RILEY CONSULTANTS

EARTHWORKS AND SEDIMENT CONTROL ASSESSMENT PROPOSED RETIREMENT VILLAGE 578 SPRINGS ROAD, PREBBLETON

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EARTHWORKS AND SEDIMENT CONTROL ASSESSMENT
PROPOSED RETIREMENT VILLAGE
578 SPRINGS ROAD, PREBBLETON

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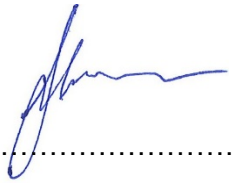

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EARTHWORKS AND SEDIMENT CONTROL ASSESSMENT PROPOSED RETIREMENT VILLAGE 578 SPRINGS ROAD, PREBBLETON

1.0 Introduction

The following report has been prepared by Riley Consultants Ltd (RILEY) at the request of Summerset Villages (Prebbleton) Ltd (Summerset). It outlines the proposed earthworks activities required to form a finished ground profile for future use of the site, the effects of those works, and the mitigation measures to be used to avoid or mitigate the effects of the proposed earthworks on the environment. This report has been prepared to support resource consent applications and should be read in conjunction with the Preliminary and Detailed Site Investigation report (RILEY Ref: 190417-H), Geotechnical Assessment (RILEY Ref: 190417-J) and the Remedial Action Plan and Site Management Plan (RILEY Ref: 190417-K).

This report and the recommended mitigation measures will be used to inform the resource consent conditions and the proposed Erosion and Sediment Control Plan (E&SCP).

2.0 Background and Site Description

The site is located along Springs Road in Prebbleton, a small town approximately 12km south-west from Christchurch city centre. The site measures approximately 330m by 280m (approximately 9.11Ha) and is surrounded by residential areas to the north, east, and south, with lifestyle dwellings and agricultural land within a kilometre of the site to the west and north-west.

A mushroom factory currently occupies the northern half of the site and comprises several large warehouses and factory buildings (approximately 1,000m^2). Most of the factory area is paved with concrete or smaller areas of gravel fill. It is understood that the southern half of the site was previously used as a horse training facility, and currently comprises grassed fields with several bunds up to 2m high separating the fields.

A number of mature trees are present towards the south-east of the site, and a residential property is currently located in the south-east corner. A 40m wide strip of grassed land with a 2.5m high bund borders the northern boundary of the site.

The site is relatively flat, with a slight slope from the north-western boundary to the south-eastern boundary of the site adjacent to Springs Road. Site contours show an approximate ground surface elevation of RL 22.4m at the north-western boundary and a minimum elevation of approximately RL 20.6m at the south-eastern boundary.

Earthworks will be carried out to satisfy Selwyn District Council (SDC) Plan requirements (in relation to site gradients, overland flow paths, future building platform levels, roads, etc.) and to enable future use of the site as a retirement village. The earthworks to be carried out on-site, to achieve the desired finished ground profile, will be undertaken in accordance with the design and engineering specifications prepared by RILEY, Selwyn District Council Code of Practice and Environment Canterbury Erosion and Sediment Control Guidelines.

3.0 Resource Consent Requirements

Resource consents are required for managing the effects of earthworks to minimise any potential adverse effects on the surrounding area. The site is located within the Living X Zone, which provides for low density residential development.

A summary of the relevant rules and provisions from the SDC District Plan and Environment Canterbury (ECAN) Canterbury Land and Water Regional Plan that relate to the proposed earthworks are outlined in Table 1 with comments. The assessment of the earthworks and associated sediment control measures outlined in this report are intended to address the District and Reginal Plan rules and provisions. Note, Boffa Miskell have provided input into the planning considerations of RILEY Reports to ensure they align correctly with the planning rules and provisions.

Table 1: District Plan and ECAN Rules and Provisions

Rules/Provisions	Comment
Selwyn District Plan	
Permitted Activities	
2.1.1. Any earthworks shall be a permitted activity if the following conditions are met:	
2.1.1.1. Any disturbed or stockpiled material is kept moist until it has consolidated	**Complies** Water cart will be utilised on-site to maintain adequate moisture in disturbed ground or stockpiles.
2.1.1.2. Any stockpiled material is kept consolidated or covered to avoid sediment run-off from rainfall	**Complies** Stockpiles will be tamped down at the end of each working day. Stockpiles may also be stabilised with polymer or grass.
2.1.1.3. Any site subject to earthworks is either: (a) built upon, (b) sealed, (c) landscaped, or (d) the land recontoured and replanted No more than 12 months after the earthworks commencing, except in the case of landscaping and planting which shall be undertaken during the first planting season following the completion of the earthworks	**Complies** Site to be built upon immediately following earthworks
2.1.1.7 Any earthworks undertaken on any site to be used to erect a building complies with NZS 4431 Code of Practice for Earth Fill for Residential Development	**Complies** Earthworks specification will be in accordance with NZS 4431
2.1.1.8 The earthworks are not part of mining or mineral exploration	**Not applicable**
Environment Canterbury: Canterbury Land and Water Regional Plan	
5.94A Construction-phase stormwater not discharged from a reticulated stormwater system. The discharge of construction-phase stormwater, other than into or from a reticulated stormwater system, to a surface waterbody, or onto or into land in circumstances where a contaminant may enter groundwater or surface water, is a permitted activity, provided the following conditions are met:	

Rules/Provisions	Comment
1. The area of disturbed land from which the discharge is generated is less than: a. 1000m^2 for any construction-phase stormwater generated as a result of work carried out in an area shown as High Soil Erosion Risk on the Planning Maps; or two hectares in any other location; and	**Complies** Disturbed areas will be less than 2ha based on earthworks phasing plan.
2. The concentration of total suspended solids in the discharge shall not exceed: a. 50g/m^3 where the discharge is to any spring-fed river, Banks Peninsula river, or to a lake except when the background total suspended solids in the waterbody is greater than 50g/m^3 in which case the Schedule 5 visual clarity standards shall apply; or b. 100g/m^3 where the discharge is to any other river or to an artificial watercourse except when the background total suspended solids in the waterbody is greater than 100g/m^3 in which case Schedule 5 visual clarity standards shall apply; and	**Complies** Not applicable as sediment pond discharge will be to groundwater. Sediment pond and chemical treatment will be utilised to ensure total suspended solids are within tolerance.
3. The discharge does not result in an increase in the flow in the receiving waterbody at the point of discharge of more than 1% of a flood event with an Annual Exceedance Probability of 20% (one in five-year event); and	**Complies** Not applicable as discharge is to groundwater.
4. The discharge is not from, into or onto contaminated or potentially contaminated land; and	**Complies** The land has been identified as contaminated under the NES-CS but will be remediated prior to the commencement of earthworks. See RMP/SMP Report (RILEY Ref: 190417-K).
5. The discharge does not contain any hazardous substance; and	**Complies** Any hazardous substances will be removed from the site prior to commencement of earthworks.
6. The discharge does not occur within a Community Drinking-water Protection Zone as set out in Schedule 1.	
5.175 The use of land to excavate material is a permitted activity, provided the following conditions are met:	
Over an unconfined or semi-confined aquifer: a. n/a b. the volume of material excavated is more than 100 m^3 and: i. there is more than 1 m of undisturbed material between the deepest part of the excavation and the seasonal high-water table level (highest groundwater level (PC7)); and	**Complies** More than 1m is available between the measured ground water in winter (July) and the deepest proposed excavation.
9. the excavation does not occur within 50 m of any surface waterbody.	**Complies** No known surface water bodies with 50m of the site.

The assessment of the earthworks and associated measures outlined in this report are intended to show compliance with the District and Regional Plan rules and provisions.

4.0 Geology and Geotechnical Considerations

The GNS Science (GNS) geological map of the area (Map 16, Christchurch, 1:250,000, 2008) indicates that the site is underlain by Holocene grey river alluvium several hundred metres thick.

RILEY have completed a series of shallow and deep subsurface investigations across the site in selected locations. The results of these geotechnical investigations concluded the following:

- In general, topsoil is present across the site to a maximum depth of 0.2m below ground level (bgl). This was underlain by stiff to very stiff sandy silt to an average depth of 2.0m (minimum 1.0m, maximum 3.5m), underlain by very dense sandy gravels likely to be several hundred metres thick. The stiff silt grades to a loose to dense sand in some test locations and contains sand lenses in others.
- Groundwater was measured at 6.1m and 6.2m depth in piezometers installed in BH203 and BH202, respectively after a week of heavy rain on 3 July 2020. Groundwater was not encountered in any shallow test (test pits, hand augers, soakage tests) locations and is expected to lie within gravel at depths greater than 4.0m across the whole site.
- A GUBC of 200kPa was generally available immediately and consistently beneath topsoil. A GUBC of 300kPa according to NZS 3604:2011 was not available in all test locations. A GUBC of 300kPa according to Stockwell (1977) was available in 19 of 23 test locations.
- The bunds in the southern part of the site and the bund to the north of the mushroom factory were of variable composition. To the north of site, the bunds comprised silt and gravel of an apparently similar nature to the natural subsurface materials, and to the south of site, the bunds comprised dry compacted organic topsoil.

