Structural soil tree pits

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Janet MacKinnon – Resilient Land & Coasts: Principal Technical Capability

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1.0 Introduction

Structural soil tree pits provide the dual benefit of effective stormwater management and supporting healthy tree growth in urban environments. These engineered systems utilise specialised structural soils that simultaneously bear the load of urban infrastructure (paths, driveways, paved areas, car parks and vegetated areas) while creating favourable conditions for tree root development. By integrating these systems into urban landscapes, structural soil tree pits can contribute to climate resilience through improved stormwater management, enhance urban greenery, and serve as a flexible tool for public realm design.

1% AEP detention	✗
50% and 10% AEP detention	✗
Detention (SMAF)	✓
Retention	✓
Water quality	✗*

* Will provide water quality improvement however not quantified to be equivalent to other GD01 devices. Similar considerations may apply to SMAF detention (pending final determination).

As part of the stormwater management network, structural soil tree pits can be proposed within resource consent applications under the Auckland Unitary Plan. They are considered utilities within the stormwater network, placing them on equal standing with other stormwater management devices and utility services.

Key benefits of structural soil tree pits

Improved stormwater management	• High infiltration rates into the structural soils, ability to retain/detain water and reduce direct runoff to the stormwater network or environment. • Some water quality benefit (contaminant removal) is likely and testing is yet to be completed to quantify this.
Support for tree health	• Ensuring adequate space and conditions for tree roots to grow, leading to healthier and more robust urban trees.
Infrastructure protection	• Encouraging tree root growth downwards below footpaths, vehicle crossings, car parks and vegetated areas while also supporting their load.
Contributing to urban aesthetics and biodiversity	• Enhancing urban spaces by supporting tree and plant health.
Climate resilience	• Mitigating stormwater runoff volumes and reducing urban heat island effects through promoting healthy tree canopy.

Structural soil tree pits are designed to integrate into the road corridor and function as a flexible tool for public realm design. They can be installed below impervious surfaces including parking spaces, paths, paving and vehicle crossings, as well as below pervious and vegetated areas, offering a practical solution for integrating stormwater management and promoting tree health in urban landscapes. They may not be used below the carriageway, which must be protected from water ingress with impervious liners.

Structural soil tree pits are one of several nature-based solutions.

Note: this guidance does not provide information for tree pits which utilise plastic-based structural tree cells.

How structural soil tree pits function

Stormwater runoff from impervious surfaces is directed into the system via a kerb, channel or dished drain. This flow enters the aeration well, which serves multiple critical functions - it acts as a sedimentation chamber capturing sediments and coarse pollutants, facilitates gaseous exchange for tree roots within the top layer of the structural soil, and effectively dissipates water into the structural soils.

The engineered structural soil utilises the Stockholm Structural Soil methodology, consisting of 40/60 mm crushed clean stone combined with a 1:1 mix of un-enriched biochar and compost (15% by volume). This established approach from Stockholm creates a structural matrix that functions structurally like standard subgrade materials while providing void spaces for water storage and nutrients for trees. This allows for these structural soils to extend under trafficked areas such paths, vehicle crossings and parking bays.

The system delivers both detention and retention capabilities whilst supporting surface infrastructure loads. The structural soil below the subsoil drain or upstream of a dam serves as retention volume, while the structural soil above the subsoil drain or dam provides detention volume.

Where subsoil infiltration rates are >25 mm/hr, subsoil drains and dams are not required as this allows the top 600 mm of structural soil to drain within 24 hours for tree root health. Higher infiltration rates in the subsoils necessitates the selection of higher drought tolerant plants and trees.

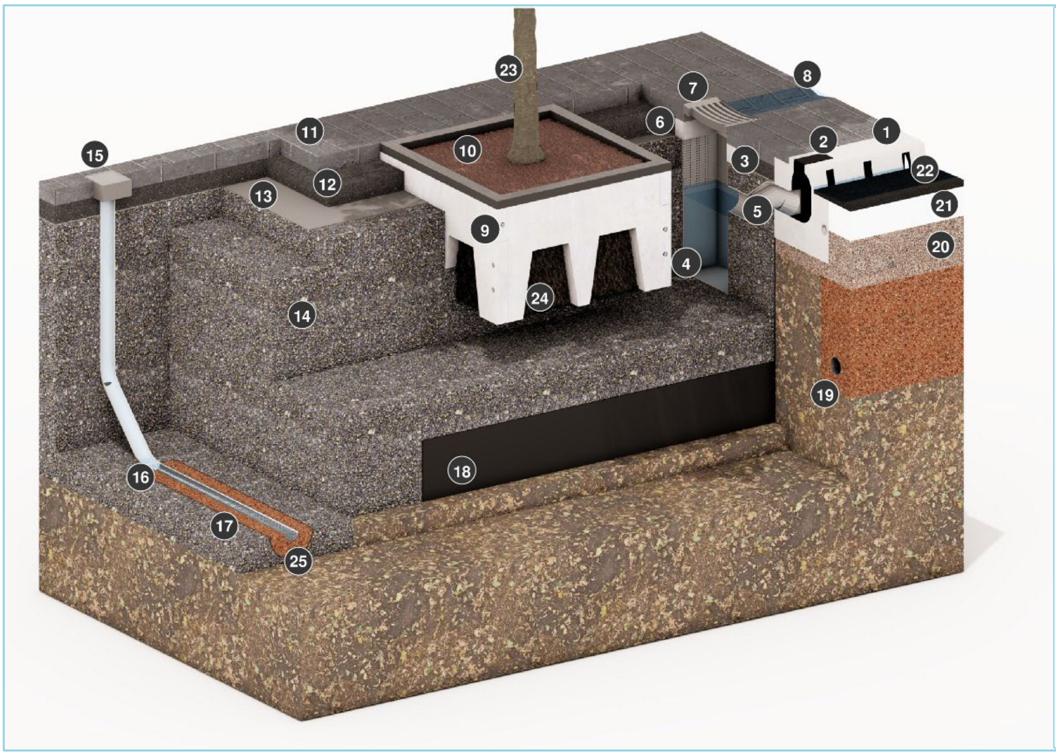
Water exits the system through three pathways:

- infiltration into surrounding soils
- Uptake by trees or vegetation
- Discharge via a subsoil drain connected to the stormwater network.

The concrete tree surround delivers structural support for the tree root ball and retention of the finer soils around the root ball, while directing root growth downward into the structural soil layer. Deep root development is further encouraged by water availability below the root zone (beneath the subsoil drain or dam level), which promotes tree health during dry periods. Further updates to the design will consider the use of alternative materials for this surround (such as non-treated timber where structural influence permits), to seek to reduce the carbon footprint and cost of these devices.

A geotextile layer between the structural soil and the topsoil or bedding material protects the structural soil from fine particle migration. This barrier prevents clogging of the void spaces in the structural soil, maintaining its water storage capacity, prevents subsidence and promotes overall functionality. Although a plastic free transition layer of small aggregate was considered for this purpose, the complexity to build and depth required to transition from small to large aggregate was considered prohibitive.

Figure 1: Structural soil tree pit



Key:

1. Kerb Drain
2. Kerb Drain Access Unit
3. Bedding around SN16 Pipe
4. Aeration Well
5. SN16 Pipe
6. Concrete Collar
7. Grate
8. Channel Profile
9. Tree Surround
10. Permeable Natural Surface
11. Surface Treatment (e.g. Paving, concrete)
12. Bedding material (for surface treatment)
13. Geotextile
14. Structural Soil
15. Rodding Eye
16. Subsoil Drain
17. Pea Gravel (around perforated section of subsoil drain)
18. Impermeable Membrane (e.g. Geosynthetic clay liner)
19. Carriageway Subsoil Drain (standard carriageway detail)
20. Carriageway Sub-base
21. Carriageway Base
22. Carriageway Surfacing
23. Tree
24. Soil
25. Connection to stormwater main

Figure 2: Structural soil tree pit components

1.1 Use in a treatment suite

Structural soil tree pits are versatile stormwater management solutions that support tree health in urban environments. These systems can be strategically placed at multiple locations throughout a catchment - from source points to lower catchment areas - providing both retention and detention of stormwater volumes.

They can be implemented with either kerb drain, channel drain or dished drain entry systems, depending on site requirements. While structural soil tree pits contribute to improving water quality, their effectiveness for contaminant removal has not yet been fully quantified through testing. Treatment within the structural soil tree pit occurs through a sequential process:

1) Initial sediment and gross pollutant removal takes place in the aeration well's sedimentation chamber

2) Water then passes through the structural soil media, where it undergoes final treatment via physical filtration, absorption to soil/biochar particulates and biological uptake by plant roots.

The combined effect of these treatment stages is designed to improve water quality outcomes while minimising maintenance requirements for the structural soils. Field testing is underway to verify both the hydrological performance and treatment effectiveness of the structural soil system.

Additional benefits include:

- Reduction in various stormwater contaminants through sedimentation, physical filtration, and biofiltration
- Reduction in peak flow volumes
- Recharge of groundwater when designed as unlined systems.

When incorporating structural soil tree pits into a broader stormwater management strategy, designers should consider their placement within the treatment train to optimise stormwater volume management while recognising that their water quality treatment capabilities, although present, have not yet been formally quantified to meet GD01 device equivalent standards.

1.2 Structural soil tree pit components

The typical components in structural soil tree pit design are illustrated in Figure 2 and Figure 3 and detailed in Table 1. Appendix 1 includes the full drawing set.

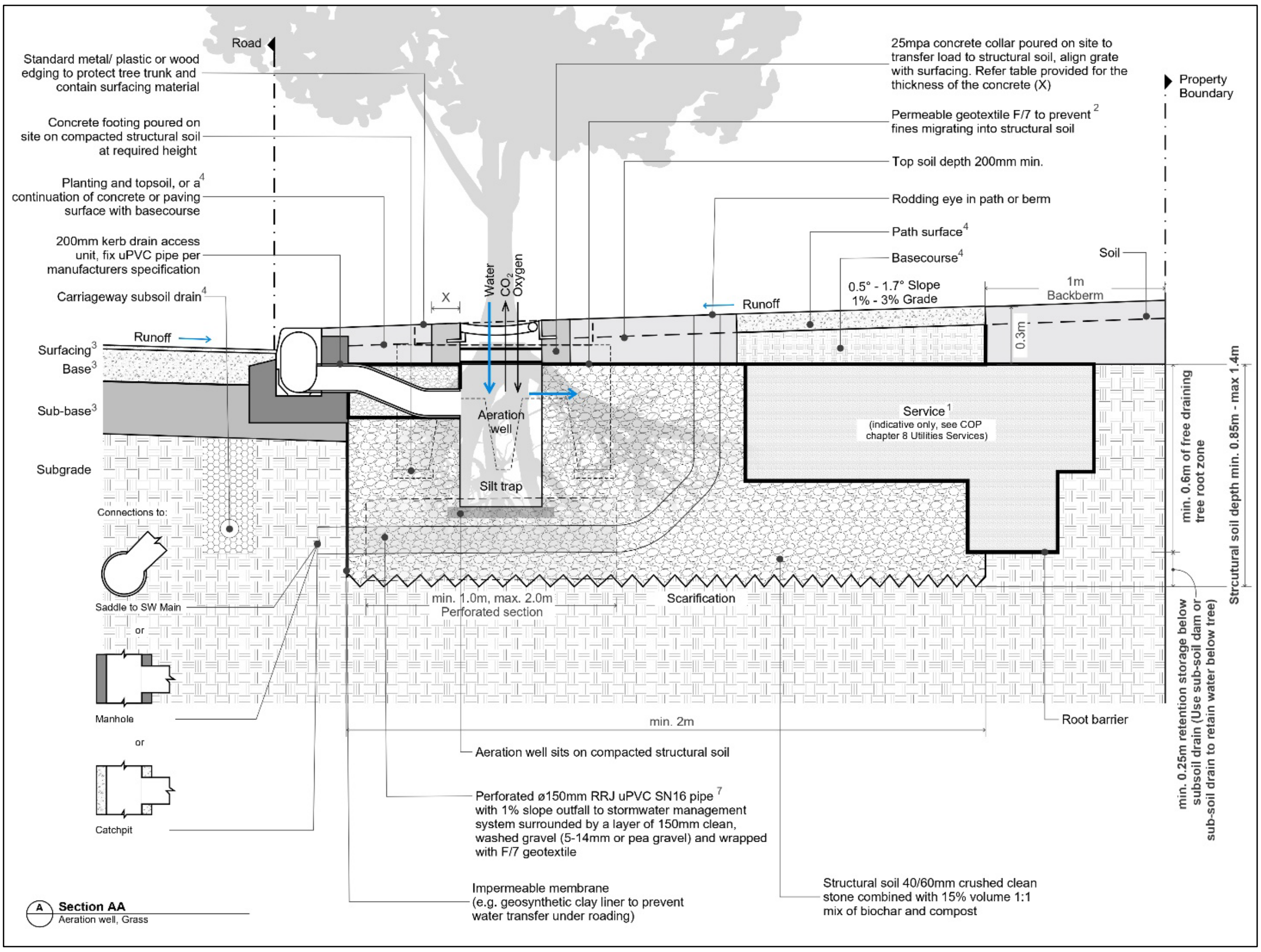


Figure 3: Cross section showing structural soil tree pit components

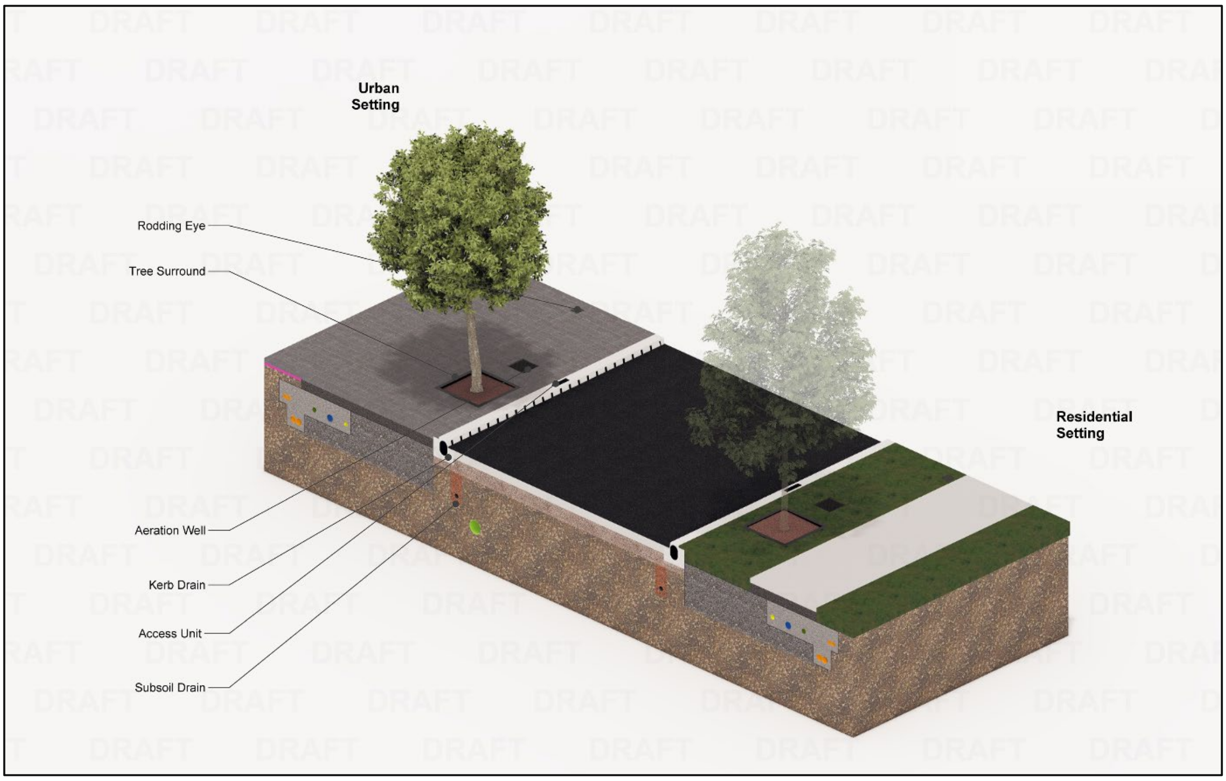


Figure 4: Structural soil tree pits shown in both urban paved and residential grassed environments

Table 1: Structural soil tree pit components

Component	Description
Kerb drain	• Required if design includes kerb and channel. • Kerb drain is where the stormwater is collected and conveyed to the aeration well. • Minimum 3 m length of kerb drain required or per supplier specification. • If inundated, the stormwater continues to a stormwater catchpit connected to the public stormwater network.
Channel drain	• Required if design is for a level street or paved environment. • Where the stormwater is collected and conveyed primarily to the aeration well connected to the tree pit. • Minimum 3 m length of channel drain required or per supplier specification. • If inundated, the stormwater continues to a stormwater catchpit connected to the public stormwater network.
Dished drain	• Simplified inlet option where feasible, e.g. public squares, paths. • Conveys stormwater directly to the aeration well via grate inlet. • If inundated, stormwater continues to another stormwater device.
Aeration well	• Receives stormwater from kerb, channel or dished drain, or directly from surface entry and disperses into structural soils. • Has a sump for sediment capture/settlement. • Provides initial treatment of sediments and floatables.

Component	Description
	• Performs gaseous exchange between outside environment and structural soils. • Standard maintenance as roadside catchpits using a vacuum truck to remove debris. • Constructed from 304 stainless steel. • Lockable grate to allow maintenance, inspection and prevent un-authorised access.
Tree surround	• Structure that protects the root ball from compaction. • Encourages tree roots downwards to allow access to the surrounding structural soils. • Provides structural support both laterally and vertically. • Reinforced concrete construction, preference for low carbon.
Subsoil drain	• Required when in-situ soils infiltration rates are <25 mm/hr to allow 600 mm of free draining soil within 24 hours for tree root health and in detention applications. • Height adjustment can be used to allow retained water below 600 mm. • Connected to public stormwater system. • Not wrapped in geotextile to avoid blocking.
Subsoil dam	• Subsoil dams may be necessary to provide for retention on sloping sites, when infiltration rates are <25 mm/hr.
Topsoil	• Organic matter must be well decomposed. • Must not contain any plastic. • Grass or underplanting requires 200 mm minimum depth.
Geotextile	• Prevents fines migrating into structural soil.
Structural soil	• 40/60 crushed clean stone, with 15% by volume 1:1 mix of well decomposed compost and biochar (or zeolite).
Biochar	• Form of charcoal created using a process called pyrolysis. • May perform a water filtration process, capture nutrients. • May aid tree/vegetation health. • Habitat for soil microbes, promoting healthy soil ecology. • See required specification in Table 7.
Zeolite	• Zeolites have a crystalline structure formed by SiO_4 (silicate) and AlO_4 (aluminate) tetrahedra. • Known to perform a water filtration process and capture nutrients. • May aid tree/vegetation health. • Habitat for soil microbes, promoting healthy soil ecology. • See required specification in Table 9.
Compost	• Must meet New Zealand Standard NZS 4454:2005. • Must not contain any plastic. • Made from well decomposed organic matter.

