These numbers are of little use in understanding an acceptable landslip scenario as a rupture over say 100mm would require the HDPE to stretch 20mm before rupture and if the same occurred over 10mm, the HDPE could stretch 2.0m before rupture. It is therefore important to provide a structure supporting the liner that does not permit excessive stress over a short distance.

64 The proposed design mitigates the most likely risk of slippage by removal of the typically ~2.0m thick layer of slip prone loess and highly weathered rock which mantles most of the site. The proposed design typically provides for cutting of 5.0m or more over most of the landfill to the more competent breccia. In areas where excavation is not required to create the landfill base grades, the weaker loess will be over cut and replaced with engineered fill including crushed breccia. Ground water drainage will be installed to control groundwater rise that could reduce the strength of fills if not controlled. Additionally, a 200mm subgrade layer will be applied under the 600mm thick compacted clay layer of the liner. The combined 800mm thick engineered fill provides a flexible and uniform soil layer to spread any movement in the substrate before over-stressing the HDPE liner.

65 Should the liner tear due to movement caused by a landslip or seismic forces, leachate losses would flow to the under-liner groundwater drainage and be detected at the groundwater sump and groundwater monitoring well at the toe of the landfill embankment. The drains are designed with large volumes of drainage aggregate wrapped in geotextile to accommodate flows that exceed the drainage pipe capacity in the aggregate, should the pipe itself be damaged. Such drains will continue to operate even if the pipework is damaged.

66 The breccia is naturally low permeability, equivalent to a silty soil (< 3×10^{6} m/s) and would encourage flows to flow laterally and to the under-liner ground water drainage where any leachate contaminated water resulting from a tear in the landfill liner would be extracted.

67 A large slip in the substrate would exceed the deformation limits of both the HDPE and clay liners and groundwater drainage. It is therefore essential that appropriate factors of safety are applied to the engineering design of earthworks and in particular embankment fills. These safety factors will be discussed by Samantha Webb in her geotechnical evidence.

68 Slips within the waste can occur. It is important that any settlement or movement in the waste does not stress the landfill liner. For that reason, the friction between each layer of the composite liner is designed to provide for shear above the top of the composite liner. This is the top of the HDPE

liner at the interface with the geotextile that supports the 300mm leachate drainage layer and is achieved by using HDPE that is textured on the underside and smooth on the face next to the geotextile that underlies the drainage media.

69 The proposed landfill Stage 1 is designed to fully fill the entire base of the landfill with waste before raising the fill levels to the next 10m bench height. This provides symmetrical support to the waste so this there is no opportunity for the waste to slide on the liner. Fresh waste placed and compacted is inherently stable due to the intermingling of solid materials. This allows temporary faces of waste to be placed at angles of 1 vertical to 1.5 horizontal.

Liner installation defects and deterioration (Submitter M Sydor)

70 The serviceable life of the landfill liner is a function of many factors that include the quality of materials and any performance additives to HDPE; the quality of the installation contractor's work; quality control and monitoring during installation; adequate liner protection; careful placement of the first lifts of the waste; heat development and contamination in waste placed in the body of the landfill; and movement and/or shear of the liner. These matters are carefully controlled through detailed design, peer review, construction monitoring, and landfill management practices. All of these factors are carefully managed in a regional landfill such as that proposed for Smooth Hill. Under ideal conditions, HDPE membranes will last 400 years before failure to the extent that leachate is not contained by the liner. The compacted clay liner below the HDPE membrane will however survive indefinitely. The proposed liner design and installation including the CQA requirements will be submitted for acceptance by the peer review panel.

71 Tonkin & Taylor discuss wrinkles in the liner in Clause 11 of their report. Wrinkles in the HDPE liner can be caused by placement over a day when there are varying levels of sunlight and therefore variations in the expansion of the plastic during welding and before placement of heavy cover materials such as drainage aggregate. These differences in thermal expansion can be reduced to a large extent with the use of white HDPE liner that does not attract large amounts of heat compared to black plastic.

72 It is important that cover materials including drainage layers are placed over completed liners as soon as possible. It is however necessary to complete all quality assurance testing and sign off before covering any of the multiple liner layers. Part of that quality assurance will include observation for wrinkles. Once the protective geotextile and drainage media is placed, the underlying HDPE liner temperatures will be less extreme and result in less

thermal expansion. Additionally the weight of the drainage aggregate will hold the HDPE to the underlying formation and thermal expansion will occur in the thickness (as opposed to the planar surface) to a greater degree than if the liner was unrestrained.

73 The proposed extension of landfill cells will be limited to the minimum required to accommodate waste for the coming 18 to 24 months. This period allows for installation of the liner over an optimal period in relation to wet (and/or extreme) weather and provides sufficient capacity beyond adverse weather conditions that would produce poor liner quality. Extensions will be in “slices” extending to the next bench 10m upslope of earlier placed liner. The area of the liner placed is dependent on waste volumes and will be determined by the landfill operator at the time of cell development

Litter (Submitter Mosgiel Taieri Community Board)

74 The submitter is concerned that waste delivery trucks must be covered to avoid loss of litter in transit from the source location and the landfill. The covering of waste trucks is standard practice and a requirement for a consent condition requiring covering of trucks is appropriate.

75 The active fill area that receives waste delivered daily to the landfill will have portable litter fences downwind of the waste placement area to catch litter that may be mobilised during windy conditions. Such fences will be permanently kept on site, however will be moved as the wind direction requires it. Litter caught on the fences will be removed on a regular basis as detailed in the Landfill Management Plan.