Reference should be made to the RILEY Geotechnical Assessment (RILEY Ref: 190417-J) for further detail.

5.0 Soil Contamination Considerations

A Detailed Site Investigation (DSI) has been completed across the site. The findings of the DSI indicated the following:

- Identified localised arsenic exceedances against relevant NES-CS soil contaminant standards for construction workers and site end-users.
- Various heavy metals (mainly arsenic, zinc, chromium, lead, nickel and copper) exceeded published regional background levels. Localised TPH was also identified, as were trace levels of OCPs and a trace PAH concentration.
- Demolition of asbestos containing buildings containing within the northern hard sealed area will require approval from WorkSafe NZ. Post-demolition, soil validation testing for potential residual asbestos will be required.

Reference should be made to the RILEY Preliminary and Detailed Site Investigation Report (RILEY Ref: 190417-H) and the RILEY Site Management Plan (190417-K) for further details.

6.0 Proposed Earthworks and Management

Earthworks are required to modify the site contours to enable the site to be developed for a retirement village. The proposed earthwork activities entail shaping of the finished topography to:

- achieve desired gradients for the proposed use of the land
- ensure stormwater overland flow paths are appropriately managed
- undertaking any potential ground improvements beneath the main building platform
- achieve required freeboard for villa finished floor levels.

Specific design assumptions adopted to develop a finished ground profile for the site for bulk earthworks are as follows:

- Based on correspondence with SDC, the site is Zoned "Living X" (residential development with 800m^2 section sizes) and is not located in one of the district plan flood zones. Therefore, no minimum floor levels are required for the site other than the NZ Building Code requirement of a minimum 150mm freeboard for finished floor levels during the 50-year storm event.
- Overland flow paths within the site are to be safely directed to rain gardens and swales This will require the localised infilling of low-lying areas to ensure that site levels and gradients can maintain adequate freeboard relative to the proposed overland flow paths.
- To achieve a cut fill balance and minimise the need for retaining structures across the site.

RILEY has developed a 3D model using 12D software to generate the proposed finished contours across the site based on the above assumptions. From this model, the estimated earthwork quantities to form the desired ground profile were determined, as shown in Table 2. The maximum cut and fill depths to undertake bulk earthworks across the site are approximately 1.0m and 1.0m, respectively (note, these depths are taken from the natural ground surface and exclude cut from the existing man-made earth bunds on-site, for which the cut extends to a maximum depth of 2.4m from the existing ground to the proposed finished ground). Refer to RILEY Dwg: 190417-13 for the proposed cut and fill depths across the site.

Table 2 provides a summary of the proposed bulk earthworks quantities.

Cut (m^3)	Fill (m^3)	Balance (m^3)	Estimated Earthworks Area (ha)
-16,100	20,200	4,100	9.11

These volumes are estimated from existing ground levels, allowing for a 300mm topsoil strip across the earthwork area, compared against the proposed subgrade levels. The stripped topsoil will be stockpiled on site for respread during landscape works. The subgrade level was assumed to be 400mm below the proposed finished levels of structures and pavement areas (allowing for road pavement, building foundations and topsoil respread). Excess topsoil that cannot be placed within the site for landscaping purposes will be removed off-site and disposed of to a suitably licensed facility.

It is unlikely that groundwater will be encountered during the proposed bulk earthworks activities, with the maximum depth of cut estimated at 1m below existing ground level. Deeper excavations will be required for service trenches and stormwater soakage devices. In localised areas, these excavations are proposed to extend to a depth of approximately 4.5m bgl. These cut depths will still ensure a minimum separation of 1m between the proposed excavation base and the measured ground water surface.

The majority of fill material used to lift existing ground levels will be sourced from off-site, with some fill material sourced from excavations within the site. It is estimated that 12,600m^3 of imported fill will be required during bulk earthworks in order to achieve the proposed subgrade levels, and that approximately 9,500m^3 of unsuitable material (including material within the existing man-made earth bunds) will be cut to waste, removed from the site and disposed of at a suitable disposal facility.

The earthwork activities will be supervised by a suitably qualified engineer, to ensure that materials have been placed and compacted in accordance with RILEY specifications.

6.1 Earthwork Philosophies and Principles

Earthworks have the potential to generate sediment runoff and dust emissions until the site has been stabilised (i.e. through placement of mulch, aggregate or topsoil/grass). Careful planning and design of the proposed earthworks has been undertaken to ensure all potential adverse environmental effects are mitigated. This will be achieved by the timing and sequencing of earthworks activities with the inclusion of specifically designed erosion and sediment control devices.

The general principles that will be adopted during the earthworks activities and incorporated in the E&SCP and the dust management plan are as follows, with specific measures discussed in the subsequent sections:

- Minimise the disturbance area due to earthwork activities as far as practicable, while satisfying all requirements for development of the site.
- Undertake earthworks in various phases, and progressively stabilise exposed areas following completion.
- Divert all clean water runoff away from exposed earthworks areas
- Direct sediment-laden runoff from exposed areas to sediment retention ponds to ensure filtration and retention of sediment prior to discharging to the downstream environment.
- Implement measures to prevent construction traffic exiting the construction area onto public roads with sediment and other materials attached to the undercarriage and tyres.
- Ensure the exposed earthwork areas remain in a damp condition, utilising water trucks as necessary, until surfaces have been stabilised.
- Regularly inspect the erosion and sediment control measures and undertake any maintenance necessary to maximise the potential retention of sediment on the site.
- In the event of forecast heavy rain, stabilise the site as far as practicable and cease works until weather becomes suitable to recommence works.
- If necessary, earthwork activities may be limited in specific areas during periods of high wind.
- Ongoing assessment of the erosion and sediment control measures and, if required, adjustments as the work progresses.
- Ensure site staff are aware of the requirements of the E&SCP and the relevant resource consent conditions prior to the works commencing.
- Ensure that after hours contact details of the site manager are available.

These principles are generally in accordance with the Environment Canterbury (ECan) Erosion and Sediment Control Online Toolbox for erosion and sediment control.

Furthermore, the earthworks contract developed for the site will place specific responsibilities on the contractor for the environmental management of the site. As part of this management, the contractor will be responsible for providing adequate erosion and sediment control measures to protect downstream environments.

7.0 Construction Methodology/Sequence and Phases

The following section outlines the anticipated construction methodology and sequencing for the proposed earthwork activities. The strategy for the construction methodology for the earthwork activities is to minimise any effects on the environment. In order to achieve this philosophy, it is proposed to undertake earthworks over six phases, progressively stabilise exposed surfaces as building platform and road subgrades are achieved and provide adequate sediment control measures to avoid the discharge of sediment laden run-off from the site.

It is expected that the proposed earthworks will take approximately six months to complete. The duration of the works may be extended if works are behind schedule, or the site may be stabilised and shut down until conditions permit the continuation of earthworks.

Construction of all underground services will likely commence at the completion of the bulk earthworks within each phase. Trenches for the services will be progressively backfilled with hardfill, and therefore will not give rise to any discharge beyond the site.

The proposed phases and layouts for the earthwork activities on the site, with the associated erosion and sediment control measures, are generally as follows:

7.1 Phase 1

Phase 1 earthworks (refer to RILEY Dwg: 190417-14) will consist of the establishment of earthmoving and demolition machinery, site offices, creation of sediment control devices, removal of existing trees (as per landscape plan) and fences, and earthworks required to construct building platforms and form road subgrade levels across the southern corner of the site adjacent to Springs Road. The sequence of works anticipated for the Phase 1 area is as follows:

a) Form stabilised entrance off Springs Road, in the Phase 6 earthworks area. Install wheel wash facility for outgoing traffic. These measures will be constructed and maintained throughout the works to minimise migration of sediments to the public roading network.

b) Remove existing fences and trees (including root systems) and vegetation.

c) Construct sediment control measures, comprising sediment retention pond in the Phase 6 earthworks area (at the eastern corner of site), diversion bunds and silt fences. The sediment retention pond is to be constructed to discharge treated runoff to ground via soakage. Downstream perimeter controls would be formed to direct runoff to this pond.

d) Strip Phase 1 topsoil and stockpile on-site to an approximate height of 2m. Construct silt fencing around the stockpile and stabilise. Stockpile to be kept away from water bodies, adjoining property boundaries and the dripline of protected trees. Stockpile location to be proposed by contractor and confirmed with the Engineer. Excess material not intended to be reused on-site shall be removed to an approved disposal site.

e) Commence bulk earthworks across the site. It is envisaged that material will be placed from the south-western boundary and progressively working north-east (in the direction of the sediment retention pond located at the eastern corner of site). Internal roading areas will be formed to subgrade level and building platforms (including adjacent areas) to the specific formation levels.

f) During the earthworks and upon formation of road and building platform subgrade levels, imported granular material will be used to stabilise areas.

g) It is likely that the construction of the underground services will continue beyond completion of the bulk earthworks. Trenches for the services will be progressively backfilled with hardfill.

h) The sediment pond, stabilised construction entrance and accessway will remain in operation to service the balance of the earthworks area.