Component	Description
Pea gravel / washed gravel (5-14 mm)	• Protects subsoil drain from point loading.
Trees	• Preference for native species for native biodiversity, cultural values, reduced maintenance for stormwater devices. • Provide some runoff volume loss through interception and evapotranspiration.
Vegetation / underplanting	• Grass or, if underplanting is used, preference for native species for biodiversity, cultural values (refer Section 2.4.13).
Impermeable liner	• Prevents water ingress under carriageway.
Root barrier	• Used to protect utility services from tree roots. Locate away from tree and close to services.

1.3 Site considerations

Structural soil tree pits have several site-specific factors that must be considered in promoting good spatial design, long-term health of the trees and the effectiveness of stormwater management. They can be utilised in brownfield, greenfield or as a retrofit solution in development. They require careful evaluation of several site-specific factors to help ensure successful integration.

Table 2: Site considerations

Item	Description
Site characteristics	• Available space and setback requirements from buildings and services. • Existing soil conditions and infiltration capacity. • Groundwater levels and contamination risk. • Traffic loading and pavement requirements. • Catchment size and runoff volumes
Tree health	• Species selection suited to local climate and site conditions. • Adequate soil volume for mature root growth, i.e. tree trenches. • Access to sunlight and protection from prevailing winds. • Irrigation needs during establishment period. • Protection from vehicle damage and soil compaction.
Stormwater management	• Contributing catchment area and expected volumes. • Pre-treatment requirements based on pollutant loads. • Overflow paths and integration with existing drainage. • Monitoring points for performance assessment. • Structural soil tree pits can be designed to contribute to SMAF hydrology mitigation requirements (retention and detention).

Item	Description
Catchment size and location	• The maximum contributing impervious catchment areas are 270 m^2 per inlet and aeration well. • The aeration well has a sediment storage capacity of 95 L, which should allow for annual sediment removal by vacuum truck. If additional sediment is expected, alterations to the design should be considered to fit with standard maintenance practice. • If designing for SMAF; structural soil volume must meet the hydrological mitigation requirements for the contributing catchment area. • Can be used under permeable and impermeable areas including; vegetated, paths, vehicle crossings, carparks with surfaces including paved, concrete, asphalt and others. • Cannot be used under carriageways.

Above and below ground space	• The stormwater components outlined in this document that are part of the structural soil tree pit inlet and outlet design do not need to adhere to setbacks from trees detailed in other guidance documents such as those listed below.
	• Make sure there is sufficient space above ground for the tree to reach maturity without interfering with other above-ground assets. Refer to other guidance documents, including but not limited to:
	  ○ The Auckland Code of Practice for Development and Subdivision Chapter 7: Landscape
	  ○ Auckland Transport Berm Maintenance Proposed Planting Guidelines
	  ○ Auckland Transport Code of Practice 2013, Chapter 14: Landscaping
	  ○ Auckland Transport Vegetation in the Road Corridor Guidelines
	  ○ Auckland Council Unitary Plan Operative in Part E17 Trees in Roads
	  ○ Vector Trees and Powerlines
	  ○ Te Ture-ā-rohe Wai āwhā 2015 Stormwater Bylaw
	  ○ Te Ture ā-Rohe Whakaroto Wai me te Pae Kōtuitui Wai Para 2015 Water Supply and Wastewater Network Bylaw 2015.
	• Provide sufficient structural soil volume for the tree species selected. Refer to the design chapter for volume considerations (Section 2.3 Device sizing) and species recommendations (Section 2.4.13 Vegetation).
	• Maintenance access for cleaning sumps and infrastructure.

Drainage	• Understanding the existing soil conditions is crucial for the successful integration of structural soils. • Conduct an in-situ soil analysis at the design depth of the tree pit to determine infiltration rates. • Poorly draining soils will require subsurface drain to prevent waterlogging.
Groundwater	• The structural soil tree pit base should be more than 300 mm above the seasonal (winter) high groundwater table. If this is not possible, an impervious liner must be used.

Item	Description
Slope	• Not suitable on slopes greater than 12.5% or 7.125°. • Installation on sloped sites less than 12.5% may require a subsoil dam, or subsoil drain to be lifted to maintain storage below the root zone to prolong water availability into drought periods and promote anaerobic activity. • Refer to Section 2.3.5 Design for sloping sites.
Contaminated land	• Structural soil tree pits must be fully lined with impervious liner if contaminated land is present.

2.0 Structural soil tree pit design

The Stockholm Structural Soil methodology utilised in these designs creates a structural matrix capable of supporting loads from paths, vehicle crossings, and parking areas, while maintaining adequate void spaces for healthy root development. The design intention for the 40/60 mm crushed stone combined with biochar and compost is to create a stable foundation with load-bearing capacity similar to other aggregates of this size generally used as subbase materials.

It is important to note that these systems are not suitable for installation under carriageways as water infiltration into the structural soil could compromise the integrity of the road surface and subgrade. Where structural soil tree pits are adjacent to carriageways, an impermeable liner must be installed to prevent water migration.

2.1 Design considerations

Table 3 provides design considerations for structural soil tree pits.

Table 3: Structural soil tree pits design consideration

Item	Requirement
Inlet and pre-treatment	• The inlet consists of kerb, channel or dished drain, which is connected to an aeration well with a sump pit for primary contaminant removal. • The aeration well discharges via 7 mm perforations in the top 300 mm into the structural soils. • The kerb or channel drain and the aeration well require periodic maintenance, so access points are required. • A simplified inlet system may be used when structural soil tree pits are in pedestrian-only areas and may not require kerb or channel drains but will always require aeration wells.
Vegetation	• Vegetation in structural soil tree pits must include a tree and may include underplanting or a grass surface above the structural soils. • Species should be selected for the site's surrounding urban environment which may have increased exposure to wind and sun. • As the structural soils are free draining for the first 600 mm, shallow rooting species should be considered for the ability to deal with both wet and dry periods. • It is expected that a wide range of tree species will grow in structural soil tree pits, and testing is underway for appropriateness of several species. • All trees should be monitored for health and vitality for an establishment period of five years by an arborist. A non-exhaustive list of suggested tree species are included in Table 10 and Table 11. • *[Note: Trees in berms planting guidance is under review by Auckland Council and will be referenced here when available.]*

Item	Requirement
	• Suggested underplanting for structural soils should be considered from plant lists in Table 12. *[Note: Auckland Council Underplanting guidance is under review and will be referenced here when available.]*
Media	• Where vegetation is used for the top surface, topsoil can be used with a minimum depth of 200 mm. Further details are provided in Section 2.4.7. A geotextile layer is required to prevent the topsoil fines migrating into the structural soils. • Structural soil specifications are provided in Section 2.4.8 and Table 4. • Subsoil drains must have a layer of clean, washed gravel (5-14 mm or pea gravel) with little/no fines and a minimum infiltration rate of 4,000 mm/hr surrounding them. The radial dimension from the drain must be at least 150 mm in all directions. An A19 grade geotextile must surround the gravel.
Structural support	• Engineering design may be required for retaining structures such as signposts, light poles etc. Support may be made from in situ or precast elements. These can reduce infiltration, which is not generally desirable.
Geotextiles	• Geotextiles are permeable in these designs and should be kept to a minimum. They are used to prevent fines from soils and aggregates migrating into the structural soils and around subsoil drains. • They should be lightweight, non-woven, needle punched, geotextile.
Impermeable liners	• Used to prevent water transfer into the carriageway. • Geosynthetic clay liners are proposed for this purpose.
Subsoil drain	• Proper drainage is essential for tree health. If the in-situ soil infiltration rate is insufficient, <25 mm/hr to achieve 600 mm of free draining structural soil within 24 hours, use rigid perforated pipe subsoil drains connected to the public stormwater main. • The subsoil drain must be surrounded by a layer of clean, washed gravel (5-14 mm or pea gravel) with little/no fines and a minimum infiltration rate of 4,000 mm/hr. • The filter gravel must be surrounded by A19 grade geotextile. • Subsoil drain requirements are described in Section 2.4.4. These can be connected to an available catchpit, manhole, or directly to the stormwater main with a standard saddle connection.
Root barriers	• Used to protect services and should be located close to the service being protected to maximise tree root space.
Other underground services	• It is recommended to avoid services running through structural soils as accessing the services is difficult. • If unavoidable use accessible ducting or protect services with underground walls or root barriers, with fine aggregates surrounding the services to reduce point loading. See Auckland Council Code of Practice Chapter 8 Utilities Services for details *[Note: COP Chapter 8 is under review and will be referenced here when available].* • Keep protection measure close to the services to maximise space for tree root growth.

Item	Requirement
Soils requiring structural support and limited water ingress	• Structural soils can support other structural soils (such as within the carriageway). Compaction is required and testing with a clegg hammer to an appropriate CIV must be achieved for the application. • In instances such as between the structural soils and the carriageway subgrade, an impermeable liner (such as geosynthetic clay) is required to prevent water ingress.
Pre-treatment	• Structural soils must be protected from high sediment loads, and floatables with primary treatment in the aeration well sump.
Connection	• Devices must be designed to ensure they can drain via gravity to the stormwater system or the receiving environment via an approved outfall.
Traffic	• Structural soils are trafficable and are permitted under parking areas, paths, paved areas, vehicle crossings, grassed and vegetated areas, however, they are not permitted under public carriageways. • Compaction requirements must be achieved. Testing with a clegg hammer to an appropriate CIV must be achieved for the application. • Consider future operation and maintenance requirements in relation to traffic management when designing the location of structural tree pits.
Setback	• Structural soil tree pits <1 m from a property boundary should have a lined vertical surface if within 5 m of private structures (such as buildings). • Structural soil tree pits should not be placed within 3 m of a structure such as a building, unless specifically engineered.
Individual trees or continuous trenching	• Structural soil tree pits can be designed for individual trees or trenched to allow for multiple trees. • A multi-tree trench gives greater volume for stormwater management with fewer components, allows the tree roots to interact and can provide more continuous canopy. Single tree pits suit limited spaces.

2.2 Design for safety

Implement comprehensive safety measures throughout the design and lifecycle of the structural soil tree pit, including:

- Excavation protection systems to prevent pit collapse according to WorkSafe NZ guidelines.
- Elimination of trip and fall hazards through clear demarcation of open excavations and appropriate finished surface treatments.
- Design for appropriate construction sequencing to minimise safety risks.
- Adequate space allocation for construction equipment operation and material staging.
- Incorporation of temporary access provisions that meet health and safety requirements.
- Detailed safety specifications in construction documents addressing site-specific hazards.

- Secure access covers for all maintenance points to prevent unauthorised entry and public safety hazards.
- Appropriate load ratings for all surface elements based on expected traffic.
- Consideration of pedestrian and cyclist safety in grate and surface feature design.
- Integration of visibility requirements for all road users, particularly at intersections.
- Design for safe maintenance access without requiring working in traffic lanes where possible.
- Minimise the need for maintenance (e.g. sufficient sediment and floatables pretreatment to prevent blinding of the structural soils).
- Ensure that maintenance access is provided to access units and connections, aeration well and rodding eyes.
- Where necessary, ensure adequate traffic management is feasible in the design.
- Ensure structures do not cause tripping or fall hazards.
- Utilise tree surrounds and structural soil areas to promote root growth downwards and outwards to prevent damage to pavements.
- Ensure planting will meet Council tree planting requirements and constraints (through growth or overhanging) on walkways or roads (see Table 2).

2.3 Device sizing

2.3.1 Structural soil volume

Adequate soil volume is essential for tree health and longevity, which in turn enhances the tree pit's effectiveness in stormwater management. Equally important are aeration well inlets, which facilitate gaseous exchange and water infiltration. Table 4 and Figure 5 detail the recommended minimum structural soil volume and minimum number of aeration well inlets.

The volume of structural soil is calculated from the base of the device to the top of the structural soil and does not include materials above the structural soils including GAP 40 or other bedding materials or topsoil.

Where appropriate, structural tree pits can be combined into a single continuous tree pit. This can achieve efficiencies in terms of minimum soil requirements as set out in Table 4 and Figure 5 below, and can enhance tree health. These trenched tree pits should generally be prioritised in flat slope environments.

Where larger trees require second aeration wells, the downstream well does not require a kerb, channel or dished drain stormwater entry system. Its primary function in this situation is gaseous exchange.

Table 4: Structural soil tree pits tree size, soil volume and aeration well requirements

	Very Small (<5 m)	Small (5-10 m)	Medium (10-15 m)	Large (15-25 m)	Massive (>25 m)
Structural soil volume	8 m³ (6 m³ shared)	15 m³ (12 m³ shared)	26 m³ (20 m³ shared)	36 m³ (28 m³ shared)	45 m³ (35 m³ shared)
Aeration well inlets	1 (0.5 shared)	1 (0.5 shared)	1	2 (1.5 shared)	2

2.3.2 Device sizing criteria for stormwater management

Structural soil tree pits shall be sized to provide, at a minimum, the required volume of structural soil to ensure good tree health as set out in Figure 5, and species selected accordingly. The size of the device can be increased to provide an additional stormwater management function; however additional trees must be added in accordance with the requirements (refer Figure 5). Trees of differing sizes can be combined within the same structural soil tree pit if desired.

When sizing for stormwater management function, consideration must be given to the full treatment train approach for the catchment and the stormwater management functions which the structural soil tree pit needs to provide.

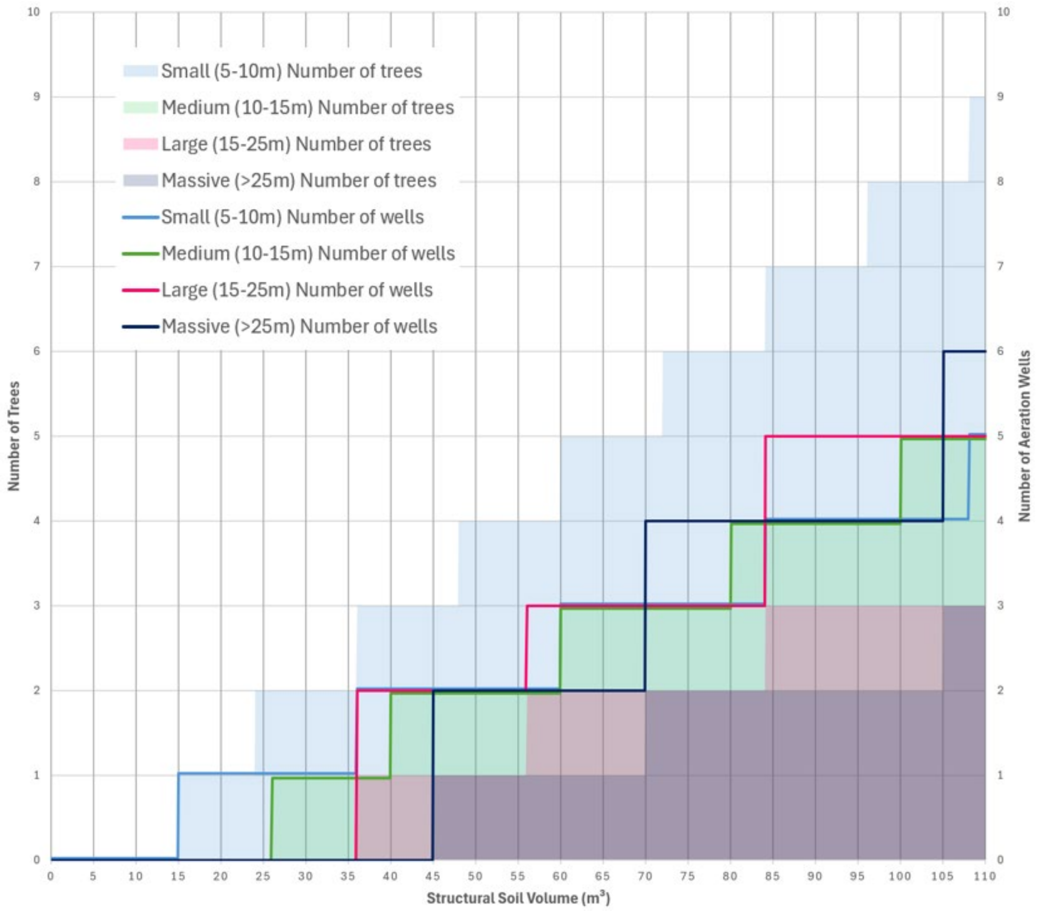


Figure 5: Tree size at maturity, minimum structural soil volume and minimum aeration well inlets

Hydrology mitigation

Structural soil tree pits can provide both retention and detention functions within the structural soil volume. No hydrology mitigation credit is provided for the topsoil or other layers above the structural soil.

Retention is provided below the subsoil outlet of the device. Detention is the volume provided above the invert of the subsoil outlet. For structural tree pits providing retention and detention, retention volume should be prioritised above detention volume, i.e. maintain the minimum 600 mm free-drained depth to the dripline of the mature tree, above the subsoil and utilise depth below the subsoil to provide the bulk of the hydrology mitigation volume. If no subsoil drain is provided (in accordance with the minimum in-situ soil infiltration requirement of 25 mm/hr), then the full available structural soil volume (accounting for voids) shall be accounted for as retention volume.

For calculation of retention and detention volumes in sloped context refer to Section 2.3.5 Design for slope.

Retention Volume

In most cases, the infiltration rates of the underlying, in-situ soils will not meet the 25 mm/hr threshold to drain 600 mm of the structural soil in 24 hours. The retention volume will therefore most commonly be provided in the void space of the structural soil located below the invert of the subsoil outlet pipe. The retention function will be provided by a combination of evapotranspiration and uptake to the tree and infiltration to the ground.

Detention Volume

If a subsoil drain is provided, detention volume is calculated as the volume contained within the structural soil above the invert of the subsoil outlet pipe. Specific outflow control is not required to achieve detention in the structural soil tree pits.

Hydrology mitigation volume, for retention or detention, can be calculated based on the void volume equation below.

$$V_{void} = A \times d \times \phi$$

A = Footprint area of the structural soil tree pit (assuming vertical sides. If sides are not vertical, multiply the volume of structural soil by the void space coefficient).

d = The depth of the hydrology mitigation layer.

Φ = Void space coefficient (26%). This value is from international literature and testing by local suppliers for similar structural soil specifications.