Fire Risk (Submitters: Big Stone Forest Ltd, S&A Ramsey, S&B Judd, South Coast Neighbourhood Society, M Sydor, S Weatherall)

76 The submitters raised concerns that the landfill is close to forestry and residential properties that would be at risk in the event of a fire occurring at the landfill. The fire risk and appropriate measures to manage the risks has been addressed in evidence prepared by Anthony Dixon and Paul De Mar. I have amended the landfill design to incorporate the recommendations by Messrs Dixon and De Mar and attached Figure 1 below (being the updated Drawing 12506381-01-C102; General Arrangement Plan) showing the amendments incorporated in the design. The amendments incorporated include the following:

(a) Provision of emergency access and turning area at the southern end of the Big Stone Road frontage for fire trucks to access directly from Big Stone Road;

(b) Provision of increased fire water storage to 2 tanks of 200 cubic metres each. One each at the northern main entrance and one at the southern emergency entrance;

(c) Installation of a vehicle track within the landfill footprint and along the south eastern and south western sides of the proposed landfill extent;

(d) Clearing of all combustible materials such as pine trees, stumps and slash from the full landfill extent and reinstating in grass at the commencement of landfill development; and

(e) Provision of a tracked water truck to provide emergency access of fire water to any part of the landfill regardless of access limitations.

Conclusion

77 The Smooth Hill landfill concept has been designed in accordance with the recommendations set out in the WasteMINZ (2018) *Technical Guidelines for Disposal to Land*. This guideline represents best practice for the development of a municipal waste landfill in New Zealand. Where appropriate; additional measures have been incorporated into the design such as avoidance of the wetland areas and increased fire management measures.

78 The location of the proposed landfill was assessed through an options assessment carried out in the early 1990s. This assessment included all the aspects considered in the current WasteMINZ (2018) guidelines. The preferred location for Smooth Hill was selected out of 32 potential site locations due to appropriate geology, rural location, and position at the head of a gully suitable for stability, surface water and leachate management. Engineering controls and site management practices will be adopted to adequately manage extreme rainfall and seismic events and residual effects such as noise, odour, leachate containment, surface water quality, fire, and bird strike to the Dunedin Airport.

79 Leachate controls adopted in the landfill design address separation of surface water from leachate and leachate flow and storage during 1 in 100 year annual recurrence interval events. Leachate conveyance and storage devices provide redundancy for increased flows and potential failure of leachate pumps and storage devices and effects of natural disasters.

80 Surface water flows are directed to the stormwater attenuation basin that has an emergency shut off valve to capture a spill of leachate or other contaminants that would flow to the stormwater system. For the commencement of the landfill development prior to a complete liner

installation to the level of the landfill toe embankment, flows from the partially unlined landfill will be monitored and diverted to the leachate system should leachate contaminate that stormwater. The surface water catchment above the catchment of the landfill liner and leachate collection system will be diverted through cut off drains thereby reducing the potential flooding of the leachate system.

81 The leachate containment of the landfill is heavily reliant on the quality of the liner system. For Smooth Hill, a liner system meeting the requirements of the WasteMINZ's Technical *Guidelines for Disposal to Land* for a Class 1 landfill will be adopted. The primary HDPE liner will incorporate a compacted clay liner, and a GCL should the clay liner require additional security. This is especially so for the base of the landfill where temporary storage of leachate in excess of 300mm depth may occur. This additional GCL on the compacted clay liner with permeability of 10^{-9} m/s base exceeds the requirements of the *Technical Guidelines for Disposal to Land*.

82 The quality assurance of the installation of the landfill liner is critical to the effective containment of leachate. Both the detailing of the liner system and the quality assurance of the installation will be fully reviewed by the proposed independent peer review panel to ensure this critical element of the landfill meets best practice.

83 The proposed independent peer review panel is a method commonly adopted for landfill design, construction and operational review and provides independent verification of all aspects of the landfill construction and operation.

84 Litter controls to be adopted will include covering of all waste delivery trucks, minimisation of the active waste placement area, daily covering of waste with inert soils and the use of litter screens at the tipping face to capture wind blown litter.

85 Additional fire prevention and management procedures will be adopted and include: additional storage of fire water supplies, access tracks to the perimeter of the landfill and all terrain water tankers to use that access and emergency fire truck access to the southern end of the site abutting Big Stone Road.

Richard Mark Coombe

29 April 2022

FIGURE 1

G. DOUGHERTY
Q1503 DRAFTING CHECK REVIEW
19/04/2022 10:29:23 AM

FOR CONSENT
NOT FOR CONSTRUCTION

No	Revision	Drawn	Job Manager	Project Director	Date
3	FIRE TANKS ALTERED	JF	NE*	SD*	19.04.22
2	RE-ISSUE FOR CONSENT	RG	NE*	SD*	21.05.21
1	FOR CONSENT	SLP	NE*	SD*	14.08.20

Note: * indicates signatures on original issue of drawing or last revision of drawing

0 25 50 75 100 125m
SCALE 1:2500 AT ORIGINAL SIZE

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Designer R. COOMBE
Drafting Check G. DOUGHERTY*
Design Check N. ELDRED*
Approved (Project Director) S. DOUGLASS*
Date 14.08.20
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Client **DUNEDIN CITY COUNCIL**
Project **SMOOTH HILL LANDFILL**
Title **GENERAL ARRANGEMENT PLAN**

Original Size A1
Drawing No: **12506381-01-C102**
Rev: 3

Plot Date: 17 April 2022 - 8:45 PM Plotted by: Jimmy Flores Cad File No: C:\12d\SW\data\P-00-12D-001\51-12506381 - Smooth Hill Landfill_293\CADD\Drawings\51-12506381-01-C102.dwg