7.2 Phase 2 to 5

Phases 2 to 5 (refer to RILEY Dwg: 190417-14) will be undertaken in sequence following the completion of Phase 1. Activities during these phases will consist of, installation of sediment control devices, removal of existing trees and fences, and earthworks required to construct building platforms and form road subgrade levels across each respective area. The bulk earthworks and management of sediment laden water will follow similar principles and sequences to Phase 1.

The sequence of works anticipated for each of Phases 2 to 5is as follows:

a) Utilise the existing stabilised entrance, accessway and wheel wash constructed during Phase 1 and situated in the Phase 6 earthworks area. These measures will be maintained throughout the works to minimise migration of sediments to the public roading network.

b) Remove existing fences and trees (including root systems) and vegetation.

c) Construct sediment control measures, including silt fences and diversion bunds to the existing sediment retention pond.

d) Strip topsoil and stockpile on-site to an approximate height of 2m. Construct silt fencing around the stockpile and stabilize. Stockpile to be kept away from water bodies, adjoining property boundaries and the driplines of protected trees. Stockpile location to be proposed by contractor and confirmed with the Engineer. Excess material not intended to be reused on-site shall be removed to an approved disposal site.

e) Commence bulk earthworks across the site. It is envisaged that material will be placed from the south-western boundary and progressively working north-east (in the direction of the sediment retention pond located at the eastern corner of site). Internal roading areas will be formed to subgrade level and building platforms (including adjacent areas) to the specific formation levels.

f) During the earthworks and upon formation of road and building platform subgrade levels, imported granular material will be used to stabilise areas.

g) It is likely that the construction of the underground services will continue beyond completion of the bulk earthworks. Trenches for the services will be progressively backfilled with hardfill.

h) The sediment pond, stabilised construction entrance and accessway will remain in operation to service the balance of the earthworks area.

7.3 Phase 6

This phase (refer to RILEY Dwg: 190417-14) will consist of activities including installation and decommissioning of sediment control devices, removal of existing trees and fences, and earthworks required to construct building platforms and form road subgrade levels across the eastern portion of the site. The bulk earthworks and management of sediment laden water will follow similar principles and sequences to the previous four phases.

The sequence of works anticipated for the Phase 6 area is as follows:

a) Utilise the existing stabilised entrance, accessway and wheel wash constructed during Phase 1 and situated in the Phase 6 earthworks area. These measures will be maintained throughout the works to minimise migration of sediments to the public roading network.

b) Remove existing fences and trees (including root systems) and vegetation.

c) Construct sediment control measures, including silt fences and diversion bunds to the existing sediment retention pond.

d) Strip topsoil and stockpile on-site to an approximate height of 2m. Construct silt fencing around the stockpile and stabilize. Stockpile to be kept away from water bodies, adjoining property boundaries and the driplines of protected trees. Stockpile location to be proposed by contractor and confirmed with the Engineer. Excess material not intended to be reused on-site shall be removed to an approved disposal site.

e) Commence bulk earthworks across the site. It is envisaged that material will be placed from the north-western boundary and progressively working south-east (in the direction of Springs Road and the sediment retention pond). Internal roading areas will be formed to subgrade level and building platforms (including adjacent areas) to the specific formation levels.

f) During the earthworks and upon formation of road and building platform subgrade levels, imported granular material will be used to stabilise areas.

g) It is likely that the construction of the underground services will continue beyond completion of the bulk earthworks. Trenches for the services will be progressively backfilled with hardfill.

h) The stabilised construction entrance and accessway will remain in operation for utilisation by the vertical build teams.

i) The Sediment pond will be decommissioned upon completion and stabilisation of the phase 6 (noting that the other areas of site will be stabilised upon the completion of the preceding 5 phases).

Please note that the above phases of works will not commence until resource consents and engineering approvals have been obtained for the site.

8.0 Assessment of Erosion and Sediment Control Measures

The management and design of the sediment and erosion control measures have been assessed based on the total area of the earthworks activities. The following outlines the methods to be used to avoid or mitigate the effects of the proposed land disturbing activities, such as erosion and subsidence. Preliminary designs of the specific erosion and sediment control devices to be used are shown on RILEY Dwgs: 190417-14 to -17.

8.1 Mitigation Measures

The following techniques will be used by the contractor to control sediment-laden runoff and to prevent erosion of exposed ground. These techniques follow the principles outlined in the ECan online toolbox. Typical details are shown on RILEY Dwgs: 190417-15 and -16

8.1.1 Stabilised Construction Entrance

A stabilised construction entrance will be formed at the site construction entrance on Springs Road in accordance with ECan standards. This will prevent tracking of soil onto the public roads. The following specifications will be used:

Table 3: Stabilised Construction Entrance Aggregate Specifications

Aggregate Size	50mm to 150mm washed aggregate
Thickness	150mm minimum or 1.5 x aggregate size
Length	10m minimum length
Width	4m minimum

8.1.2 Wheel Wash

A wheel wash facility is proposed at the site construction exit point on Springs Road. The wheel wash will consist of a temporary mobile chamber or a shallow pit (stabilised with roading aggregates) and will be filled with water. The purpose of the wash is to clean the earthmoving truck tyres and therefore, reduce the amount of sediment being tracked over public roads. The wheel wash will maintain a pool depth of 400mm to 500mm, and water will be replenished regularly (dirty water to be pumped and removed from site or overflow directed to sediment pond/decanting structures).

8.1.3 Silt and Super Silt Fences

These will be used at various locations and times during construction. The silt fences will detain flows from the construction area so deposition of transported sediment can occur through settlement. The design and implementation of these silt fences will be in accordance with the ECan online toolbox.

8.1.4 Runoff Diversion Channels and Cleanwater Diversion Bunds

Runoff diversion channels will be used to intercept silt-laden runoff and divert into earth decants and sediment ponds to be treated and discharged to ground. Cleanwater diversion bunds will be used to divert upstream catchment flows safely away from proposed earthwork areas and adjoining properties, and to limit catchment areas contributing to downstream treatment devices. Channels and bunds are to be sized for the 20-year ARI rainfall storm event and generally include a 0.30m freeboard, where possible. However, as per ECan guidelines, specific design is not required for channels and bunds with catchment areas up to 5.0ha.

The typical worst-case dimensions and locations of the channels/bunds used during earthworks are summarised in Table 4 and 5:

Table 4: Runoff Diversion Channel

Location/Description	Catchment Area (ha)	Typical Grade	Total Depth (m)*	Lining/Rock Checks Required
Phase 1	1.07	0.5%	0.50	N/A
Phase 2	1.76	0.5%	0.50	N/A
Phase 3	1.99	0.5%	0.50	N/A
Phase 4	1.11	0.5%	0.50	N/A
Phase 5	1.71	0.5%	0.50	N/A
Phase 6	1.34	0.5%	0.50	N/A

Note: *Channels all have 1:3 side slopes and total depths include 300mm freeboard unless stated. Channel sizes based on maximum catchment.

Table 5: Cleanwater Diversion Bunds

Location/Description	Catchment Area* (ha)	Typical Grade	Total Depth (m)	Lining/Rock Checks Required
Phase 1	0.41	0.5%	0.55**	N/A
Phase 2	0.60	0.5%	0.55**	N/A
Phase 3	0.42	0.5%	0.55**	N/A
Phase 4	0.45	0.5%	0.55**	N/A
Phase 5	0.27	0.5%	0.55**	N/A
Phase 6	0.43	0.5%	0.55**	N/A

Note: *Specific design not required for catchment areas less than 5ha
** 0.55m minimum depth as per ECan details

The channels and bunds generally have longitudinal gradients less than 1%. Where the grade exceeds this, or flow velocities are high, the channels should be lined with either rocks or geotextile fabric to prevent erosion of the underlying soils.

8.1.5 Mulching and Granular Hardfill

Mulching will be used to provide protection of exposed soils where earthworks require immediate stabilisation (e.g. stockpiles and landscape areas). Mulching would be mechanically applied to ensure even spread and appropriate application. The mulch will protect exposed soils from the erosive forces of raindrop impact and overland flow. Mulching also prevents the drying of the exposed soil by retaining moisture, controlling weeds, and promoting the establishment of desirable vegetation. The mulch comprises unrotten small grain straw and would be applied at a minimum rate of 0.6kg/m^2 or until no bare soil is visible through the mulch layer.

It is unlikely significant areas of mulching will be required as surfaces will be progressively stabilised with compacted granular hardfill once subgrade levels have been achieved. Alternatively, the application of hydroseeding or use of dust suppressant polymers will be employed where mulching is not desirable.

8.1.6 Sediment Retention Pond

A sediment retention pond will be used to treat sediment-laden runoff and minimise the volume of sediment leaving the site. Sediment retention ponds are used where large areas of earthworks will remain exposed to erosion during a construction period.