Water quality

Testing is underway to quantify the full extent of the water quality benefits that structural soil tree pits provide. Until this is complete, structural soil tree pits are not considered to provide water quality treatment equivalent to other GD01 water quality devices. However, it is accepted that structural tree pits provide nominal water quality treatment and may therefore be suitable as part of a treatment train for areas with lower contaminant generation potential.

2.3.3 Cross-sectional geometry

The geometry of the structural soil tree pit is determined by tree root and stormwater management needs, and available urban space. Ideally, side walls should be vertical (1V:0H) to maximise soil volume. However, sloped walls (no flatter than 1V:2H) can be used for specific site requirements.

Structural soil tree pits can be designed for individual trees or trenched to allow for multiple trees. It is important that retained water is held under each tree root zone for additional retention volume and a water supply for tree health further into dry periods.

2.3.4 Base width, length and water depth

Consideration of the base width, length, and water depth should allow for urban constraints, while helping ensure sufficient space for tree root growth (species dependant) and providing the required stormwater management.

Base width

Tree pit structural soil shall have a minimum dimension of 2 m x 2 m to account for the tree allowing 0.5 m in each direction for root growth outside of the tree surround. The base width of a structural soil tree pit is usually set to avoid extending under the carriageway and to allow a 1 m area of natural soil adjoining private property for easier installation and maintenance of utilities. Deep soil in this area is sometimes available for tree roots from nearby private properties in areas that have not been terraced or experienced large-scale earthworks. Keep in mind that not all utilities will be in this back area; some may need to go under the footpath or be included in the structural soils.

Length

The length of the tree pit should provide the required soil volume for root growth and stormwater management. A longer tree pit can provide additional hydrology mitigation volume and increasing the infiltration area for groundwater recharge. Multiple trees can be connected in a trench.

Saturation depth

Saturation depth in a structural soil tree pit relates to the design depth required for hydrological mitigation and to provide adequate soil moisture for tree roots. Design depth of the structural soils (excluding topsoil, bedding materials, aeration layer) range from a minimum of 0.85 m to a maximum of 1.4 m, depending on site constraints, soil permeability and expected stormwater volumes. The depth should be sufficient to provide retention, while also maintaining a minimum of 0.6 m of structural soil depth that will drain within 24 hours of a rain event (above the sub-soil drain if underlying soil infiltration is not sufficient).

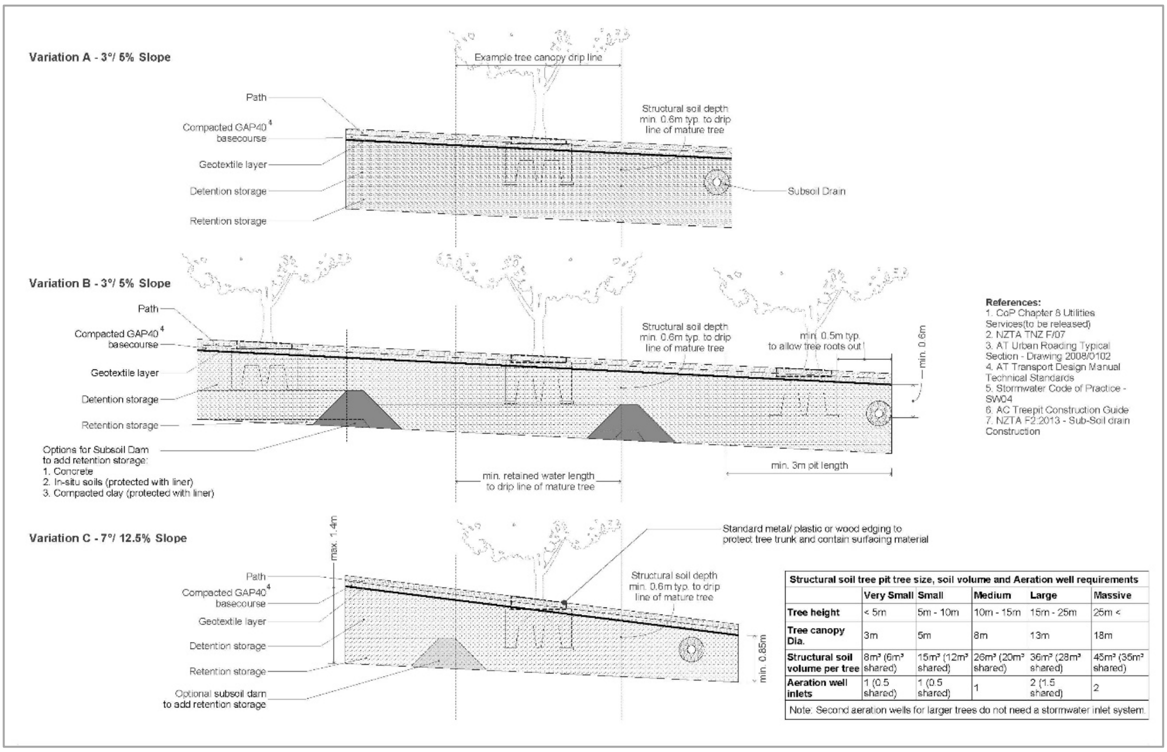
2.3.5 Design for sloping sites

Structural tree pits will generally be installed in sloping sites; the severity of the slope shall prescribe the size and hydrology mitigation volumes available. Unlike raingardens, structural tree pits do not have a surface ponding component meaning that the top level can be constructed to follow the surrounding ground levels. Options are shown in Figure 6 below.

Where longer trenches are required, these can be combined with subsoil dams (explained below and shown in Figure 7) to ensure water is available to trees and retention volume provided. Both options should comply with the requirements below:

- Not suitable on slopes greater than 12.5% or 7.125°.
- Installation on sloped sites may require a subsoil dam, or consideration of the height of the subsoil drain to maintain water below the root zone to prolong water availability into drought periods and promote anaerobic activity.
- Must maintain 600 mm of drained structural soil below the top of the structural soil at the expected dripline of the mature tree specified.

Figure 6 highlights some of the options for the implementation of structural tree pits in a sloped context and how the retention and detention volumes are delineated. The delineation point is taken as the invert of the subsoil outlet pipe.



Structural soil tree pit tree size, soil volume and Aeration well requirements

	Very Small	Small	Medium	Large	Massive
Tree height	< 5m	5m - 10m	10m - 15m	15m - 25m	25m <
Tree canopy Dia.	3m	5m	8m	13m	18m
Structural soil volume per tree	8m³ (6m³ shared)	15m³ (12m³ shared)	26m³ (20m³ shared)	36m³ (28m³ shared)	45m³ (35m³ shared)
Aeration well inlets	1 (0.5 shared)	1 (0.5 shared)	1	2 (1.5 shared)	2

Note: Second aeration wells for larger trees do not need a stormwater inlet system.

Figure 6: Sloped site examples for structural tree pits

Subsoil dams

Subsoil dams should be provided in instances where the structural tree pit is installed in a sloped setting and is suitably long enough so that there is no ponding water available below the root ball of the tree. In this case, subsoil dams shall be implemented to provide available water for trees and increase the stormwater management function.

Subsoil dams shall be constructed using:

- Concrete
- In-situ soils (protected with liner)
- Compacted clay (protected with liner).

To avoid future maintenance issues, subsoil dams cannot be constructed using:

- Wood
- Polyethylene sheet.

Figure 6 details examples of structural soil tree pits on various slopes utilising subsoil dams and the subsoil drain to maintain sitting water below the tree root ball, and to increase retention volume if required.

2.3.6 Summary of structural soil tree pit design constraints

Table 5 provides a quick-reference summary of key design parameters for structural soil tree pits. These parameters are drawn from the guidance offering values for sizing, setbacks, slopes, and other critical design considerations. Designers should refer to the full guidance document and relevant drawings for context and application in site-specific scenarios.

Table 5: Summary of structural soil tree pit design constraints

Design Parameter	Recommended Value or Range	Notes / Reference (Drawings)
Minimum structural soil volume per tree	Small tree (5-10 m): 15 m^3 Medium tree (10-15 m): 26 m^3 Large tree (15-25 m): 36 m^3 Massive tree (>25 m): 45 m^3	Table 4 and Figure 5 Tree size vs. volume
Minimum pit base size	Width ≥ 2.0 m Length ≥ 3.0 m	Section 2.3.4 Drawing 3, 4
Structural soil depth	0.85–1.4 m	Section 2.3.4 Drawing 3, 4
Free-draining depth (above subsoil drain)	≥ 600 mm	Section 2.3.4 Drawing 3, 4
Catchment size per inlet + aeration well	Max 270 m^2	Section 1.3 Table 2
Minimum topsoil depth (if used)	200 mm	Section 2.4.7 Drawing 3
Infiltration rate for no subsoil drain	≥ 25 mm/hr	Section 2.3.2
Aeration well internal dimensions (sump)	L460 x W460 x D450 mm (volume 95l)	Section 2.4.2 Drawing 10
Minimum number of aeration wells per tree (rounded up to whole number)	1 per small tree (5-10 m), (0.5 if shared) 1 per medium tree (10-15 m) 2 per large tree (15-25 m) (1.5 if shared) 2 per massive tree (>25 m)	Table 4 and Figure 5 Based on tree size
Minimum kerb/channel drain length	3.0 m	Section 2.4.1, Drawing 7

Design Parameter	Recommended Value or Range	Notes / Reference (Drawings)
Minimum setback from private structure (e.g. building)	≥3.0 m (unlined) or lined ≥1.0 m	Table 3
Slope limit	≤ 12.5% (7.125°)	Section 2.3.5; and Figure 6

2.4 Component design

This section outlines the design considerations for components within structural soil tree pits.

2.4.1 Inlet design

The inlet design for structural soil tree pits should provide intended stormwater functionality, while minimising maintenance. The inlet should discharge into the structural soils at the upstream end of the structural soil tree pit. The design should be such that standard construction and maintenance procedures are utilised to minimise costs and mitigate construction errors.

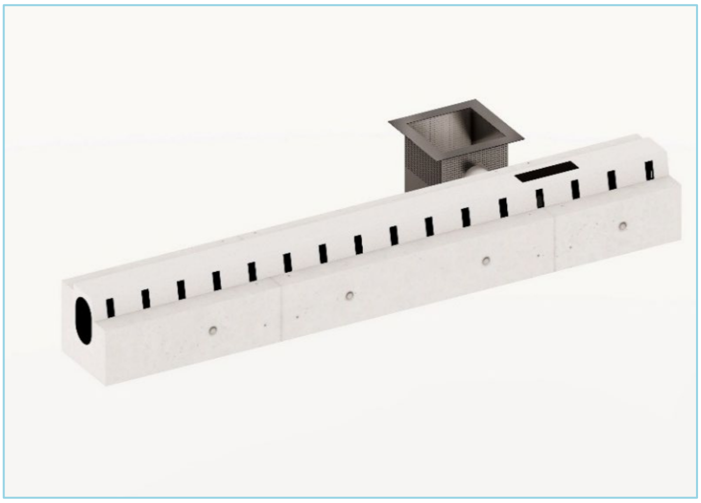
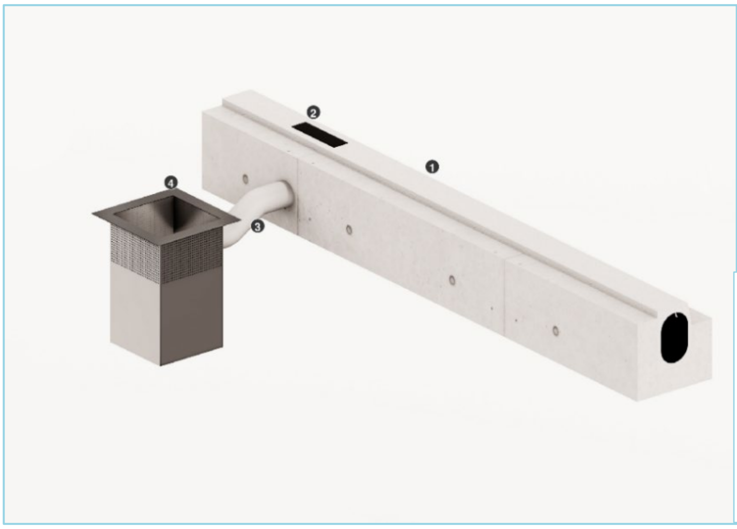


Figure 7: Inlet system



Key:

1. Kerb Drain (or Channel Drain) 200 series
2. Kerb Drain Access Unit
3. 160 mm OD SN16 Pipe
4. Aeration Well

Figure 8: Inlet system components

The initial capture of stormwater can be either into a kerb drain or channel drain which then connects to the aeration well. The size and length of the drain should be sufficient to provide for the 50% AEP. A minimum length of 3 m should be adopted as a baseline. Refer to the manufacturer's specification for installation and capacity information.

Catchpits are not considered an appropriate inlet option for the structural tree pits as they would have a surface overflow. The design event for the inlet is less than the 10% AEP event that normal catchpits capture and so the overflows would result in unnecessary requests for service to Auckland Council. The kerb and channel drains do not have an 'overflow', in large events they will stop capturing and flows will continue down the channel to the next available catchpit.

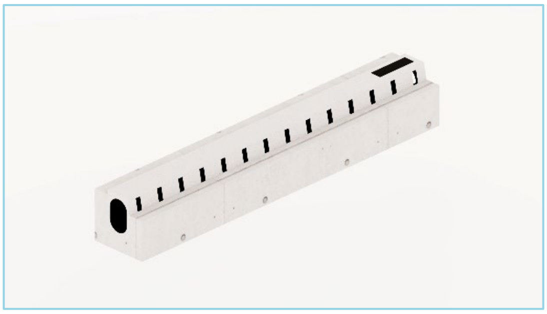



Figure 9: Kerb drain and channel drain 3 m section

Kerb drains should be used in situations where a kerb is required, and slope is less than 12.5%.

Channel drains should be used in situations where there is no kerb, with 12.5% being the maximum slope in which structural soil tree pits are appropriate.

The kerb or channel drain intercepts surface water runoff and directs it into a connected aeration well that has a sump. These must be easy to maintain with standard practises and have sufficient access points.

Pedestrian-only environments may not require a kerb or channel drain. The runoff may enter the tree pit directly via the dished channel and aeration well. The design will need to provide for instances when the tree pit is inundated with water, and an appropriate flow path designed.

Figure 10 shows an aeration well within a structural soil tree pit where kerb or channel drains are not required, such as a civic square.

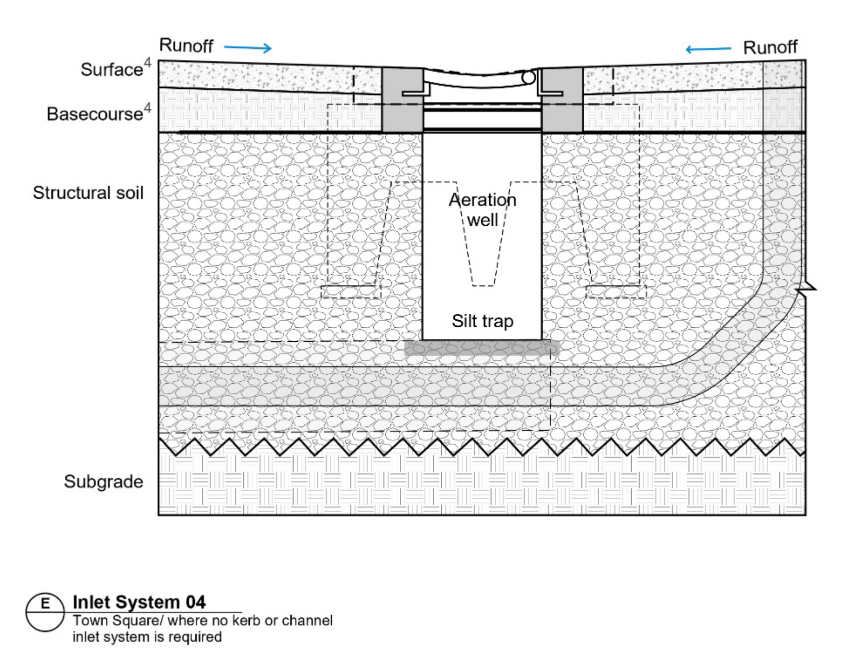


Figure 10: Surface inlet via aeration well

2.4.2 Aeration well

From the kerb or channel drain, water is directed into an aeration well. The well shall have a sump with minimum internal dimensions of: length 0.46 m; width 0.46 m; height to inlet invert level 0.45 m providing 95 L sediment storage. Where larger trees require a second aeration well, a kerb or channel drain stormwater inlet system is not required on the downstream aeration well.

The aeration well functions include:

- Initial sediment capture: Provides primary sedimentation to remove coarse particles before entering the structural soil
- Water distribution: Disperses stormwater into the structural soil
- Gaseous exchange: Facilitates the movement of gases such as oxygen, carbon dioxide, and methane between the upper layer of the structural soil and atmosphere.

It must be located outside of the zone of influence of the carriageway. Refer to Table 4 and Figure 5 for the number of aeration wells required per tree. Spacers/risers are used above the aeration well to support a standard grate. The spacers transfer loads to the structural soils. The aeration well is not designed to be load bearing. It must be easily accessible for standard maintenance by vacuum truck and high-pressure water.

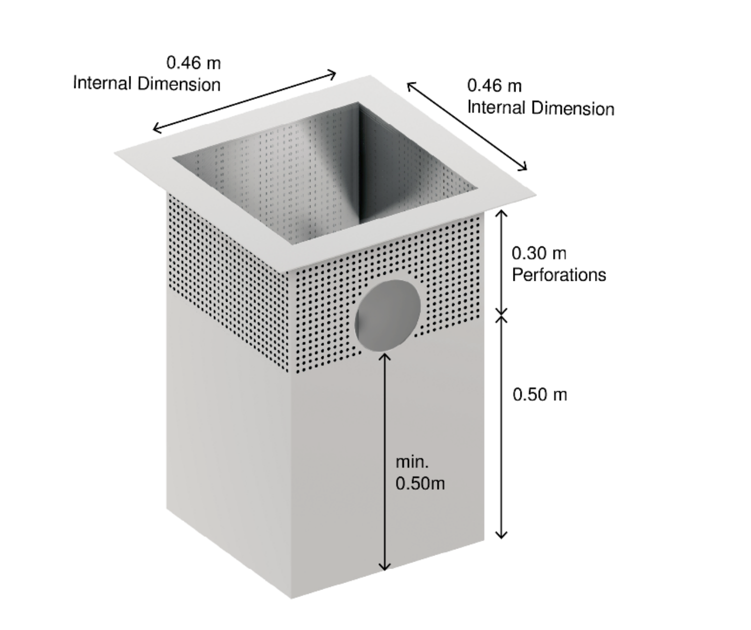


Figure 11: Aeration well

The aeration well is to be constructed out of 3.2 mm (minimum) 304 stainless steel to be robust enough for vacuum truck maintenance and avoid zinc coatings or microplastics. Ø7 mm aeration/hydration holes are machined at 15 mm centres in the top 300 mm as detailed in Appendix 1, Drawing 10.