The sediment retention pond will be positioned at the eastern corner of the site (within the Phase 6 area) and will be designed and constructed to discharge treated construction stormwater to ground via soakage. This is the natural low point in the site, and thus a convenient collection point for the sediment-laden runoff. This position will also allow for easy access to carry out routine maintenance of the structure. Emergency spillway arrangement will be directed down the construction accessway and across existing ground surfaces.

The contributing catchment area for the sediment retention pond is shown in Table 6. The minimum capacity of the pond will be 200m^3 for each hectare of maximum contributing catchment (2% of the contributing catchment) where 10% of this volume is used as a sediment forebay.

The sediment retention pond will be constructed and maintained in general accordance with TR0902. Typical layout details for the sediment retention pond and the decant structures are shown on RILEY Dwg: 190417-15.

Table 6: Sediment Retention Pond

Pond Reference and Stage	Catchment Area* (ha)	Top Width (m)	Top Length (m)	Total Depth (m)	Width of Spillway (m)	Storage Volume (m^3)
Pond A (Phases 1 through 6)	1.99	15.2	43.5	1.4	8	611

Note: *Largest of catchments 1 through 6

Perimeter controls shall be formed around the site/phase boundaries to direct runoff to this pond.

8.1.7 Chemical Treatment

In conjunction with the sediment retention pond, the collected sediment laden runoff from the catchment area will require chemical treatment.

Chemical treatment of the runoff is proposed to enhance the effectiveness of the sediment ponds and sediment control measures on-site. The chemical liquid coagulant will be added to the incoming flows to the sediment retention pond and decanting bunds via rainfall-activated systems. The coagulant neutralises the electrical forces between the sediment particles, thus accelerating coagulation and rate of sedimentation within a sediment retention pond. This will minimise the quantity of sediment being discharged to groundwater.

The rainfall activated chemical systems and the layout will be designed and constructed in accordance with the ECan Erosion and Sediment Control Online Toolbox. The anticipated design, operation, and maintenance of the proposed systems are described in the following sections of this report.

8.1.1.1 Assessment of Dosing Rates

The chemical coagulate used for the rainfall activated treatment system will be Poly Aluminium Chloride (PAC). The dosing rate required to achieve effective coagulation and settlement of suspended solids within the sediment laden runoff generated from the exposed earthwork area varies for different soil types. The PAC dose generally required to achieve effective coagulation and settlement of the sediment laden runoff will vary between 31ml to 155ml per cubic metre of stormwater (equivalent to 2ppm to 10ppm of aluminium). For the purposes of this report, the PAC dose rate has been assumed to be 95ml per cubic metre of stormwater (equivalent to 6mg/L of aluminium). However, bench testing on sediment laden water samples obtained from the site will be carried out by the contractor prior to construction to confirm the minimum dosing rate. The bench testing will consist of the following:

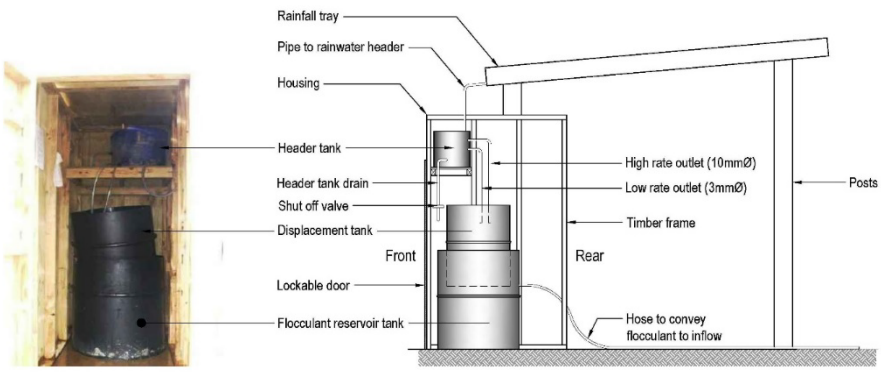
- Obtain several sediment laden water samples from the site. If not available, soils from the site will be mixed with stormwater to obtain samples.
- Introduce progressively, doses to the samples with different quantities of PAC to determine the optimum dose rate. The optimum dose rate is assessed when between 50mm to 100mm clarity is obtained (allow two hours for final settling).
- Test the selected samples to ensure the pH is above 5.5 and below 8.5.

The chemical treatment system will be progressively reviewed by the contractor and may require ongoing manipulation to ensure the design suits the site characteristics and runoff. Where the pH of the pond stormwater discharge falls below 5.5 or rises above 8.5, chemical treatment will cease.

8.1.1.2 General Treatment System Details

The components of the chemical treatment systems will include a rainfall catchment tray, header tank, displacement tank, and reservoir tank, as detailed in Figure 1.

Figure 1: Typical Rainfall Driven Dosing System



The purpose and the design requirements for each of the components used for the chemical treatment system are as follows:

8.1.1.3 Catchment Tray

The catchment tray is specifically designed to collect rainfall and drain to the header tank. The catchment tray will be sized based on the catchment area contributing to the sediment retention pond and the chemical dose required to achieve effective removal of suspended solids. It will be assumed 100% of the runoff generated from the catchment area contributing to the devices require treatment at the designed dose rate.

8.1.1.4 Header Tank

The header tank will provide storage capacity to avoid dosing during initial rainfall following a dry period, and attenuate dosing at the beginning and end of a rainstorm to simulate the runoff hydrograph. The design of the header tank will include the following:

- Header tank drainpipe at the base of the tank. This will enable the lowering of the water level prior to the next rainfall event to provide pre-dose rainfall allowance and delay the start of dosing under dry conditions.

- Low and high rate outlets. The low and high rate outlets will consist of a 3mm and 10mm internal diameter hose, respectively. The high rate outlet will provide sufficient capacity to convey the maximum predicted flow from the catchment tray for a short-term rainfall (up to 40mm/hour).
- Sufficient capacity in the header tank for up to 12mm of rainfall before dosing commences. This will provide for a delayed start volume between the lowest outlet pipe and low rate outlet of the header tank (12l/m² of rainfall catchment tray).
- The high rate outlet invert is positioned at the level where the volume between the low rate outlet and the high rate outlet is equal to volume assessed from 12l/m² of rainfall catchment tray.
- 50mm of freeboard above the top of the high rate outlet pipe.

8.1.1.5 Displacement Tank

The displacement tank will be placed within the reservoir tank that stores the chemical coagulant. As water fills the displacement tank from the header tank, coagulant will be displaced through an outlet in the reservoir tank to the dosing point. The design of the displacement tank will include the following:

- Tank dimensions to ensure a neat fit within the chemical reservoir tank. This will optimise the proportion of stored chemical available for dosing.
- Minimum capacity within the displacement tank for the 50% AEP 24-hour storm event.

8.1.1.6 Flocculant Reservoir Tank

The reservoir tank will store and release the chemical coagulant during rainfall events. The design of the reservoir tank will include the following:

- Reservoir tank will be slightly larger than the displacement tank, but of similar height.
- Minimum capacity of reservoir tank will be sufficient to provide dosing for the runoff from the 50% AEP storm event.
- Outlet hose (20mm internal diameter) in the side of the tank to enable drainage of coagulant. The outlet hose shall be directed into the sediment diversion channel least 5m upstream of the sediment retention pond forebay to promote mixing of the flocculent.

8.1.8 Dust Control

Dust can be made airborne by wind or vehicular movement or a mixture of both. Activities considered likely to generate dust include the following:

- Site clearance.
- Vehicle movements.
- Removal and replacement of topsoil.
- Excavation of material.
- Stockpiles, especially uplifting of material from stockpiles.
- Loading of vehicles.
- Temporary haul road construction.
- Foundation construction.

Exposed earthwork areas will be maintained (e.g. compacted, wetted down, temporarily stabilised etc.) to minimise the release of dust into the atmosphere. In the event of visible dust generation or forecast of significant winds, appropriate measures to reduce the dust release to acceptable levels will be undertaken.

Methods that may be adopted for the dust control measures are as follows (note, these are addressed in more detail in the Dust Management Plan):

- Ensure the exposed earthwork areas remain in a damp condition, utilising water trucks as necessary, until surfaces have been stabilised.
- Limit site traffic speed to a level to reduce the production of dust into the atmosphere.
- Stabilised entrance at the entry/exit points of the site with provision of a wheel wash facility.
- Phasing of earthworks in order to isolate and reduce the area of exposed earthworks, and mulch or place granular fill over exposed surfaces as soon as practical.
- If necessary, earthwork activities may be limited in specific areas during periods of high wind.

Furthermore, it should be noted that stockpiled material has the potential to create dust nuisance. Dust can also be generated when material is added to or excavated from a stockpile. The following methods, as appropriate, are considered to be effective in controlling dust from stockpiles:

- Wet suppression via water trucks.
- Covered storage in sensitive locations.
- Reduced/controlling stockpile height and slopes (reduce wind entrainment).
- In the extreme event that remedial measures are found to be ineffective for the control of dust, works may be suspended as a precautionary measure until conditions are suitable for resumption.
- Stabilisation of stockpile areas.

At this stage it is anticipated that water required for dust suppression will be primarily sourced from water supply connections servicing the site.

8.2 Management and Maintenance of Sediment Control Measures

As part of the earthworks contract, the contractor will be responsible for providing adequate sediment and erosion control measures in accordance with resource consent conditions and the E&SCP, to protect downstream environments from sedimentation and water quality degradation.

Regular maintenance will be carried out during the operational life of the sediment, dust, and erosion control devices/measures. Inspections will be carried out after every significant rainfall event and during periods of prolonged rainfall. Checks should include inspection for scour and signs of a possible breach for devices, such as the diversion bund. Signs of failure should be repaired immediately. Accumulated sediment should be removed to ensure the design capacity of devices are maintained. Devices should be maintained until the construction areas are secure and stabilised.

8.2.1 Accidental Dust or Sediment Emission

In the event that the primary control measures are placed under significant pressure (e.g. extreme weather event), the following secondary measures will apply:

- Cease earthworks carried out in the contributing catchment area.
- Sediment – Repair existing sediment control devices and/or construct secondary devices to intercept and prevent further migration of sediment-laden runoff from entering the downstream system.
- Notify the site engineer of the event. The contractor will provide details of the mitigation measures employed to the site engineer prior to recommencing earthworks.

The consent holder will nominate an appropriately qualified and experienced person, to be responsible for the control of sediment and dust in the course of earthworks construction on the site. The consent holder will nominate a point of contact for receipt of any complaints. The consent holder will erect a sign at the entrance with the 24-hour contact details for the person who will respond to complaints. A typical procedure for responding to a complaint is as follows:

- The contractor's nominated representative should contact the engineer and provide details for the cause of the complaint. The contractor will also provide options to rectify the cause of the complaint.
- The contractor/engineer would liaise with the complainant to discuss the mitigation options, if applicable.
- The contractor will carry out the remedial measures following the approval from the engineer.

9.0 Conclusion

A summary of the recommendations outlined in this report for mitigating the effects of the earthwork activities on the receiving environment is as follows:

- Where possible, works will be staged to minimise the extent of exposed areas. However, sediment and erosion controls have been designed to cater for the entire site.
- Works would be carried out in general accordance with the ECan online toolbox.

We consider the effects on the environment due to suspended sediments arising from the proposed earthwork activities at the site will be adequately addressed by the mitigation measures detailed in this report.

10.0 Limitation

This report has been prepared solely for the benefit of Summerset Villages (Prebbleton) Ltd as our client, with respect to the brief, and consent authorities in processing the consent(s). The reliance by other parties on the information or opinions contained in the report will, without our prior review and agreement in writing, be at such parties' sole risk.

Opinions and judgements expressed herein are based on our understanding and interpretation of current regulatory standards and should not be construed as legal or planning opinions. Where opinions or judgements are to be relied on, they should be independently verified with appropriate advice.

APPENDIX A

Catchment Assessments - Calculations for Sediment Control Measures

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Email: rileychch@riley.co.nz
Web: www.riley.co.nz

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CHRISTCHURCH
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PO Box 4355, Christchurch 8140
Tel: +64 3 379 4402 Fax: +64 3 379 4403

SEDIMENT CONTROL MEASURES
CATCHMENT ASSESSMENT
DESIGN CALCULATIONS

Prepared for:	Summerset Villages (Prebbleton) Ltd
Prepared by:	Reuven Lee, Civil Engineer  ……
Reviewed and approved for issue by:	Simon Bradshaw, Civil Engineer  ……
Project reference:	190417-M
Date:	23 September 2020

Sediment Pond Design: (in general accordance with ECan Online Toolbox 2017

Job Name:	Summerset Prebbleton
Job Number:	190417
Prepared by:	RL
Date:	31/08/2020
Reviewed by:	SB
Date:	3/09/2020

Catchment Area	1.99	ha	Slope <	18	%	minimum volume of	2	%	of the contributing catchment
Slope of earthworks	3	%	Slope >			minimum volume of	3	%	of the contributing catchment
Length of earthworks	260	m	Length <	200	m	minimum volume of	2	%	of the contributing catchment
			Length >			minimum volume of	3	%	of the contributing catchment

Design % of catchment	3	%	
Minimum Volume of Pond	597	m^3	
Dead Storage Volume	179.1	m^3	30% of minimum volume of pond
Live Storage Volume	417.9	m^3	70% of minimum volume of pond

Shape of pond

Inlet side slope (Spreader)	3	:	1		gradient
General side slopes	2	:	1		gradient
Length to Width ratio	3	:	1		Should range between 3:1 and 5:1
Depth of Pond	1.4	m			Should range between 1 to 2m depth
Depth of Dead Storage	0.55	m			Should range between 0.4 to 0.8m
Depth of Live Storage	0.85	m			
Width (top)	14	m		Width (junc btw top & bottom)	10.6 m
Length (top)	42	m		Length (junc btw top & bottom)	37.8 m
Width (bottom)	8.4	m			
Length (bottom)	35	m			

Freeboard dimensions

Freeboard depth	0.3	m
Width (top)	15.2	m
Length (top)	43.5	m

Calculated Storage

Dead Storage Volume	191	m^3	**PASS**
Live Storage Volume	420	m^3	**PASS**
Total Storage Volume	611	m^3	**PASS**

Forebay Design

Width	15.2	m
Depth	1	m
Length	2	m
Approximate Volume	30.4	m^3

Decants

Max outflow rate	3	l/sec/ha	
Max flow for each decant	4.5	l/sec	(200 holes per decant)
Number of decants required	1.33		265 holes

$Q_{(100)}$ Design Flows (From Rational Method)

Area	1.99	ha	
Runoff coeffient	0.35		
Rainfall intensity	88.2	mm/hr	SDC CoP (100 yr 10 min)
$Q_{(100)}$	0.17	m^3/sec	

Emergency Spillway

Base width	8	m		6m minimum	2.52
Depth	0.3	m		0.3m minimum	0.88
Side slopes	5	:	1	gradient	0.13
Flow Capacity (Qw)	2.54	m^3/sec		**PASS**	

APPENDIX B

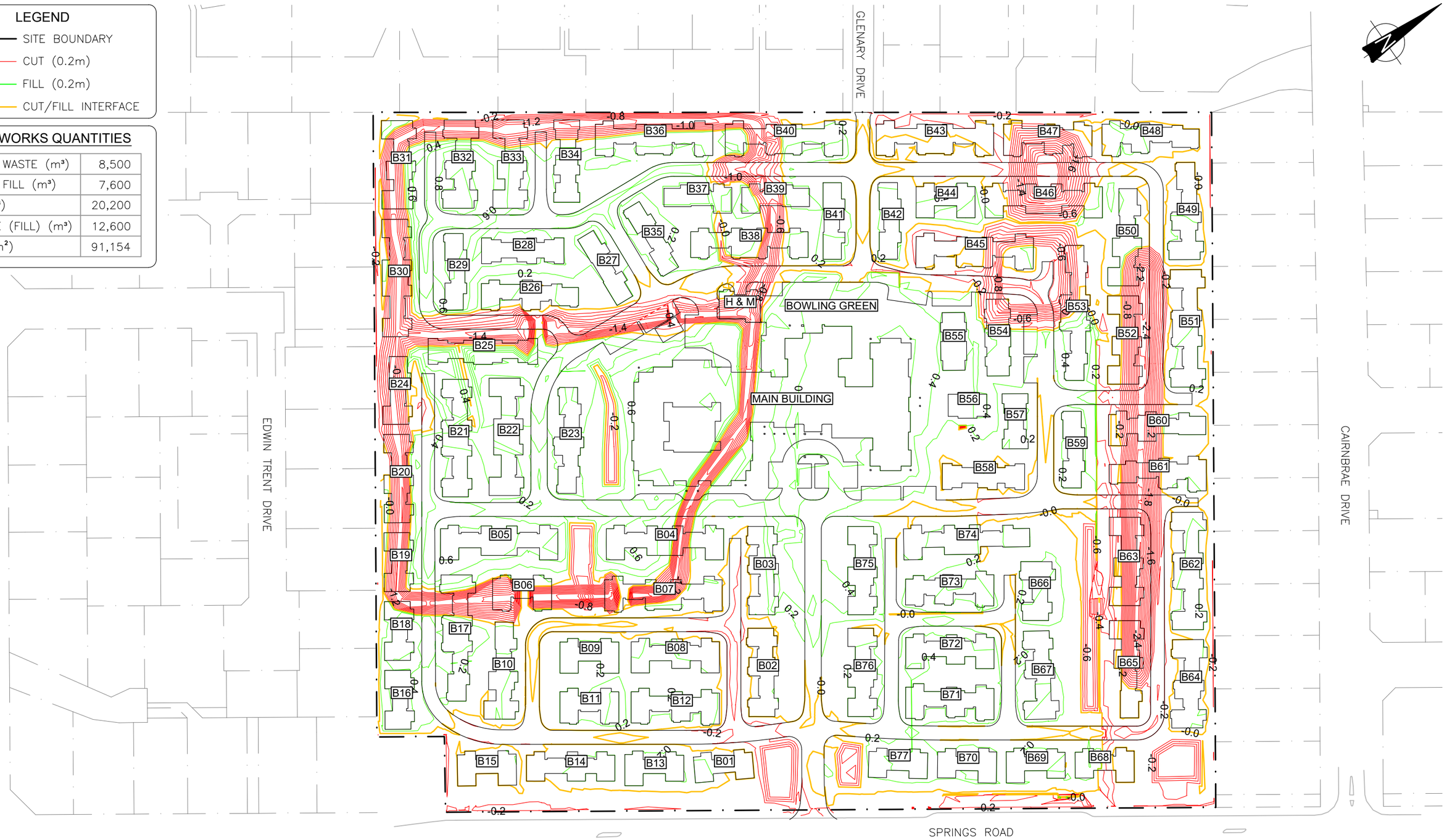
RILEY Dwgs:
190417-13 to -15

LEGEND

- SITE BOUNDARY
- CUT (0.2m)
- FILL (0.2m)
- CUT/FILL INTERFACE

EARTHWORKS QUANTITIES

CUT TO WASTE (m³)	8,500
CUT TO FILL (m³)	7,600
FILL (m³)	20,200
BALANCE (FILL) (m³)	12,600
AREA (m²)	91,154



NOTES:

1. CUT/FILL CONTOURS ARE MEASURED BETWEEN EXISTING GROUND SURFACE LESS 300mm TOP SOIL STRIP AND PROPOSED FINISHED SURFACE LESS 400mm (ASSUMED AVERAGE DEPTH TO SUBGRADE SURFACE).
2. LEVELS AND VOLUMES SPECIFIED FOR PRELIMINARY BULK EARTHWORKS ASSESSMENT ONLY. NOTE, THESE ARE SUBJECT TO CHANGE THROUGH DETAILED DESIGN.
3. EARTHWORK QUANTITIES CONSIDERED MATERIAL NOT SUITABLE FOR REUSE (i.e. CUT TO WASTE) FROM SITE, AS INDICATED BY GEOTECHNICAL TESTING RESULTS.

FOR CONSENT

REV	DATE	ISSUE	BY
1	23.09.20	CONSENT ISSUE	SB

DESIGN	DES CHECK	APPROVED FOR ISSUE
BF		S. JAMES
DRAWN	CAD CHECK	
FY		
DATE DRAWN		ISSUE DATE
15.06.2020		23 / 9 / 20

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www.riley.co.nz

Summerset

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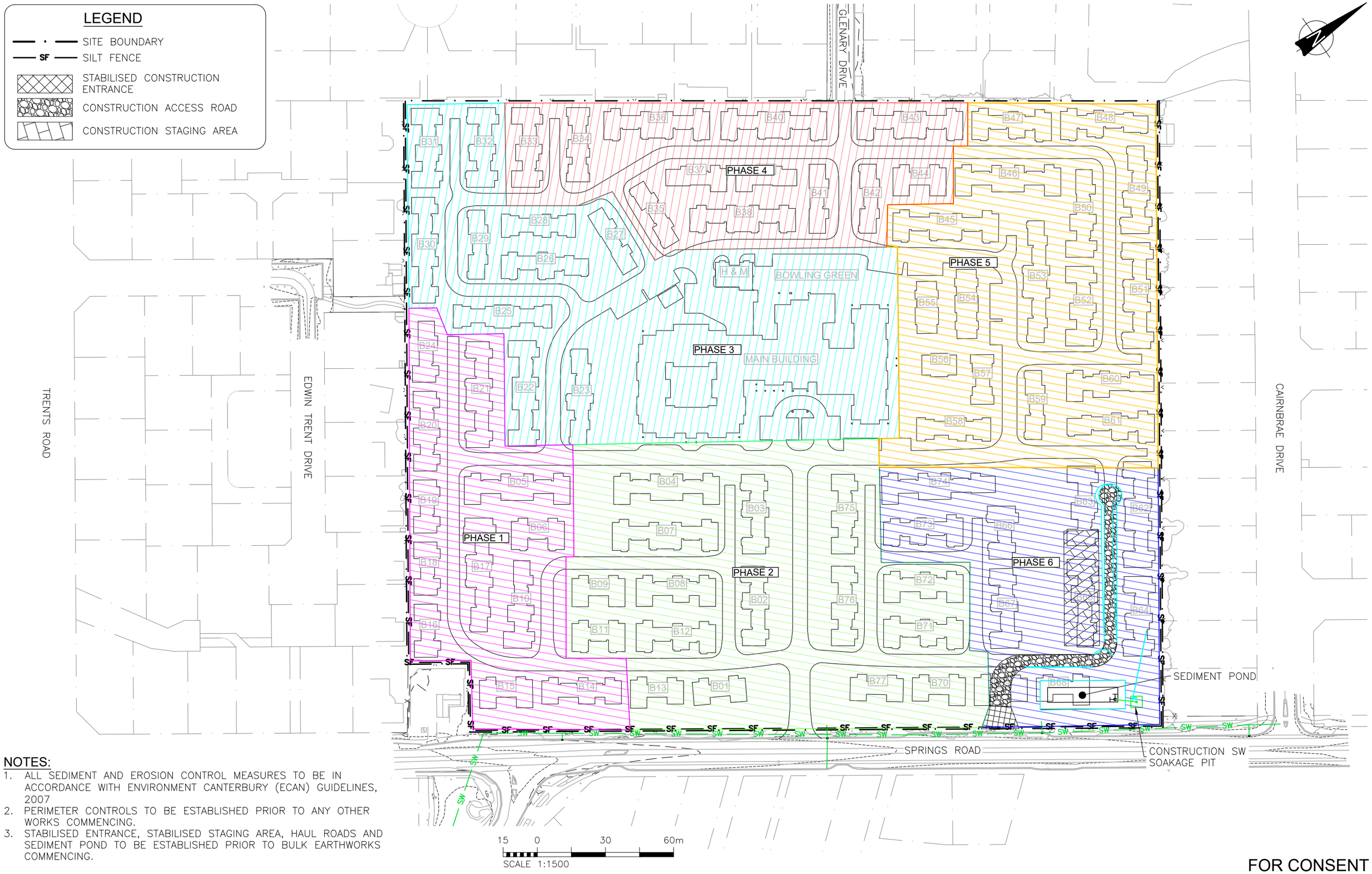
ADDRESS	578-606 SPRINGS ROAD, PREBBLETON
PROJECT	SUMMERSET PREBBLETON RETIREMENT VILLAGE
SHEET TITLE	CUT / FILL PLAN

ACENZ
ISO CERTIFIED GCS

CADFILE	190417-13.dwg
SCALE (A3)	ORIG. SHEET SIZE
1:1500	A3
DRAWING No.	REV.
190417-13	1

LEGEND

- SITE BOUNDARY
- SF — SILT FENCE
- STABILISED CONSTRUCTION ENTRANCE
- CONSTRUCTION ACCESS ROAD
- CONSTRUCTION STAGING AREA



NOTES:

1. ALL SEDIMENT AND EROSION CONTROL MEASURES TO BE IN ACCORDANCE WITH ENVIRONMENT CANTERBURY (ECAN) GUIDELINES, 2007
2. PERIMETER CONTROLS TO BE ESTABLISHED PRIOR TO ANY OTHER WORKS COMMENCING.
3. STABILISED ENTRANCE, STABILISED STAGING AREA, HAUL ROADS AND SEDIMENT POND TO BE ESTABLISHED PRIOR TO BULK EARTHWORKS COMMENCING.

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1	23.09.20	CONSENT ISSUE	SB

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PROJECT	SUMMERSET PREBBLETON RETIREMENT VILLAGE
SHEET TITLE	EARTHWORKS AND SEDIMENT CONTROL PLAN