2.4.3 Tree surround

The tree surround is designed to protect the tree root ball from compaction and encourages the tree roots downwards to help avoid damaging surrounding surface infrastructure such as paths and vehicle crossings. It can provide structural support both laterally and vertically. It is positioned below the surface treatment and can be used to support paving, tree guards or other above surface treatments. Within the tree surround, surfacing can be natural permeable materials such as pebble, scoria, shell, grass or underplanting. Replacement of dead trees can usually happen within the tree surround with care, using cutting equipment such as stump augers and saws, and in some cases may require air vacuum to help remove soils.

Figure 12: Tree surround

Tree surrounds should be made from low carbon, reinforced concrete and if constructed in sections, the sections should bolt together. They must have suitable inside dimensions for the basel diameter of the tree at maturity. The sizes are proposed in 0.5 m increments between 1 m and 2 m square internally. They are located below the surface layers and are to provide structural support both laterally and vertically to support both surface loading and lateral support when within the zone of influence of a carriageway, as well as protecting compaction of the initial root ball space.

Each section should be ≥80 mm thick and provide sufficient depth to direct the roots below surrounding surface treatments, bedding materials and the geotextile layer. The roots grow out into the structural soils through the crown shaped gaps, which should be sufficiently large for this purpose. The specific dimensions used in this document are shown in Appendix 1, Drawing 9.

2.4.4 Subsoil drains

Subsoil drains are necessary when the in-situ soil infiltration rate is below 25 mm/hr and should be positioned to allow 600 mm of free draining structural soil to the dripline of the tree (at maturity) within 24 hours for tree root health. Subsoil drains are located at the downstream end of the structural soil tree pit and are connected to the mains stormwater system via either a stormwater catch pit, manhole or directly to the stormwater pipe with a saddle.

The drains are made of perforated rigid pipe, with sufficient sizing and perforations to drain the volume above the subsoil in 24 hours. The perforated section shall be laid with a 1% slope toward the outfall and be a minimum of 1 m and a maximum of 2 m long. The rodding eye shall be non-perforated. Note that if the flat section of pipe needs to be longer than 2 m to account for the width of the structural soil tree pit, the extra lengths are provided as non-perforated.

All sub-soil drains shall be easily maintainable with a rodding eye to allow high pressure flushing and for root cutting machine access. All bends shall be maximum 45° and have long radius bend to allow for root cutting machines.

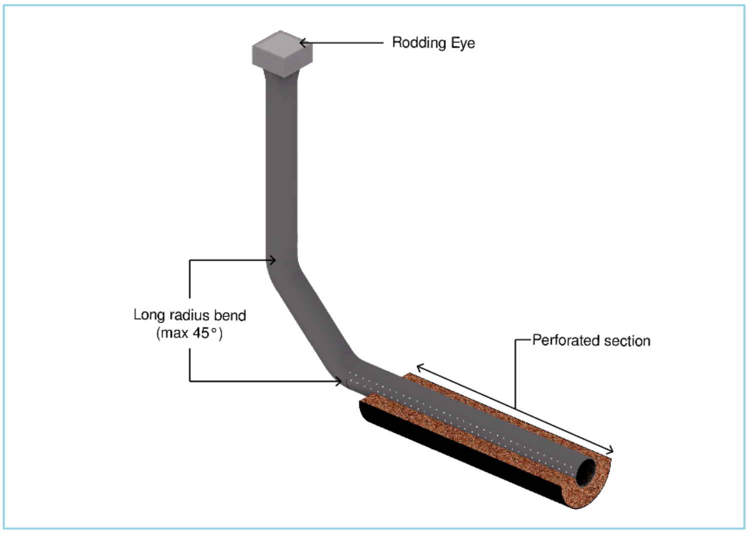


Figure 13: Subsoil drain

2.4.5 Subsoil dams

Subsoil dams may be necessary on sloping sites to increase retention volume when the in-situ soil's infiltration rate is below 25 mm/hr, and to maintain water below the dripline of the tree. Subsoil dams shall be located to prioritise retention via ponding at a frequency to avoid lengths that provide no storage.

2.4.6 Sitting water

Sitting water below the tree root zone in structural soil tree pits serves as a water reservoir, extending water availability into drought periods and providing the stormwater retention function. This may also promote anaerobic functions which help with water purification including breakdown of pollutants like nitrates and heavy metals.

Sitting water must be at least 600 mm below the top surface of the structural soils to prevent waterlogging of tree roots.

2.4.7 Topsoil

Topsoil used on the surface of structural soil tree pits must:

- Be a minimum of 200 mm deep to support vegetation
- Have sufficient available water, air and initial nutrients to support a healthy, resilient plant cover specific to Auckland conditions
- Not generate contaminants and not shrink or structurally collapse
- Be either protected from compaction, or resistant to compaction. The depth, type, area and volume of media should be selected to meet the landscaping/ecology, hydrologic and water quality objectives for a site
- Be sourced from a reputable supplier with high quality assurance, consistency of supply and performance under specified installation.

2.4.8 Structural soils

Structural soils are primarily designed to bear the load of vehicles and people on urban infrastructure such as paths, driveways, parking spaces and paved areas and expand the potential root zones of trees. The high void ratio and rapid drainage of water from the upper 600 mm of the root zone within 24 hours ensures adequate aeration to support tree health. Hydration and aeration are provided via the aeration well, so the surface above can be sealed, although pervious surfaces reduce tree stress. Structural soils hold low volumes of plant-available water. Water is provided in the short term by conventional tree soils around the root ball and by water stored in the base of the device between rainfall events, as such trees need to be watered during establishment until their roots extend to the base of the device. In the Auckland context, structural soils are also being used to provide stormwater management benefits through hydrology mitigation.

Structural soils are made up of clean crushed rock and a relatively small volume of a 'filler' of compost and biochar. It may be possible to use zeolite as an alternative to biochar; however, this is untested in New Zealand.

Quality assurance is vital. Suppliers must provide certification that their aggregate meets these specifications, with an authorising signature of compliance.

Proper handling and storage are essential to maintain the qualities of the structural soils. It should be used immediately if delivered pre-blended (recommended option) as the fines coating the aggregates need to be kept moist to prevent segregation of components. Storage is not recommended and requires a hard-surfaced, clean, dry area to prevent contamination and covered to protect it from rainfall, moisture and debris. When handling, care should be taken to avoid contamination and segregation of materials. Appropriate protective equipment should be used to prevent dust inhalation and other potential hazards (i.e. from compost component).

Table 6: Structural soil specifications

Item	Value
Aggregate	• 100% v/v
Compost	• 7.5% v/v and 1:1 mix with biochar
Biochar	• 7.5% v/v and 1:1 mix with compost
Saturated hydraulic conductivity (Ks)	• >500 mm/hr

2.4.9 Aggregate

The aggregate should be composed of clean, crushed stone, free from contaminants such as soil, organic matter, and any foreign substances that could affect its performance or leach harmful chemicals into the soil. The crushed stone should be 40/60 mm clean stone.

The aggregate must be angular and have a crushing resistance to withstand the pressures from above-ground infrastructure, with a minimum crushing resistance of 100kN.

Table 7: Aggregate specifications

Sieve Size + Shape	**% Passing**
63 mm	• 100%
37.5 mm	• 0-10%
Shape 2:1:1 (H:W:L)	• >90%
Crushing resistance	• >100 kN

2.4.10 Biochar

Biochar is a carbon-rich material produced for biomass through pyrolysis. Radiata pine is the dominant feedstock in New Zealand, although biochar is also produced from agricultural and arborist prunings. The properties of biochar are heavily influenced by the feedstock and pyrolysis temperature - and this, with particle size, impacts the resultant biochar nutrient and contaminant sorption, or supply. The biochar should be derived from clean, untreated organic materials such as wood chips. It is important to avoid biochar produced from treated wood, plastic, biosolids, or other contaminated materials. Biochar shall not be mixed with other materials before use (i.e. before being mixed with compost).

The physical and chemical properties (see Table 8) of the biochar are critical for its performance:

- The particle size should <3 mm to support adequate soil aeration and water retention
- The biochar should have a high carbon content, typically greater than 70%
- The pH should be neutral to slightly alkaline, within the range of 6 to 7.5, to support a wide range of plant species
- Additionally, the biochar should possess high porosity, greater than 50%, to enhance water retention, soil aeration, and provide a habitat for soil microorganisms.

Biochar is intended to assist in stormwater purification and therefore must not be a source of stormwater contaminants. It should meet or exceed the New Zealand standards for soil amendments (NZS 4454:2005).

Biochar should be tested by an accredited laboratory, and suppliers must provide certification confirming that their biochar meets these specifications, including detailed test results; i.e. verification that contaminant concentrations in biochar produced from clean feedstocks (forestry waste, arboriculture prunings) are low, and feedstocks are unchanged.

Proper handling and storage of biochar are also essential. It should be stored in a dry, covered area to prevent contamination and degradation. When handling biochar, appropriate protective equipment such as gloves and masks should be used to prevent inhalation of dust. It should be thoroughly mixed with soil before application to avoid clumping and ensure even distribution.

Table 8: Biochar specification[i1]

PAHs	• <20 mg/kg
Total Carbon	• >70%
pH	• 6-7.5
Particles < 3 mm	• >95%
Iron	• <6,000 ppm
Lead	• <30 ppm
Cadmium	• <0.5 ppm
Copper	• <30 ppm
Nickel	• <15 ppm

[1] In 2024, the biochar industry in NZ was characterised by about 6 produce/retailers with capacity to produce large volumes of biochar and a large number of small-scale 'artisan' producers. Broadly agreed, standardised testing is yet to be developed. The existing Code of Practice (ANZ Biochar Industry Group 2021) is a starting point.

Zinc	<140 ppm
Arsenic	<10 ppm
Mercury	<0.2 ppm
Chromium	<50 ppm

2.4.11 Compost

Compost should be derived from clean, uncontaminated organic materials such as wood chips, agricultural residues, and food scraps. It is important to avoid compost made from treated wood, synthetic materials, or any other sources that might introduce contaminants.

Compost requirements:

- Must meet NZ Standard NZS/AS 4454:2005
- Particles should be finely screened with majority of particles <10 mm and at least 95% <3 mm
- Moisture content should be approximately 30% w/w, to allow for handling, blending and incorporation into media.

Further compost specifications are outlined in Table 9.

The compost must be well-decomposed, stable and free from pathogens and weed seeds. As the structural soils are intended to treat stormwater the compost specifications are stringent.

Table 9: Compost specification

Total Nitrogen	1.5-2.0%
Phosphorous	0.2-0.5%
Potassium	1.0-1.5%
Magnesium	0.3-0.6%
Calcium	1.5-2.5%
Iron	<6,000 ppm
Lead	<30 ppm
Cadmium	<0.5 ppm
Copper	<30 ppm
Nickel	<15 ppm
Zinc	<140 ppm
Arsenic	<10 ppm
Mercury	<0.2 ppm
Chromium	<50 ppm
C / N Ratio	15-20.1

2.4.12 Option to exchange biochar for zeolite

Zeolite is a naturally occurring mineral that may be an effective alternative to biochar for enhancing soil properties and supporting tree health. Zeolite provides several benefits, including high cation exchange capacity (CEC) which allows it to retain essential nutrients such as nitrogen, potassium, and calcium, making them available to plants over time. Additionally, zeolite can help buffer soil pH, maintaining a stable environment suitable for a wide range of tree species, and can adsorb heavy metals and other contaminants, reducing leaching into groundwater.

Zeolite requirements are:

- Purity: Zeolite must be free from contaminants and sourced from a reputable supplier to ensure safety and effectiveness
- Each batch of zeolite should be tested for its chemical and physical properties by an accredited laboratory, and suppliers must provide signed certification confirming that their zeolite meets these specifications.

Table 10: Zeolite specification

PAHs	• <20 mg/kg
pH	• 6.5-8
Particles < 3 mm	• >95%
Magnesium	• 0.3-0.6%
Calcium	• 1.5-2.5%
Cation Exchange Capacity (CEC)	• >100 meq/100 g
Lead	• <30 ppm
Cadmium	• <0.5 ppm

2.4.13 Vegetation

<u>Trees</u>

Trees are planted within the tree surround in a dedicated soil volume that integrates with the underlying structural soil to support healthy root development. Species must be well-adapted to urban conditions and compatible with the structural soil system. Trees should be able to tolerate warmer stormwater runoff from adjacent impervious surfaces, as well as periods of low soil moisture. Selection must also consider the available soil volume to ensure long-term growth and structural stability.

<u>Species selection policy</u>

Tree species planted in structural soil tree pits shall be selected in accordance with the principles of Auckland's Urban Ngahere Strategy, ensuring they contribute to long-term urban forest outcomes. Species may be native or exotic where they are non-invasive, appropriate to the site conditions, and support the intended functional and environmental objectives. Given that this construction method is new in New Zealand, species performance is not yet fully established; monitoring and review of plantings shall be undertaken to inform ongoing and future species selection.

Tree selection criteria

- Tree specimens must comply with AS 2303:2018 - Tree Stock for Landscape Use
- Select species that are resilient in urban environments, including heat, drought, sun exposure and available rooting space
- Ensure species can access and utilise structural soil for anchorage, stormwater uptake, and long-term health
- Choose trees that minimise root conflicts with surrounding infrastructure and reduce the risk of ingress into drainage systems
- Select only non-invasive species that comply with all biosecurity regulations
- Designers must consider the tree's mature size, above ground constraints, root anchorage, and exposure to wind, as these factors influence tree stability and risk of windthrow/fall

Approval requirements

The designer shall supply species selection information and obtain written approval from Auckland Transport Asset Manager, Healthy Waters, and Auckland Council Parks for all species selections in structural soil tree pit applications.

Indicative species lists

The following tables provide indicative species that may be suitable for structural soil tree pit applications. These lists are not exhaustive and are intended as a starting point for designers. Species performance in structural soil systems in New Zealand is still being established through monitoring and field trials. Alternative species may be considered where they meet the selection criteria above and receive approval from relevant asset managers.

Note on deciduous species: If deciduous trees are used, maintenance protocols must include twice-monthly clearing during peak leaf fall season (March-June) and emergency response provisions for storm events to prevent inlet blockages and maintain stormwater function.

Table 11: Non-exhaustive native tree species (>5 m at maturity)

Name	Common Name	Growth Form	Max. height	Drought	Frost	Salt Wind	Water log	Wet	Moist	Dry	Mature Basal	Tree Surround (m)
Small trees (5 – 10 m)												
Sophora fulvida	Kōwhai	Small tree	6	High	Med	Med	Low	N	Y	Y	0.4	1
Metrosideros excelsa 'Vibrance'	Pōhutukawa (Compact)	Small tree	6	High	Low	High	Low	N	Y	Y	0.5	1
Streblus banksii	Tūrepo; Milk-tree	Small tree	8	Med	Low	Med	Low	N	Y	Y	0.4	1
Myoporum laetum	Ngaio	Small tree	10	High	Low	High	Low	N	Y	Y	0.5	1
Rhopalostylis sapida	Nīkau	Palm	10	Low	Low	Med	Med	Y	Y	N	0.4	1
Olearia angulata	Wavy leaved tanguru	Small tree	5	Med	Med	Med	Low	N	Y	Y	0.3	1
Melicope ternata	Wharangi	Tall shrub	4	Med	Low	High	Med	N	Y	Y	0.3	1
Pseudopanax arboreus	Whauwhaupaku	Small tree	6	Med	Low	Low	Low	N	Y	Y	0.3	1
Medium trees (10 – 15 m)												
Kunzea robusta	Kānuka	Tree	15	Med	Med	Med	Med	N	Y	Y	0.5	1
Hoheria populnea	Lacebark	Medium tree	12	Med	Med	Med	Low	N	Y	Y	0.5	1
Hoheria sexstylosa	Narrow-leaved lacebark	Medium tree	10	Med	High	Med	Low	N	Y	Y	0.4	1
Hedycarya arborea	Porokaiwhiri; pigeonwood	Medium tree	15	Low	Low	Low	Low	Y	Y	N	0.4	1
Carpodetus serratus	Putaputawētā	Small tree	10	Med	Med	Low	Med	N	Y	N	0.3	1
Didymocheton spectabilis	Kohekohe	Medium tree	15	Med	Low	Low	Low	Y	Y	N	0.5	1

Name	Common Name	Growth Form	Max. height	Drought	Frost	Salt Wind	Water log	Wet	Moist	Dry	Mature Basal	Tree Surround (m)
Plagianthus regius	Lowland ribbonwood; mānatu; ribbonwood	Medium tree	15	Med	High	Med	Med	N	Y	N	0.5	1
Planchonella costata	Tawāpou	Medium tree	15	Med	Low	Med	Low	N	Y	Y	0.5	1
Large trees (15 – 25 m)												
Nestegis apetala	Coastal maire	Large tree	20	High	Med	Med	Low	N	Y	Y	0.7	1.5
Pterophylla racemosa	Kāmahi	Large tree	25	Med	Med	Low	Med	Y	Y	Y	0.7	1.5
Litsea calicaris	Mangeao	Large tree	20	Med	Med	Med	Low	N	Y	Y	0.6	1.5
Metrosideros excelsa	Pōhutukawa	Large tree	20	High	Low	High	Low	N	Y	Y	1.2	2
Vitex lucens	Pūriri	Large tree	20	Med	Low	Med	Low	N	Y	N	0.8	2
Pterophylla sylvicola	Tōwai	Large tree	25	Med	Med	Low	Low	Y	Y	N	0.7	1.5

Table 12: Non-exhaustive exotic tree species (>5 m at maturity)

Name	Common Name	Growth Form	Max. height	Drought	Frost	Salt Wind	Water log	Wet	Moist	Dry	Mature Basal Ø (m)	Tree Surround (m)
Small trees (5 – 10 m)												
Magnolia 'Little Gem'	Little Gem Magnolia	Compact	4 m	Med	Med	Med	Low	Y	Y	N	0.4	1
Acer palmatum 'Red Emperor'	Emperor Japanese Maple	Open crown	4.5 m	Low	High	Low	Low	N	Y	N	0.3	1
Lagerstroemia indica	Crape Myrtle	Vase-shaped	7.5 m	High	High	Med	Low	N	Y	Y	0.5	1

Name	Common Name	Growth Form	Max. height	Drought	Frost	Salt Wind	Water log	Wet	Moist	Dry	Mature Basal ø (m)	Tree Surround (m)
Prunus campanulata 'Pink Cloud' (sterile)	Taiwan Cherry 'Pink Cloud'	Rounded	8 m	Low	Med	Low	Low	N	Y	N	0.4	1
Medium Trees (10-15 m)												
Acer rubrum 'October Glory'	October Glory Red Maple	Rounded crown, upright	12 m	Med	High	Med	High	Y	Y	Y	0.8	1.5
Prunus yedoensis 'Awanui' (sterile)	Yoshino Cherry 'Awanui'	Vase-shaped, spreading	12 m	Low	High	Med	Low	N	Y	N	0.6	1.5
Large Trees (15-25 m+)												
Afrocarpus gracilior	African Fern Pine	Evergreen, rounded dense crown	18 m	Med	Low	Med	Low	N	Y	N	0.8	1.5
Jacaranda mimosifolia	Blue Jacaranda	Spreading	20 m	High	Low	Med	Low	N	Y	Y	0.7	1.5
Ginkgo biloba (male)	Maidenhair Tree	Conical, broad with age	25 m	High	High	High	Low	N	Y	Y	1	2

Underplanting

In structural soil tree pits, understorey planting is typically established in a 200 mm topsoil layer above a geotextile. While this zone will often sustain grass, standard maintenance regimes for public roads in Auckland usually do not support more complex underplanting. The guidance below applies where underplanting has been specifically considered and approved as part of a consented landscape design.