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ISO CERTIFIED GCS

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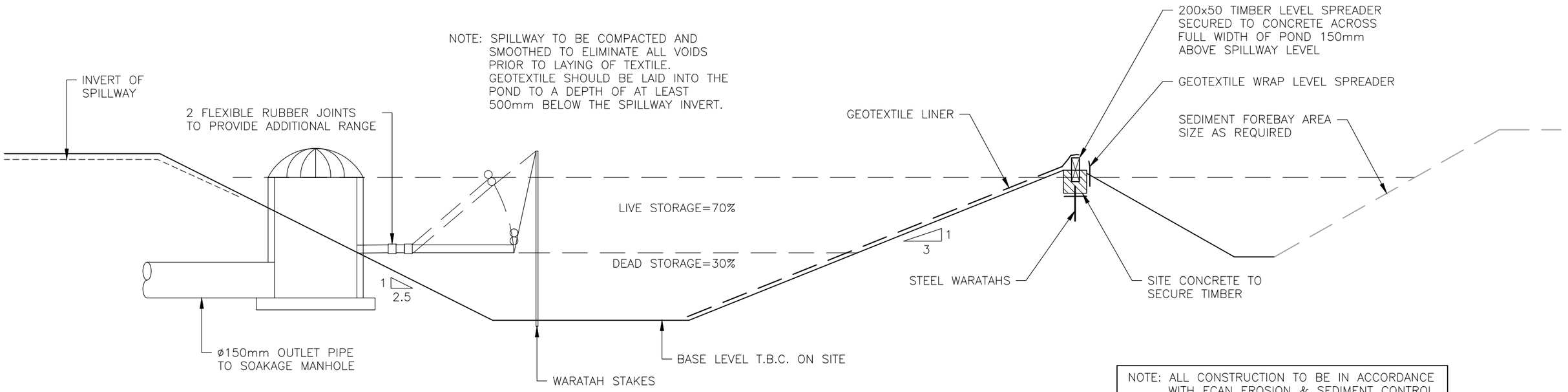
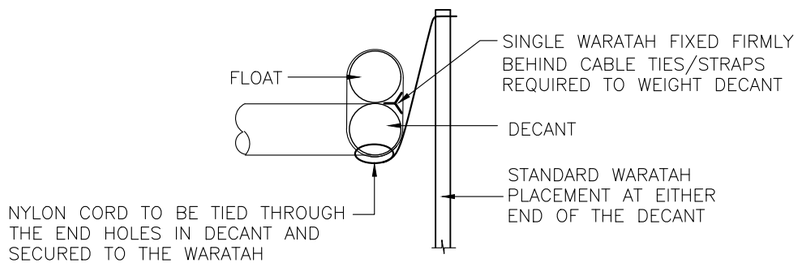


NOTE: ALL CONSTRUCTION TO BE IN ACCORDANCE WITH ECAN EROSION & SEDIMENT CONTROL GUNIDELINES

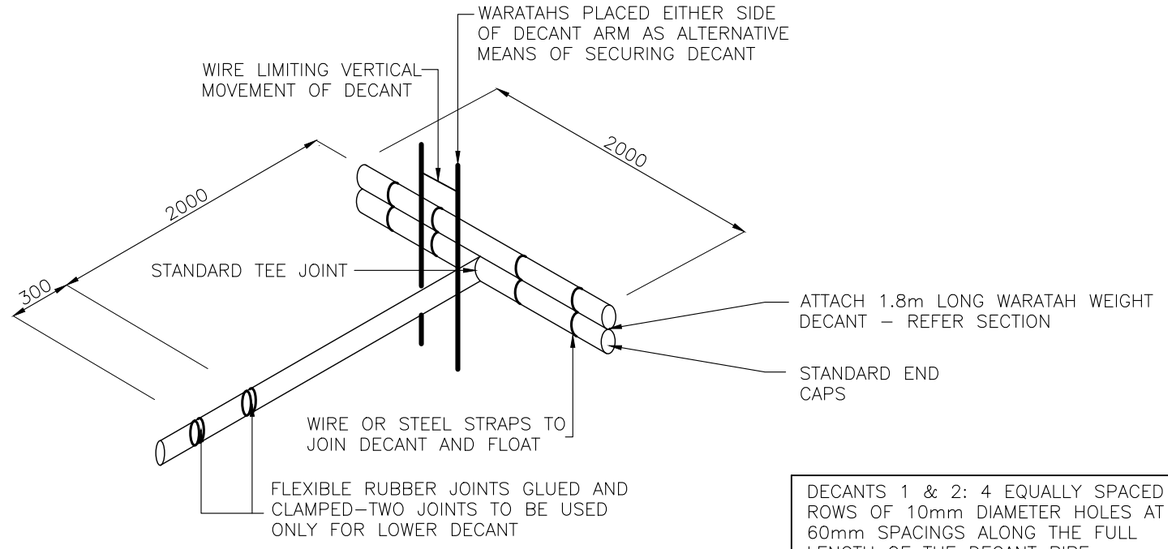
TYPICAL SECTION - SEDIMENT TREATMENT POND

N.T.S.



TYPICAL SECTION - FLOATING DECANT OUTLET

N.T.S.



DECANTS 1 & 2: 4 EQUALLY SPACED ROWS OF 10mm DIAMETER HOLES AT 60mm SPACINGS ALONG THE FULL LENGTH OF THE DECANT PIPE

SCHEMATIC - DECANT OUTLET

N.T.S.

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PROJECT	SUMMERSET PREBBLETON RETIREMENT VILLAGE
SHEET TITLE	SEDIMENT POND TYPICAL SECTION AND DETAILS

ACENZ ISO CERTIFIED GCS

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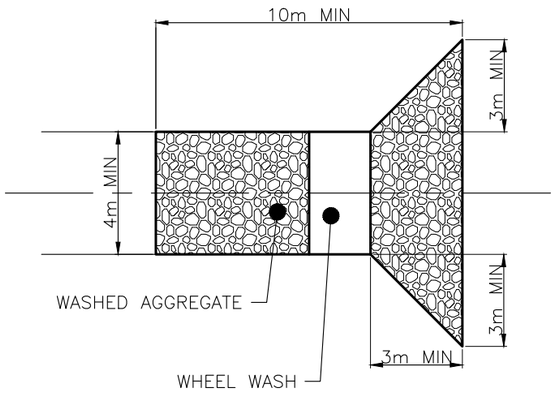
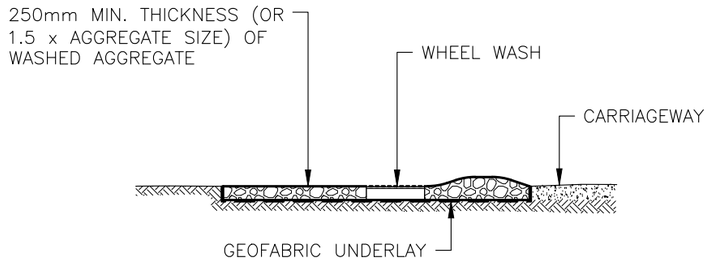
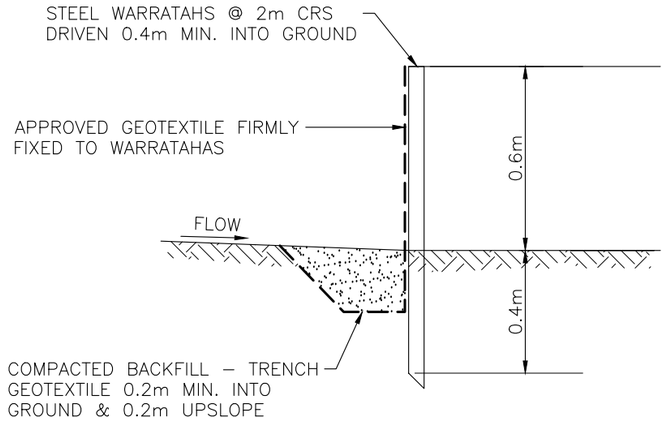
SCALE (A3)	N.T.S.	ORIG. SHEET SIZE	A3
DRAWING No.	190417-15	REV.	1



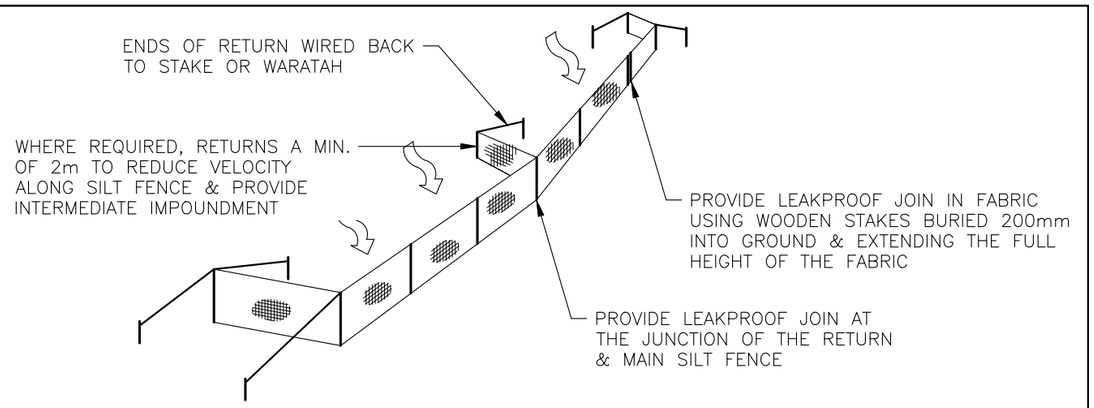
PLAN

SECTION

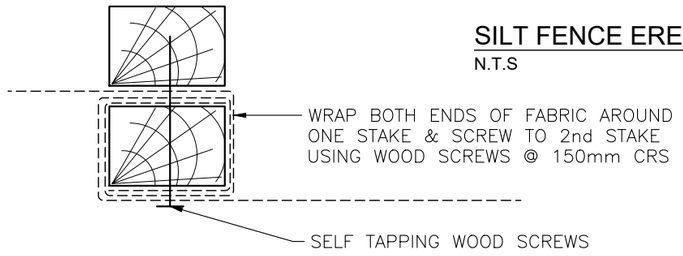




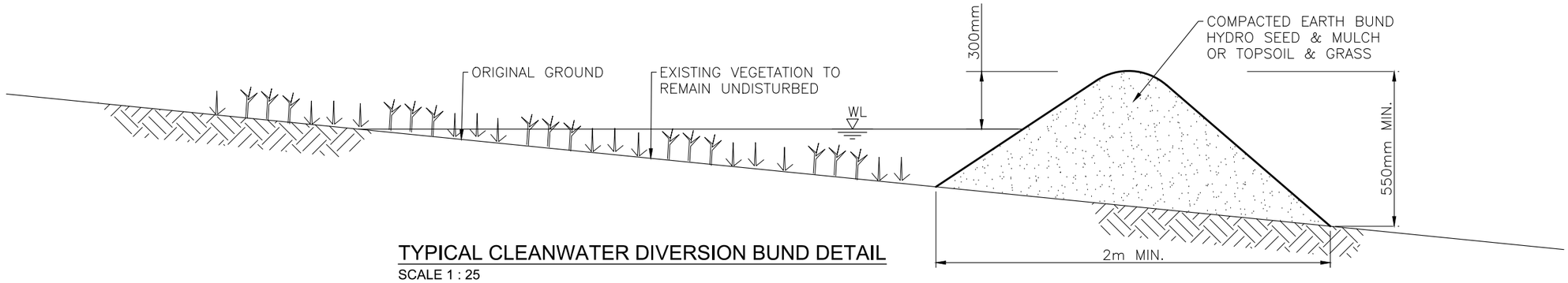
TYPICAL SILT FENCE DETAIL
SCALE 1:20



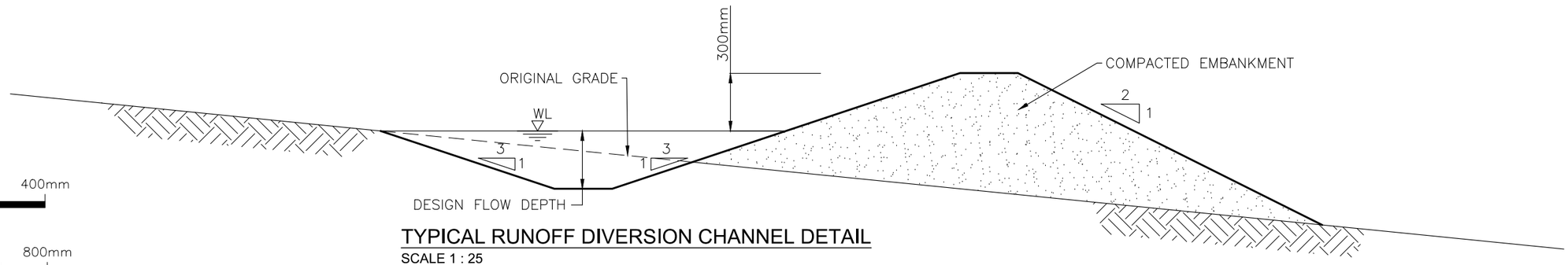
SILT FENCE ERECTION DETAIL
N.T.S



SILT FENCE GEOTEXTILE FIXING DETAIL
SCALE 1:10



TYPICAL CLEANWATER DIVERSION BUND DETAIL
SCALE 1 : 25



TYPICAL RUNOFF DIVERSION CHANNEL DETAIL
SCALE 1 : 25

100 0 200 400mm
SCALE 1:10

200 0 400 800mm
SCALE 1:20

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PROJECT	SUMMERSET PREBBLETON RETIREMENT VILLAGE
SHEET TITLE	EROSION AND SEDIMENT CONTROL TYPICAL DETAILS

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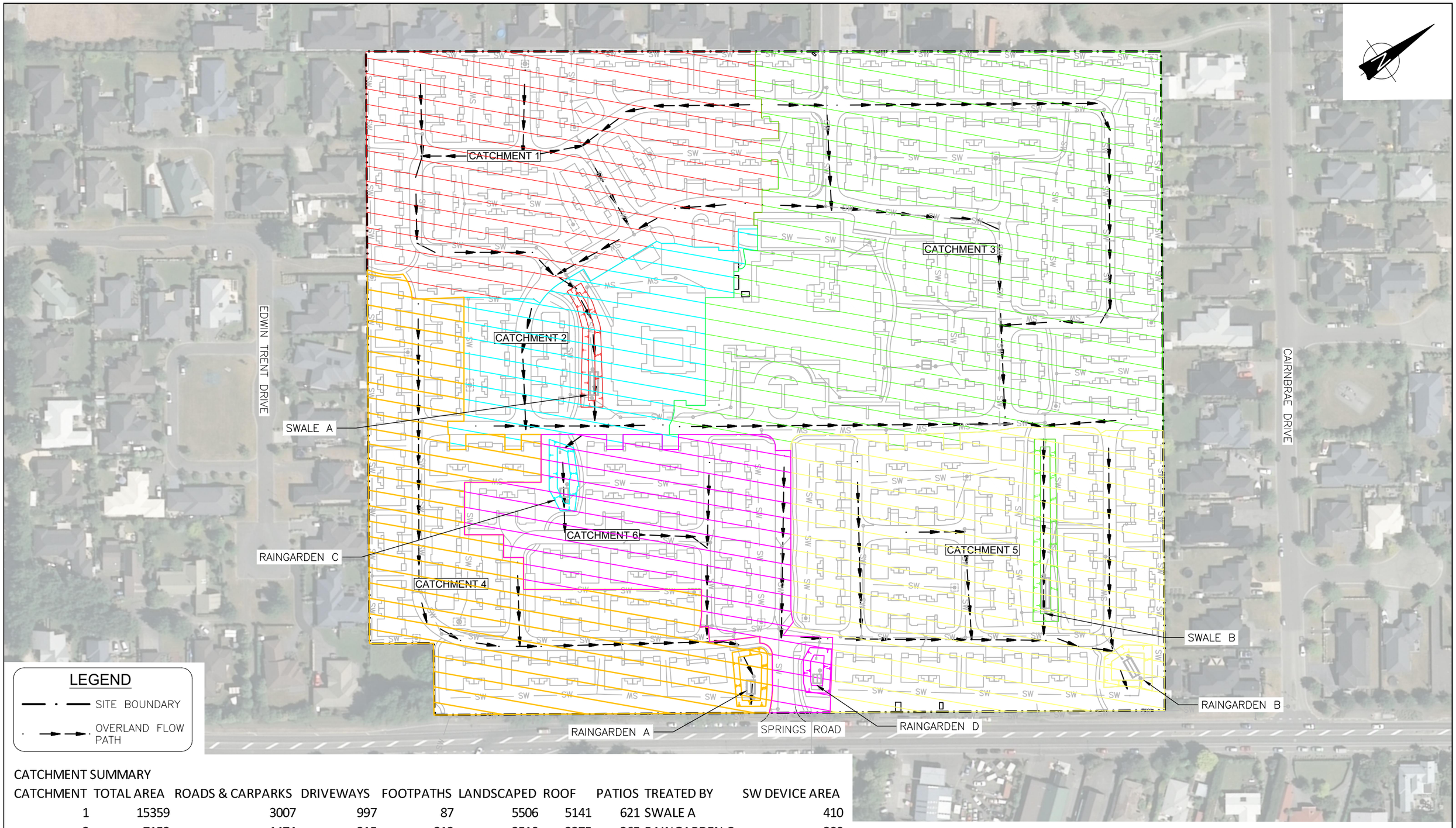
ISO CERTIFIED GCS

CADFILE	190417-16.dwg
SCALE (A3)	ORIG. SHEET SIZE
AS SHOWN	A3
DRAWING No.	REV.
190417-16	1



CATCHMENT SUMMARY

CATCHMENT	TOTAL AREA	ROADS & CARPARKS	DRIVEWAYS	FOOTPATHS	LANDSCAPED	ROOF	PATIOS	TREATED BY	SW DEVICE AREA
1	15359	3007	997	87	5506	5141	621	SWALE A	410
2	7152	1474	315	213	2510	2275	365	RAINGARDEN C	300
3	28440	5550	1298	887	9902	9459	1346	SWALE B	740
4	13421	1720	771	158	5765	4457	551	RAINGARDEN A	320
5	17644	2153	902	507	8362	5101	619	RAINGARDEN B	340
6	9142	1798	420	221	4009	2405	289	RAINGARDEN D	220

NOTES:

1. LOCATIONS AND SIZES OF RAIN GARDENS AND SWALES AS SHOWN. SHAPES ARE INDICATIVE AND TO BE FINALISED IN DETAILED DESIGN.

15 0 30 60m

SCALE 1:1500

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PROJECT	SUMMERSET PREBBLETON RETIREMENT VILLAGE
SHEET TITLE	STORMWATER CATCHMENT & OVERLAND FLOW PATH PLAN

ACENZ
ISO CERTIFIED GCS

CADFILE	190417-17.dwg
SCALE (A3)	1:1500
ORIG. SHEET SIZE	A3
DRAWING No.	190417-17
REV.	1