Moisture will wick and transpire upward from the underlying structural soil, however selected species must primarily tolerate dry, free-draining conditions with some subsurface moisture.

Plant selection and installation guidance

Topsoil depth:

- Select species with suitable rooting depths for the topsoil depth available. The species recommendation tables include estimated root depths. As a general guide:
  - Minimum 200 mm for groundcovers, grasses, and low perennials
  - 300–450 mm preferred where space allows, to support a broader plant palette
  - 600+ mm where feasible (e.g. within tree surrounds) where shrubs and trees or deeper-rooting species are proposed.

Understorey plant selection:

- Free-draining, low-moisture environments
- Moisture wicking or condensation from the structural soil layer below
- Urban stressors such as heat, compaction and wind.

Erosion control:

- Select fibrous-rooted and rhizomatous species around pit edges to stabilise soil and reduce runoff scouring.

Sun and exposure:

- Use site-appropriate species, such as hardy, non-brittle species adapted to full sun and heat-reflective surfaces in urban settings adjacent to paving
- Include native flowering plants or culturally appropriate species where possible to support ecological and community outcomes
- Avoid annuals or high-maintenance species.

Maintenance considerations:

- Avoid dense or clumping species where they may obstruct inspection or maintenance access
- Select plants that will achieve full groundcover within 12–18 months to suppress weeds and stabilise the surface.

The following suggested native species suitable for structural tree pits is not an exhaustive list, other species may also be appropriate depending on site-specific conditions.

Table 13: Suggested underplanting species (<100 mm height at maturity)

Name	Common Name	Growth Form	Max. height	Drought	Frost	Salt Wind	Water log	Wet	Moist	Dry	Root depth (m)
Acaena novae-zealandiae and other Acaenas	Piripiri; bidi bidi	Mat-forming herb	0.1	High	High	Low	Med	N	Y	N	0.1–0.2
Carex breviculmis	Grassland sedge	Sedge	0.2	Med	Med	Med	Med	N	Y	N	.15–.3
Leptinella dioica	Leptinella	Mat-forming herb	0.01	Med	High	Med	High	Y	Y	N	.05–.1
Leptostigma setulosa		Mat-forming herb	0.02	Med	Med	Low	Med	Y	Y	N	.03–.08
Selliera radicans	Remuremu	Mat-forming herb	0.01	Med	Med	High	High	Y	N	N	.03–.1

Table 14: Suggested ground cover species (0.25 – 2 m height at maturity)

Name	Common Name	Growth Form	Max. height	Drought	Frost	Salt Wind	Water log	Wet	Moist	Dry	Root depth (m)
Apodasmia similis	Oioi; jointed wire rush	Densely clumping reed	1.2	Med	Med	High	High	Y	Y	Y	0.4–0.8
Austroderia fulvida	Toetoe	Tall grass	1.5	High	High	High	High	Y	Y	Y	0.5–1.2
Astelia banksii/ A. chathamica; Astelia grandis	costal astelia; Chatham Island astelia	Tall tussock	1.2	Med	Med	Low	Med	N	Y	Y	0.3–0.6
Carex flagellifera	Trip me up	Short tussock	0.6	Med	High	Low	Med	Y	Y	N	0.2–0.4
Carex lambertiana	Bush sedge	Tall tussock	0.9	Med	Med	Low	Med	N	Y	N	0.3–0.5
Carex virgata	Pukio; purei	Tall tussock	1	Med	High	Med	High	Y	Y	N	0.3–0.6
Coprosma acerosa	Sand dune coprosma	Groundcover	0.3	High	High	High	Med	N	Y	Y	0.2–0.5

Name	Common Name	Growth Form	Max. height	Drought	Frost	Salt Wind	Water log	Wet	Moist	Dry	Root depth (m)
Cyperus ustulatus	Giant umbrella sedge; toetoe upokotangata; coastal cutty grass	Tall tussock	1	Med	Med	High	High	Y	Y	N	0.4–0.8
Dianella nigra	Turutu; Inkberry; blueberry	Short tussock	0.5	Med	Med	Med	Low	N	Y	N	0.2–0.4
Eleocharis acuta	Sharp spike sedge	Sedge	1	Med	Med	Y	Med	N	Y	N	0.3–0.5
Ficinia nodosa	Wiwi; Knobby clubrush	Rush	0.6	High	Med	High	Low	N	Y	N	0.3–0.6
Juncus edgariae	Leafless rush	Rush	1	Med	High	Low	High	Y	Y	N	0.3–0.6
Lepidopserma australe	Square-stemmed sedge; square sedge	Rush	0.6	Med	Med	Med	Med	N	Y	N	0.2–0.5
Libertia ixioides, L. grandiflora	Mikoikoi; New Zealand iris	Short tussock	0.7	High	High	Med	Low	N	Y	N	0.2–0.4
Arthropodium cirratum	Rengarenga	Clumping herb	0.6	Med	Low	High	Low	N	Y	Y	0.2–0.4
Phormium cookianum subsp. hookeri	wharariki; Coastal flax	Tall tussock	1	Med	Med	Med	Med	Y	Y	N	0.5–1.0

Table 15: Suggested tree and shrub species (2 m to 5 m height at maturity)

Name	Common Name	Growth Form	Max. height	Drought	Frost	Salt Wind	Water log	Wet	Moist	Dry	Root depth (m)
Muehlenbeckia astonii	Mingimingi	Shrub	3	High	Med	High	High	N	Y	Y	0.6–1.0
Coprosma propinqua	Mimikimi; mimingimingii	Tall shrub	3	High	High	High	High	Y	Y	N	0.6–1.2
Melicope ternata	Wharangi	Tall shrub	4	Med	Low	High	Med	N	Y	Y	0.6–1.0
Olearia solandri	Coastal shrub daisy	Tall shrub	4	Med	Med	High	Low	N	Y	N	0.5–0.8

Name	Common Name	Growth Form	Max. height	Drought	Frost	Salt Wind	Water log	Wet	Moist	Dry	Root depth (m)
Phormium tenax	Harakeke; flax	Flax	2.5	High	High	High	High	Y	Y	Y	0.5–1.0
Coprosma repens	Taupata	Shrub	4	High	High	High	Med	N	Y	Y	0.6–1.0
Corokia cotoneaster	Korokio	Shrub	2.5	High	High	High	Low	N	Y	Y	0.5–0.8

2.4.14 Co-location with other services

Key design considerations for co-locating with other services:

- Engaging with utility stakeholders in the early stages of design helps anticipate possible conflicts and address them proactively.
- Rear berm and footpath zones: Utility services may not always be confined to rear berms and paths; in some instances, they may also need to transit front berms. Designers should account for this when planning structural soil tree pits and consult early with service providers.
- Clearance requirements: Maintain adequate separation between tree pits and utilities to prevent root interference. Standard clearances should follow CoP Chapter 8 Utilities Services specifications and align with local council and utility provider standards.
- Where utilities are located near or in tree pits, the installation of root barriers can help mitigate the risk of root encroachment. The root barriers should be installed around the services or service trench being installed to allow tree root growth below the services.
- Acknowledging potential challenges with regulatory consents and service approvals; this guidance encourages early engagement with asset owners and utility providers.
- Collaborative planning can help streamline the design process and ensure structural soil tree pit installations meet required standards without compromising utility functionality.

2.5 Construction design considerations

The following details construction design considerations for structural tree pits.

2.5.1 Structural soils

Prior to construction, areas where structural soil tree pits are to be located should be fenced off and the soils protected.

- Excavations for structural soils should ensure that the sides of the subsoil are not compacted or sealed during digging, which would hinder water infiltration. To promote proper drainage, the sides should be roughened or left naturally uneven, allowing water to percolate through the soil layers and avoid creating an impermeable barrier.

- Structural soil tree pits must be protected from any construction sediment, including via any drainage or surface entry.
- Structural soils should be delivered pre-mixed by the supplier.
- The supplier is responsible for ensuring that structural soils are tested and meet project specifications for drainage, compaction resistance, and organic content. A signed certificate of compliance and recent laboratory test results must be provided prior to installation.
- Structural soils should be remixed on-site by randomising the mix as it is transferred into the pit (i.e. taking bucket loads from left, right, top and bottom of truck delivery in equal proportions).
- Structural soils are to be installed in lifts of up to 200 mm and compacted at each lift.
- A vibratory plate compactor or a vibratory roller shall be used for compacting structural soils at each lift.
- Compaction should be tested using a clegg impact soil tester at each lift of up to 200 mm during installation. Testing must be undertaken at a frequency and to acceptance criteria appropriate to the location and function of the surface, particularly where materials are within the structural influence zone of pavements or carriageways.
- Clegg Impact Values (CIV) are to be interpreted against site-specific, Council-approved performance benchmarks. Refer to NZTA Specification TNZ F/1 and NZS 4402 for guidance on compaction control and test methodology.
- Once at finished height, water the structural soil to pre-condition the system. This will establish an aeration layer at the top surface.

2.5.2 Planting

- Irrigation and/or additional watering is required in the establishment phase of planting.
- All planting areas must be protected from compaction, contamination, and physical damage during construction. Clearly mark and fence designated planting zones and avoid stockpiling materials or storing machinery within these areas.
- Soil preparation, including ripping or decompaction, must be completed prior to planting where ground disturbance has occurred.
- Ensure timing of planting aligns with seasonal conditions and irrigation availability, and that plant species specified are suited to the final soil profile, drainage, and microclimate conditions.

2.5.3 Other

- The subsoil drain shall be located at the intended ponding level, not at the base of the device. Particular attention should be paid to the invert level of the drain.

- Any liners or geotextiles shall be installed such that they do not puncture or rip and should allow enough media volume and depth for mature root development of the designed vegetation.
- The subsoil drain shall be enclosed by a surrounded by a layer of 150 mm clean, washed gravel (5-14 mm or pea gravel) with a minimum 50 mm bedding layer to prevent clogging and must be designed and installed to allow for inspection and flushing.

2.5.4 Construction process

The following construction process is recommended:

1) Excavate the tree pit to the required depths.
2) Construct the kerb, channel or dished drains.
3) Install impermeable membrane to protect carriageway.
4) Install lifts of structural soil to the bottom level of the utility services trench, subsoil drain, tree surround, aeration well, and install each on top of levelling plates or media when the desired height is reached.
5) Continue installing lifts of 200 mm of structural soil compacting between each lift and testing the compaction with a clegg hammer.
6) Install all pipes and connections between the inlet system.
7) Install geotextile and protection aggregates around the pipes.
8) Complete lifts of structural soils, and water to precondition the soils.
9) Install surface layers and any top layer planting, paving or concreting.
10) Install the tree with guying system and topsoil.
11) Commence routine maintenance.

2.6 Operation and maintenance

A stand-alone document is provided for detailed operations and maintenance guidance. General operation and maintenance considerations include:

- The device should be located to allow for easy and safe maintenance with consideration of traffic control, irrigation and sump cleaning
- Planting should be designed for minimal maintenance and control (for example, foliage should not droop onto footpaths after rainfall)
- It is important to not use fertiliser or herbicides in bioretention devices
- Irrigation should be allowed for during the vegetation's establishment phase.

2.6.1 Inlet

The inlet design is intended for standard maintenance procedures and will require regular maintenance for the system to function correctly.

Contractors must follow the manufacturer's guidance for maintenance procedures on all products.

Generally, the kerb or channel drain should be maintained using high pressure water to flush debris away from and through the inlet system, and via vacuum truck at the access points and aeration well sump after flushing.

2.6.2 Aeration well

The aeration well should be maintained by using a vacuum truck to remove any debris. Inspect the perforations within the top 300 mm for any blinding and flush with high-pressure water to clear blockages. If tree roots are present and obstructing the perforations, carefully remove them using root-cutting tools; if the roots are causing significant blockage, the top 300 mm of structural soil surrounding the aeration well may need to be cleared of roots. Regular checks for root intrusion should be performed to prevent recurring issues and maintain the system's efficiency.

2.6.3 Tree surround

The tree surround should not require maintenance unless it is compromised structurally, in which case the damaged part should be replaced. The surrounding soils would need to be excavated and reinstated to the appropriate levels and compaction requirements, with like for like materials.

2.6.4 Topsoil

Topsoil can be topped up if necessary to maintain adequate levels, but if erosion is identified as the cause of the loss, it is important to correct the underlying problem first. Addressing the cause of erosion might involve stabilising the site with appropriate vegetation, improving drainage, or implementing erosion control measures, such as installing barriers or applying mulch. Once the issue is resolved, topsoil can be replenished to ensure healthy plant growth and proper soil function.

2.6.5 Geotextile layer

If the geotextile layer above the structural soils becomes blocked, blinded, or otherwise damaged, the top surface above it will need to be removed, and the section of geotextile replaced. The geotextile should be checked when any excavation is made and before the surface layers above are replaced, or if any performance issues (such as ponding, or excessive soil moisture) is noted during regular inspection.

2.6.6 Structural soils

Structural soils generally require minimal maintenance. However, there are a few specific maintenance practices to keep them functioning effectively:

- Regular surface inspections (typically annually) check for soil compaction, tree health, and potential settling of soil near the surface. If signs of settling, poor tree health, or compaction are noticed, interventions may be needed.
- Structural soils themselves usually don't need replacement or topping up if installed correctly. However, if the surface soil has settled significantly over time or if major root development has displaced the soil, structural soil or aggregate might be added (or removed) to bring it back to its original level. Any new soil should match the existing structural soil in composition to maintain consistency and load-bearing capacity.

2.6.7 Tree replacement

The removal and replacement of a tree requires careful planning due to the engineered soil structure and potential utilities surrounding it. The steps to replacing a tree in may include:

- Tree removal: Cut down the tree above ground and remove the trunk and branches. Try to prevent root disturbance beyond what is necessary to protect the structural soil system.
- Root removal: Excavate and cut roots away within the tree surround, around the root ball carefully, and remove the root ball if possible. If it is necessary to excavate around the tree surround in the structural soils, try to minimise disruption to the structural soils. The removal will involve cutting the roots away from the structural soil aggregate, leaving it as undisturbed as possible.
- Re-stabilise structural soil: If the structural soil is disturbed during root removal, the replaced soil will need compaction. Top up or supplement the structural soil to maintain load-bearing capacity and ensure the structural integrity is retained.
- Tree replacement: Place the new tree in the tree surround, ensuring roots are adequately spread and in contact with soil for optimal establishment. Follow good arboricultural processes for tree planting. Backfill as necessary, using a compatible soil mix.
- Post-replacement care: Given the disturbance to the soil, provide extra care to the new tree, such as staking (if needed), and regular watering, to help it establish within the modified soil environment.

2.6.8 Long term maintenance/replacement

Structural soil systems are typically designed as long-life infrastructure components, with an expected service life of 50+ years when properly installed and maintained. This often exceeds the functional lifespan of many urban trees, which may vary from 20 to 60 years depending on species selection, site conditions, and maintenance practices. As such, case-by-case management of structural soil tree pits may be required.

3.0 Design example

The following example explains how a structural tree pit can be sized to provide SMAF 1 hydrology mitigation for a 500 m² road catchment.

Table 16: Example structural tree pit sizing SMAF 1 500 m² road catchment

Parameter	Value	Ref
95th %ile rainfall depth	35 mm	
Pre-development curve number	74	$CN_{(pre)}$
Post development curve number	98	$CN_{(post)}$
Soil infiltration rate	3 mm/hr	
Structural soil void ratio	26%	Φ
Catchment impervious %	80%	

3.1 Design steps

Step 1: Determine hydrology mitigation requirements

Based on the impervious percentage, the total impervious area for the catchment is 400m². Using GD01 Section B and TP108:

Pre-development runoff volume = 3.78 m³

Post-development runoff volume = 12.95 m³

Required retention volume:

5 mm x total impervious area = 2 m³

Required detention volume:

Post-development runoff volume – pre-development runoff volume – retention volume

12.95 m³ - 3.78 m³ - 2 m³ = 7.17 m³

Step 2 - Check soil infiltration rate to see whether a subsoil drain is required

3 mm/hr x 24 hours = 72 mm

72 mm < 600 mm so subsoil drain is required

Step 3 - Determine total structural soil volume requirement:

(Retention volume + detention volume) / void ratio

(2 m³ + 7.17 m³) / 0.26 = 36 m³

Step 4 – Determine aeration well and tree requirements:

Based on a structural soil volume of 36 m^3 (from step 3):

Number of trees (from Figure 5) = 3 x small tree (or 1 x large tree)

Number of aeration wells (from Figure 5): 2 x aeration wells

Step 5 - Determine structural tree pit dimensions:

Assumed total structural soil depth of 1 m (600 mm drained, 400 mm saturated)

Area required: 36 m^3 / 1 m = 36 m^2

Assume width of 3.6 m

Total length: 36 m^2 / 3.6 m = 10 m

Step 6 - Confirm retention volume provided:

Saturated depth (below subsoil) = 400 mm

Saturated structural soil void volume: $V_{void}=A \times d \times \phi$

Vvoid = 36 m^2 x 0.4 m x 26% = 3.74 m^3 (> 2 m^3 so sufficiently large)

Step 7 - Confirm detention volume provided

Drained depth (above subsoil) = 600 mm

Drained structural soil void volume: $V_{void}=A \times d \times \phi$

Vvoid = 36 m^2 x 0.6 m x 26% = 5.62 m^3

This is less than the 7.17 m^3 required, however additional retention volume has been provided, so the detention requirement is now less. Based on the equation in Step 1, the actual detention volume required is:

12.95 m^3 - 3.78 m^3 - 3.74 m^3 = 5.43 m^3 < 5.62 m^3, so size is sufficient

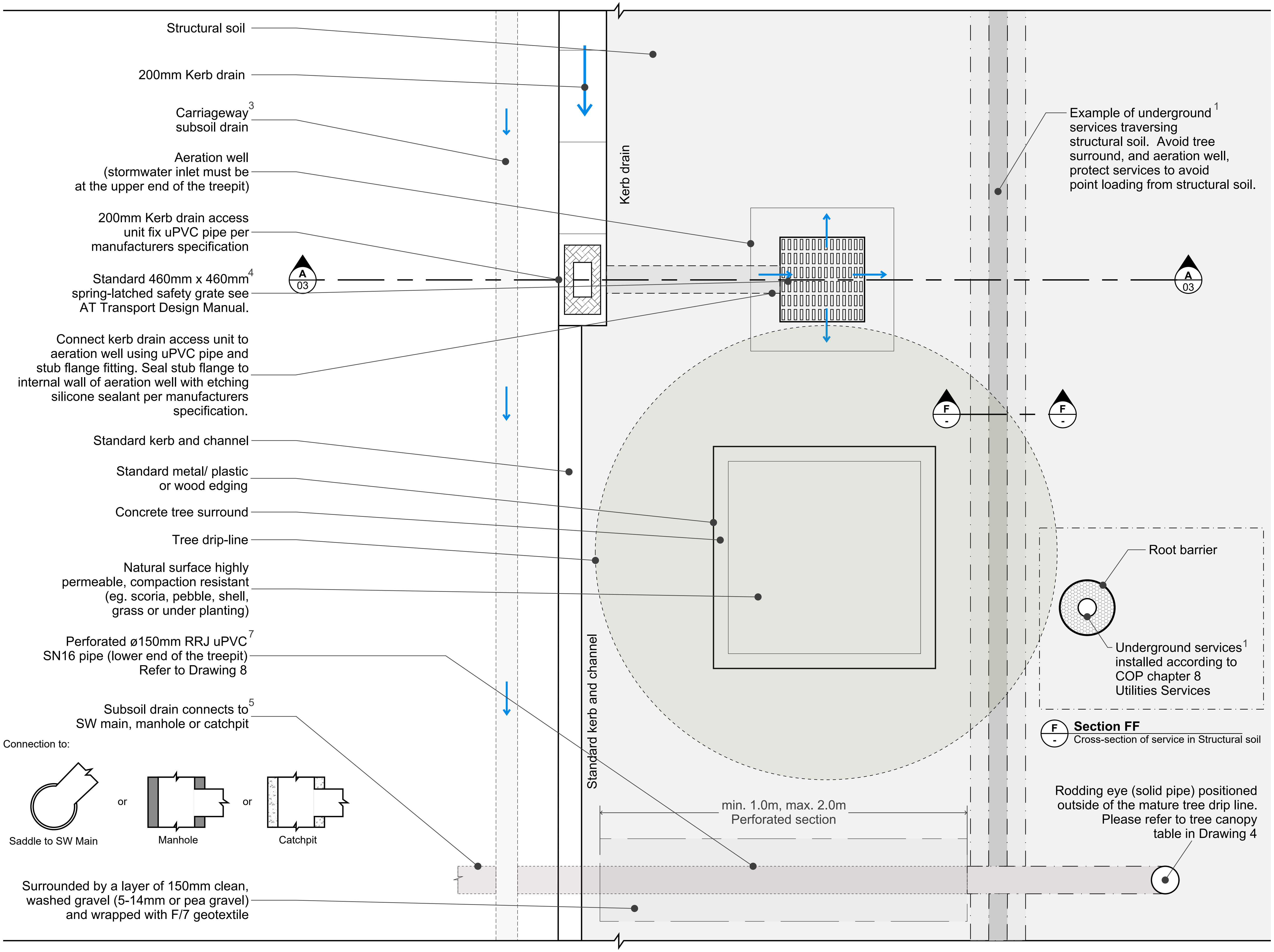
4.0 Appendices

DRAWING NO:	01	SCALE:	NTS @ A3
DRAWING SET:	v6.0	DATE:	29-10-2025
REVISION:	00		

DRAWING TITLE:

Example Structural Soil Tree Pit Setting

Auckland Council
Te Kaunihera o Tāmaki Makaurau



References:
1. CoP Chapter 8 Utilities Services(to be released)
2. NZTA TNZ F/07
3. AT Urban Roading Typical Section - Drawing 2008/0102
4. AT Transport Design Manual Technical Standards
5. Stormwater Code of Practice - SW04
6. AC Treepit Construction Guide
7. NZTA F2:2013 - Sub-Soil drain Construction

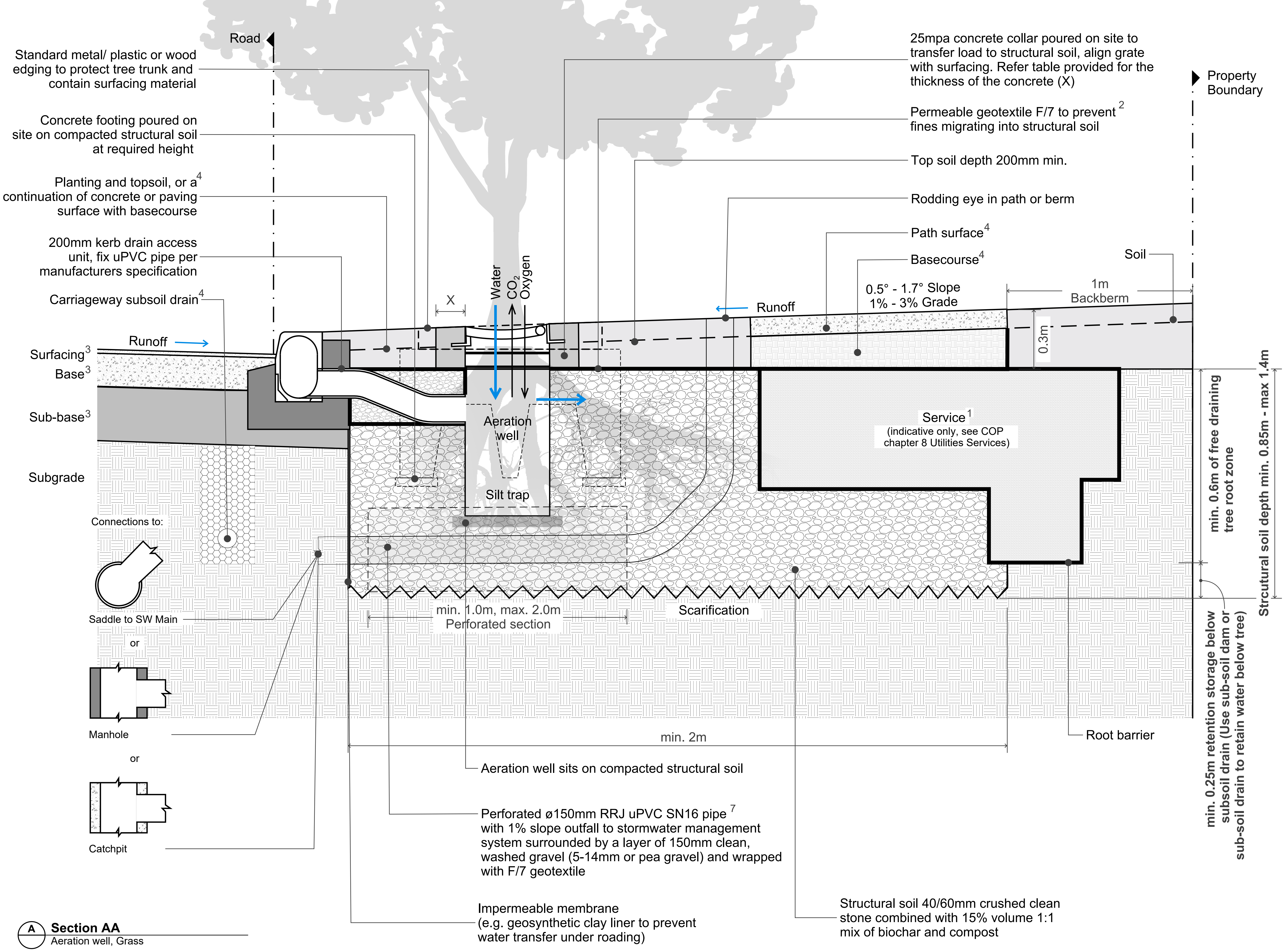
Notes:
All infrastructure associated with structural soil treepits shall be designed to suit their intended application, ensuring vehicular trafficability where required, cycling compatibility, and pedestrian safety free from trip hazards.

DRAWING NO:	02	SCALE:	1:20 @ A3
DRAWING SET:	v6.0	DATE:	29-10-2025
REVISION:	00		

DRAWING TITLE:

SSTP Plan View

Auckland Council
Te Kaunihera o Tāmaki Makaurau



References:
1. CoP Chapter 8 Utilities Services(to be released)
2. NZTA TNZ F/07
3. AT Urban Roading Typical Section - Drawing 2008/0102
4. AT Transport Design Manual Technical Standards
5. Stormwater Code of Practice - SW04
6. AC Treepit Construction Guide
7. NZTA F2:2013 - Sub-Soil drain Construction

Thickness of Concrete Collar

Load Rating	X
AS 3996 Class A - B	100 mm
AS 3996 Class C - D	150 mm
AS 3996 Class E - G	200 mm

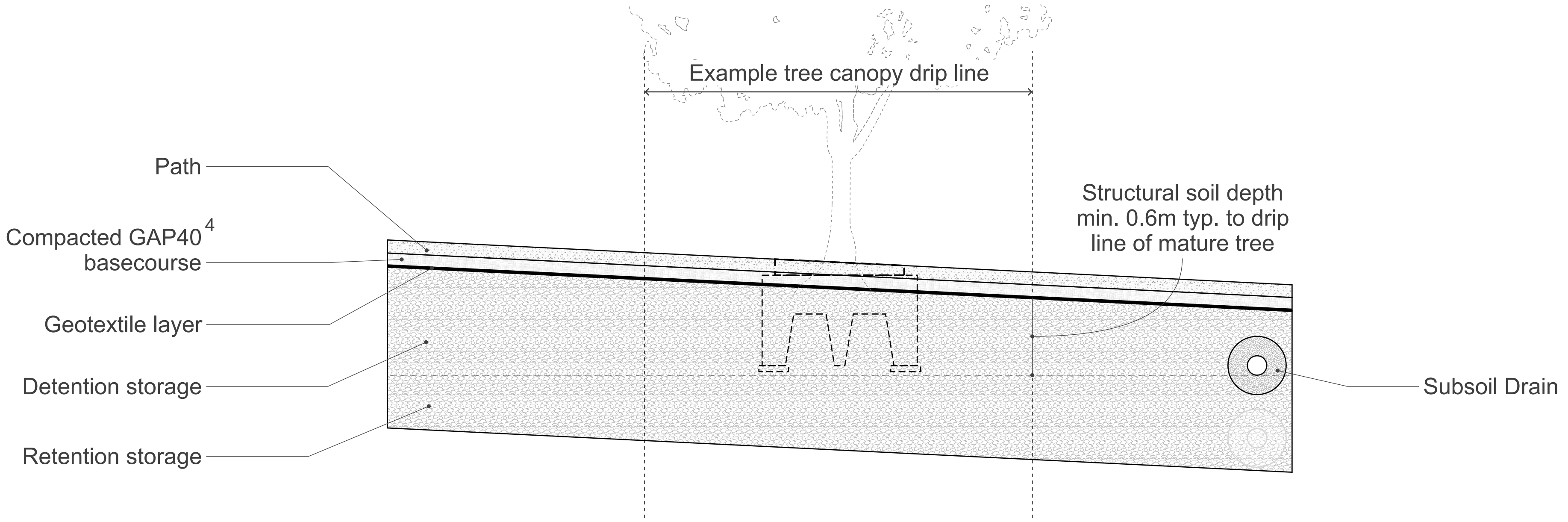
DRAWING NO: 03
DRAWING SET: v6.0
REVISION: 00

SCALE: 1:20 @ A3
DATE: 29-10-2025

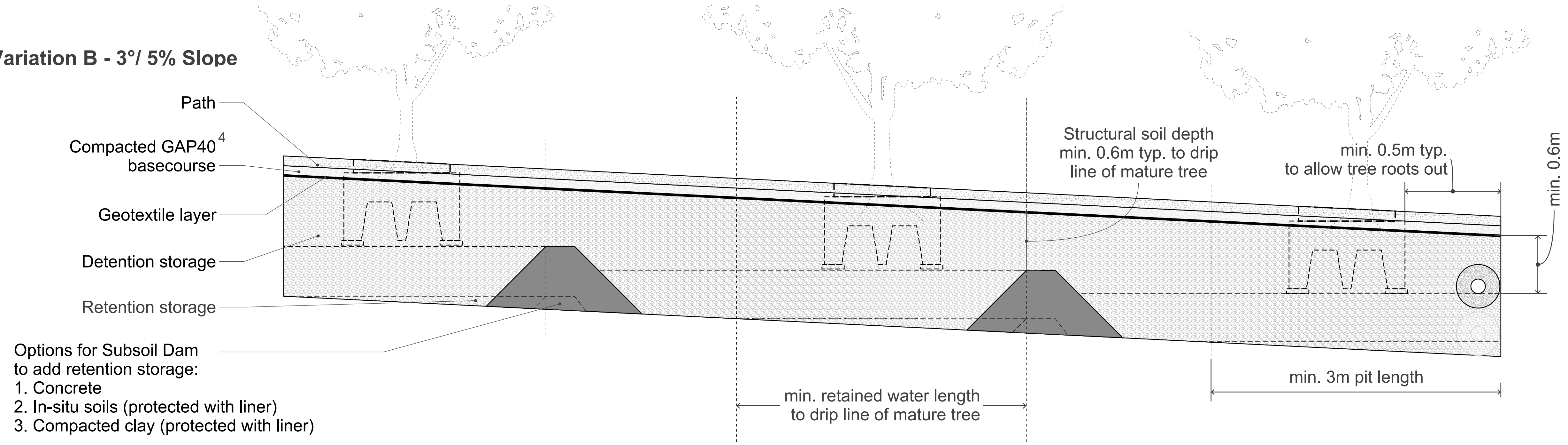
DRAWING TITLE:
SSTP Section AA

Auckland Council
Te Kaunihera o Tāmaki Makaurau

Variation A - 3°/ 5% Slope

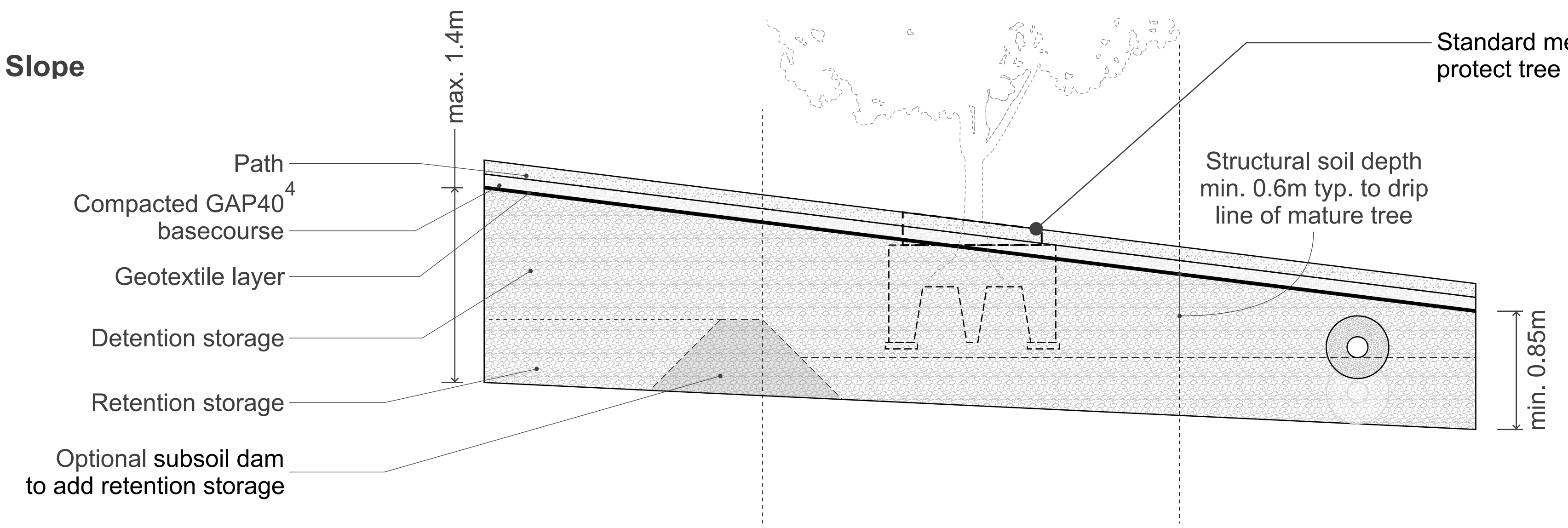


Variation B - 3°/ 5% Slope



References:
1. CoP Chapter 8 Utilities Services(to be released)
2. NZTA TNZ F/07
3. AT Urban Roading Typical Section - Drawing 2008/0102
4. AT Transport Design Manual Technical Standards
5. Stormwater Code of Practice - SW04
6. AC Treepit Construction Guide
7. NZTA F2:2013 - Sub-Soil drain Construction

Variation C - 7°/ 12.5% Slope



Structural soil tree pit tree size, soil volume and Aeration well requirements					
	Very Small	**Small**	**Medium**	**Large**	**Massive**
Tree height	< 5m	5m - 10m	10m - 15m	15m - 25m	25m <
Tree canopy Dia.	3m	5m	8m	13m	18m
Structural soil volume per tree	8m³ (6m³ shared)	15m³ (12m³ shared)	26m³ (20m³ shared)	36m³ (28m³ shared)	45m³ (35m³ shared)
Aeration well inlets	1 (0.5 shared)	1 (0.5 shared)	1	2 (1.5 shared)	2
Note: Second aeration wells for larger trees do not need a stormwater inlet system.					

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SCALE: **1:50 @ A3**
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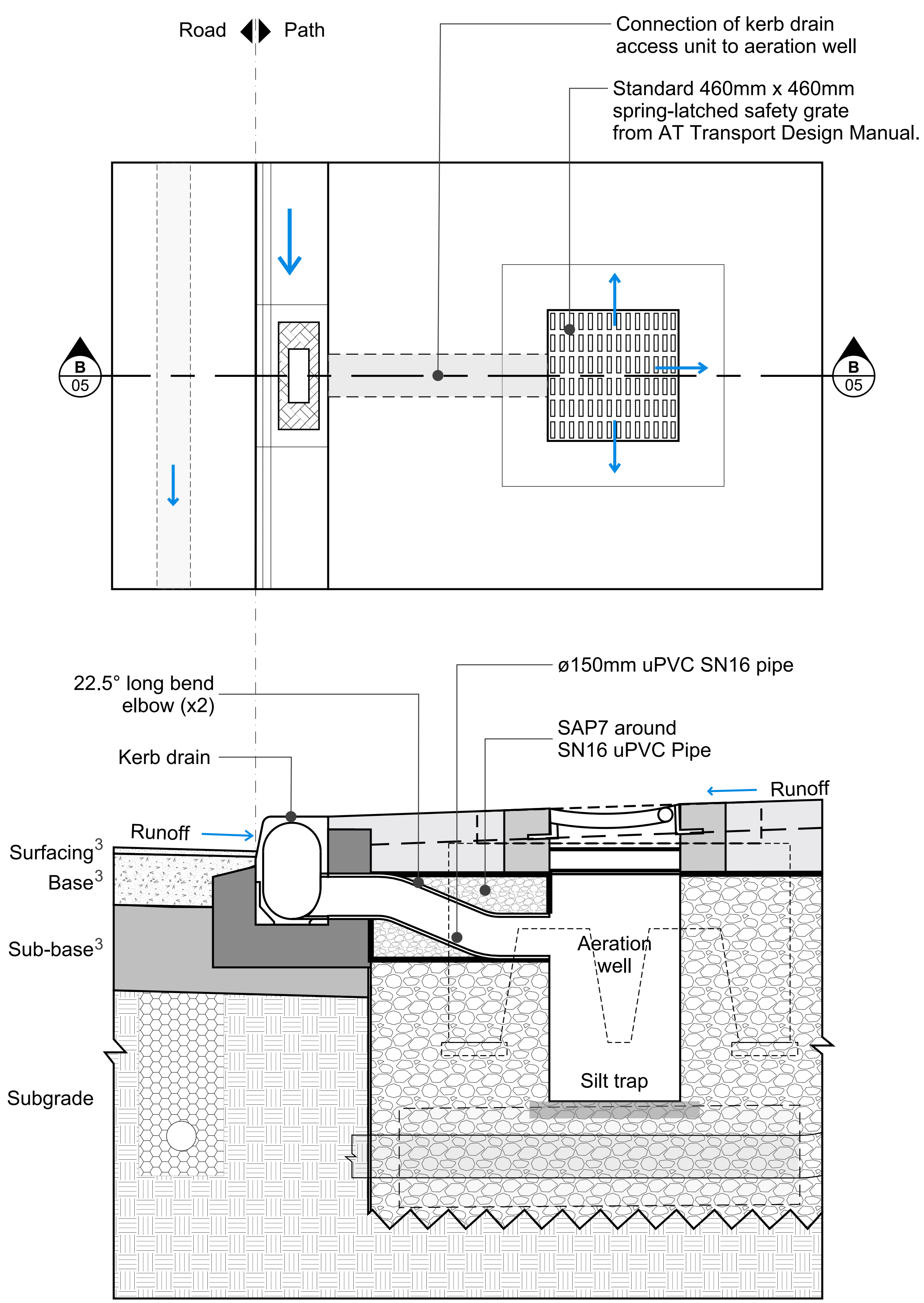
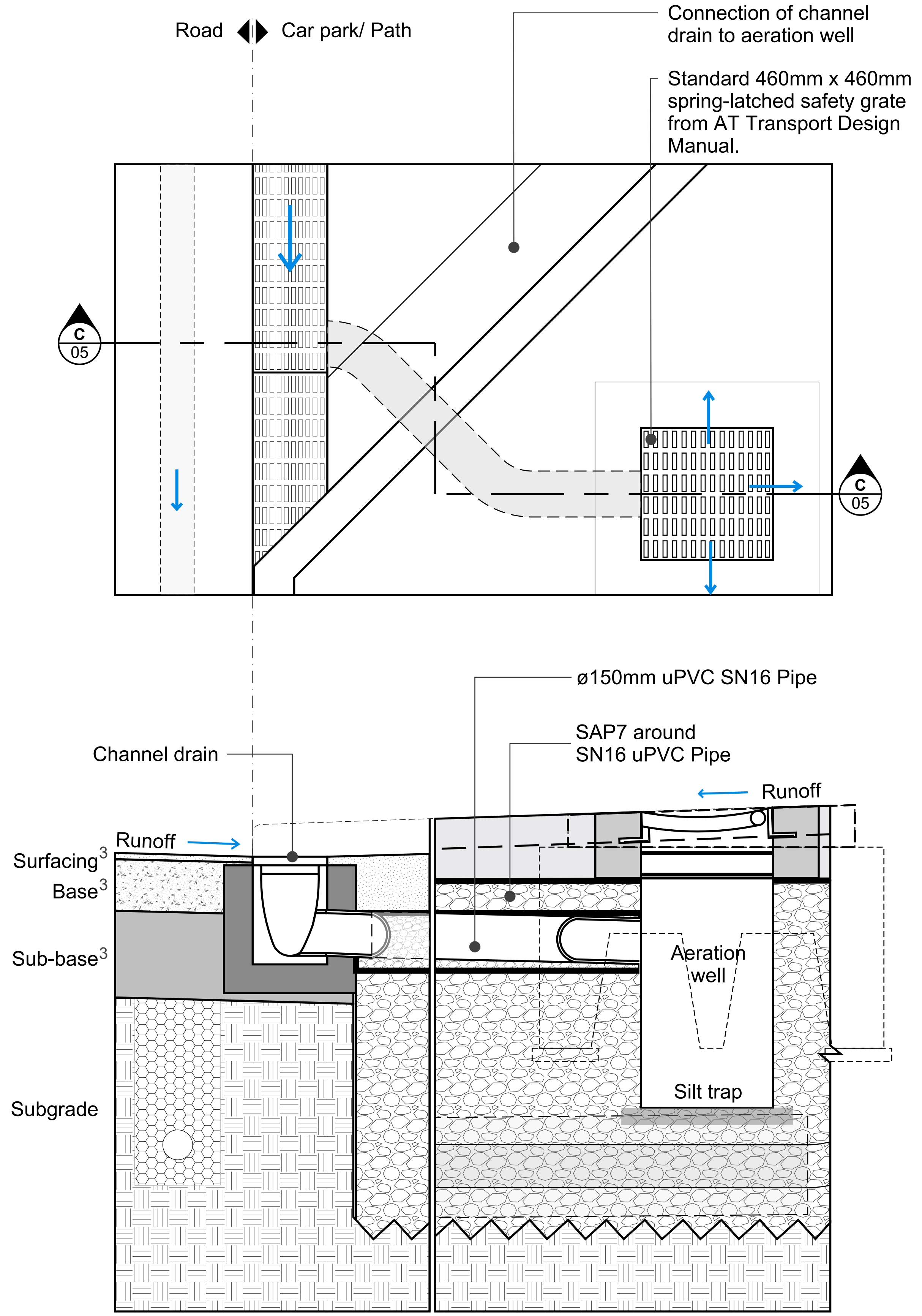
DRAWING TITLE:
SSTP Slope Examples

Auckland Council
Te Kaunihera o Tāmaki Makaurau



B **Inlet System 01**
Standard Street



C **Inlet System 02**
On-Street Carpark

References:
1. CoP Chapter 8 Utilities Services(to be released)
2. NZTA TNZ F/07
3. AT Urban Roading Typical Section - Drawing 2008/0102
4. AT Transport Design Manual Technical Standards
5. Stormwater Code of Practice - SW04
6. AC Treepit Construction Guide
7. NZTA F2:2013 - Sub-Soil drain Construction

Notes:
Please refer to Auckland Transport Design Manual for requirements for carpark pavement details.

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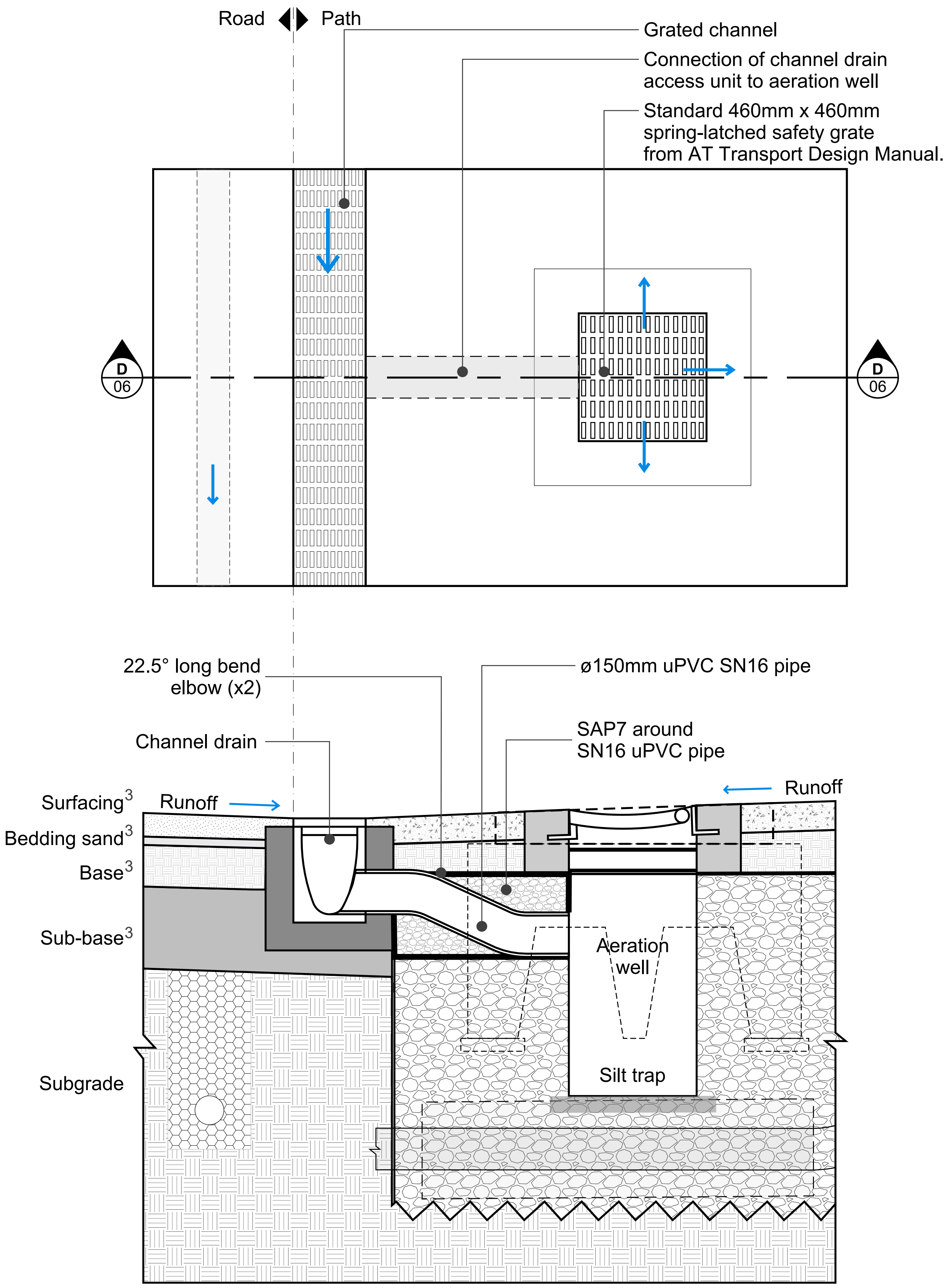
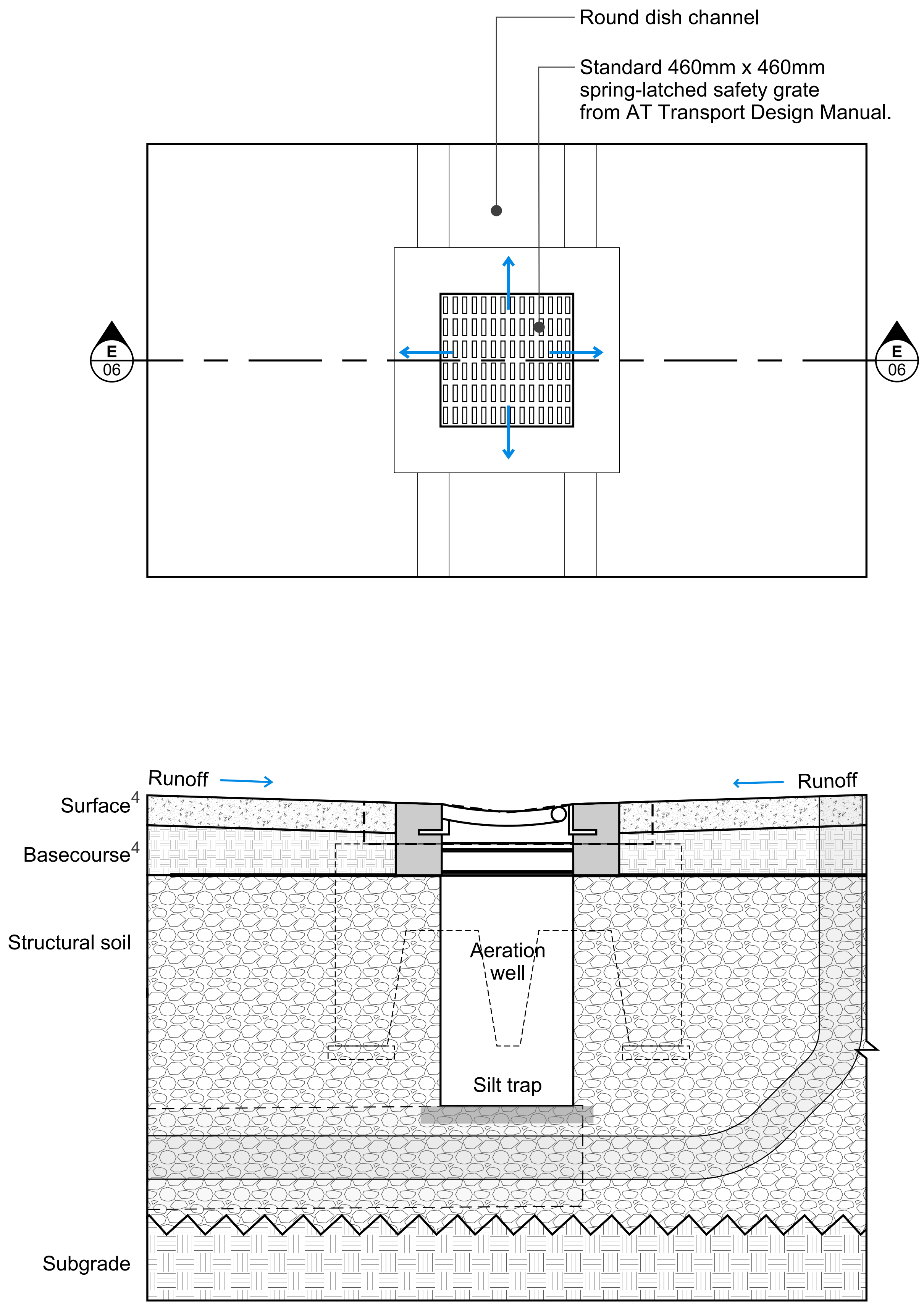
DATE: **29-10-2025**

DRAWING TITLE:
SSTP Inlet Systems 01

Auckland Council
Te Kaunihera o Tāmaki Makaurau



D **Inlet System 03**
Shared Street



E **Inlet System 04**
Town Square/ where no kerb or channel inlet system is required

References:
1. CoP Chapter 8 Utilities Services(to be released)
2. NZTA TNZ F/07
3. AT Urban Roading Typical Section - Drawing 2008/0102
4. AT Transport Design Manual Technical Standards
5. Stormwater Code of Practice - SW04
6. AC Treepit Construction Guide
7. NZTA F2:2013 - Sub-Soil drain Construction

Notes:
Please refer to Auckland Transport Design Manual for requirements for carpark pavement details.

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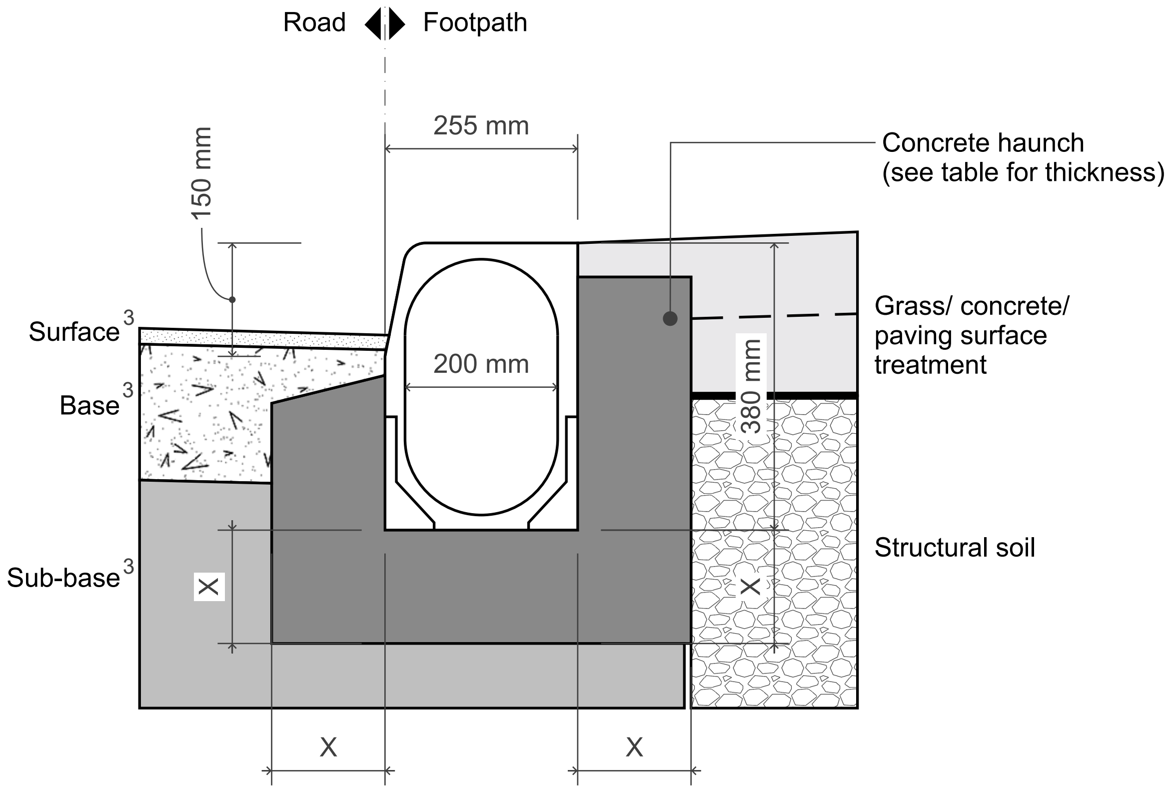
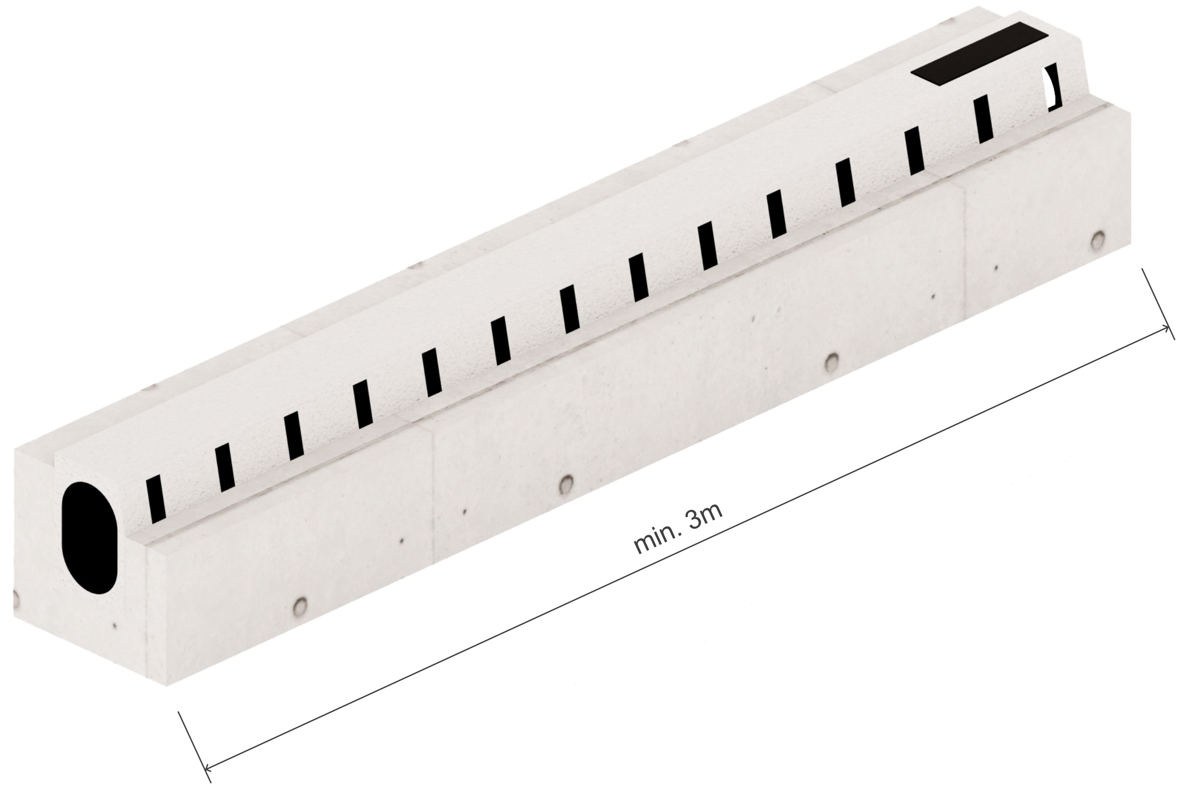
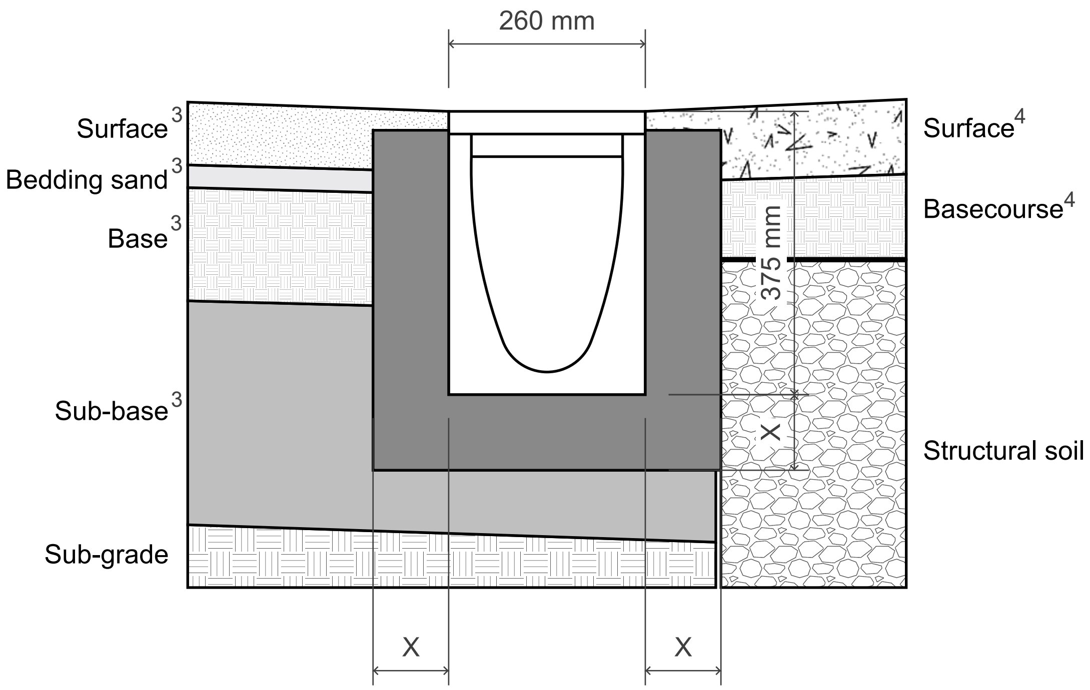
DRAWING TITLE:
SSTP Inlet Systems 02

Te Kaunihera o Tāmaki Makaurau

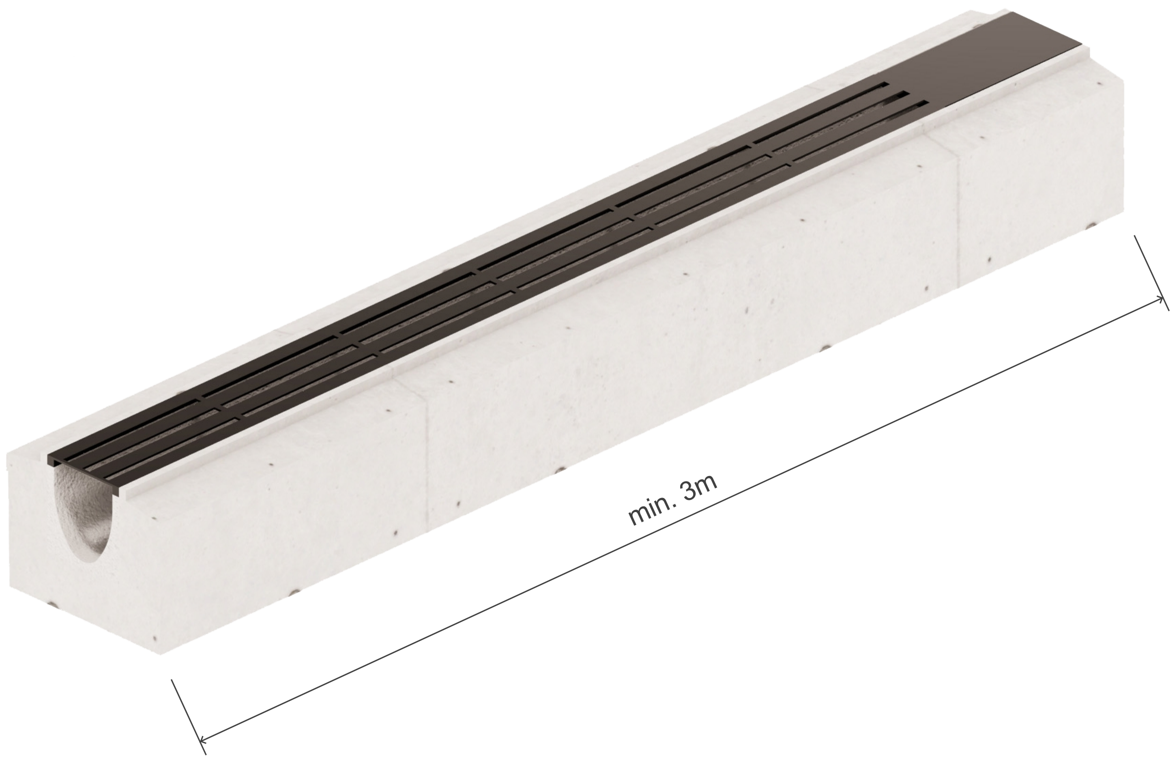


A **Inlet Detail 01**
Kerb drain





B **Inlet Detail 02**
Channel drain



References:
1. CoP Chapter 8 Utilities Services(to be released)
2. NZTA TNZ F/07
3. AT Urban Roading Typical Section - Drawing 2008/0102
4. AT Transport Design Manual Technical Standards
5. Stormwater Code of Practice - SW04
6. AC Treepit Construction Guide
7. NZTA F2:2013 - Sub-Soil drain Construction

Notes:
For haunching and concrete details please refer to manufacturer's specifications and drawings.

Thickness of Concrete Haunch

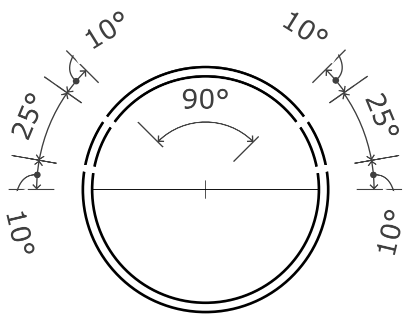
Load Rating	X
AS 3996 Class A - B	100 mm
AS 3996 Class C - D	150 mm
AS 3996 Class E - G	200 mm

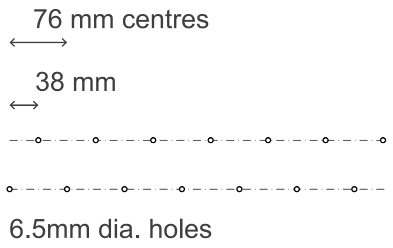
DRAWING NO: **07**
DRAWING SET: **v6.0**
REVISION: **00**

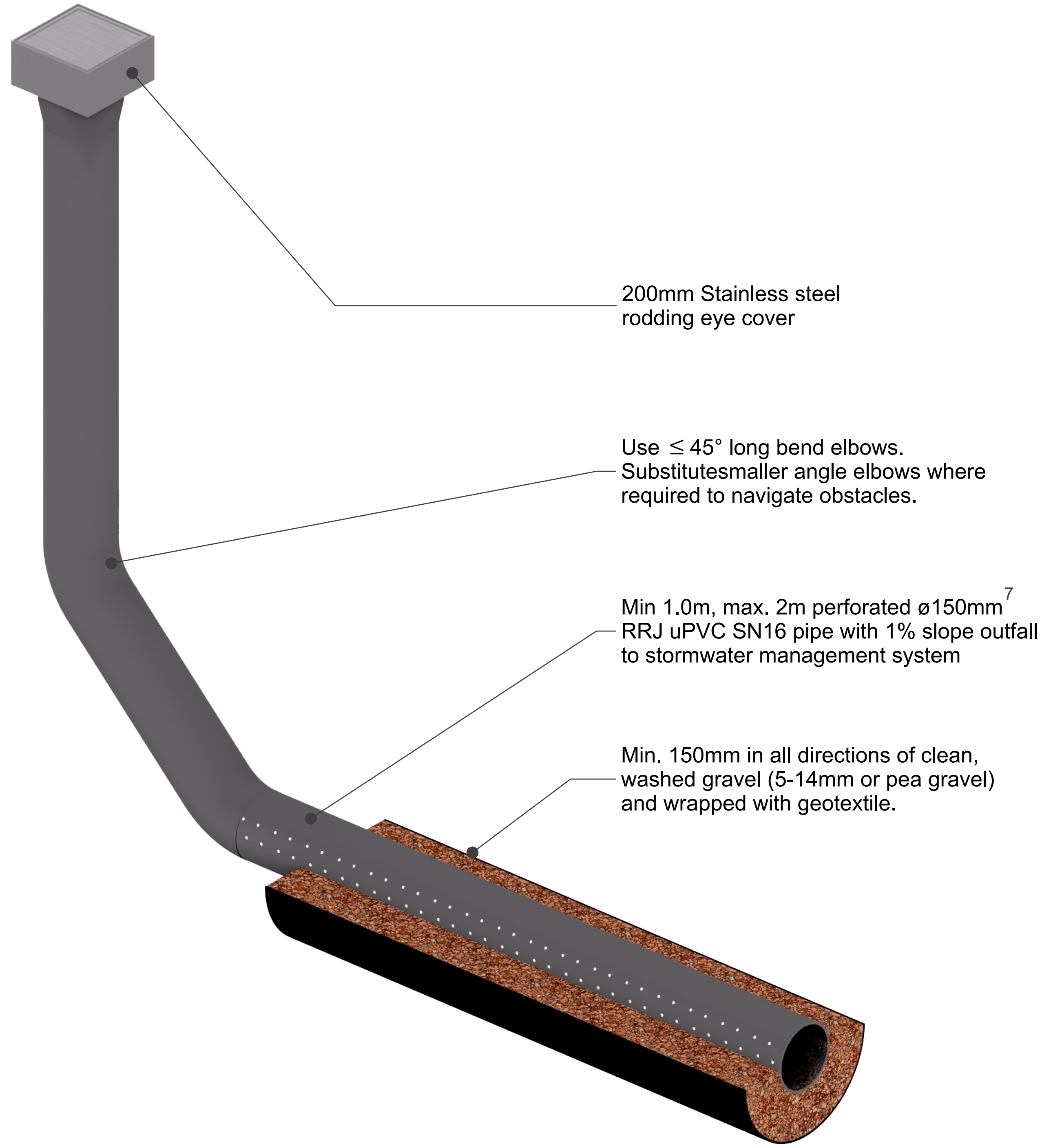
SCALE: **1:10 @ A3**
DATE: **29-10-2025**

DRAWING TITLE:
SSTP Inlet Details 01

Auckland Council
Te Kaunihera o Tāmaki Makaurau







C Inlet Detail 03
Rigid pipe sub-soil drain

References:
1. CoP Chapter 8 Utilities Services(to be released)
2. NZTA TNZ F/07
3. AT Urban Roading Typical Section - Drawing 2008/0102
4. AT Transport Design Manual Technical Standards
5. Stormwater Code of Practice - SW04
6. AC Treepit Construction Guide
7. NZTA F2:2013 - Sub-Soil drain Construction

DRAWING NO: **08**
DRAWING SET: **v6.0**
REVISION: **00**

SCALE: **1:10 @ A3**
DATE: **29-10-2025**

DRAWING TITLE:
Subsoil Drain

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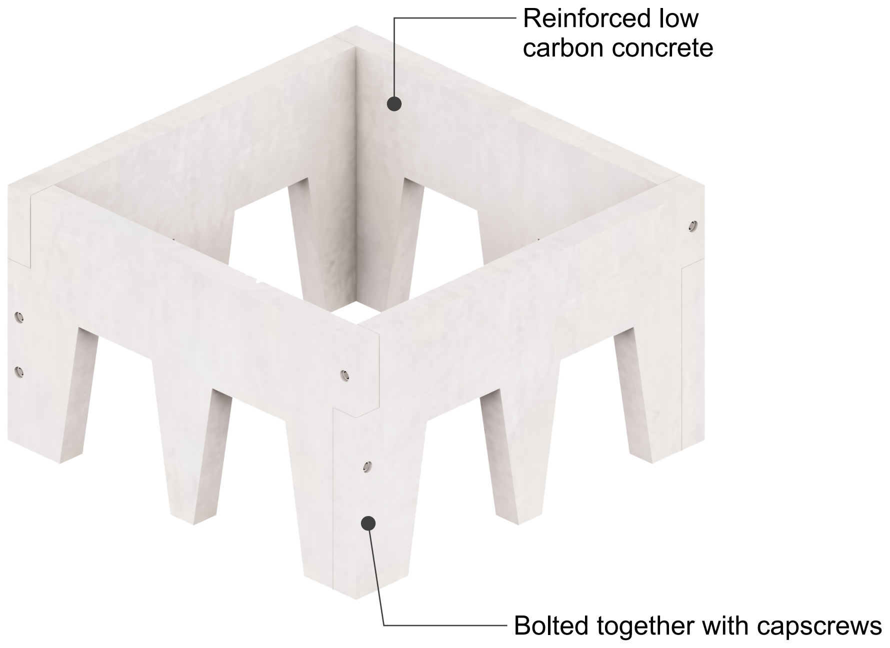
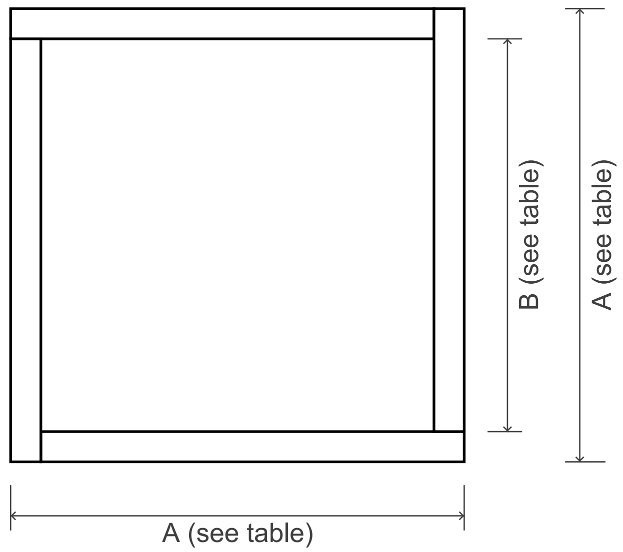
Te Kaunihera o Tāmaki Makaurau





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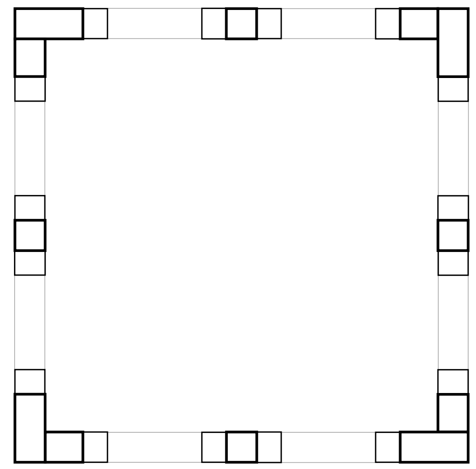
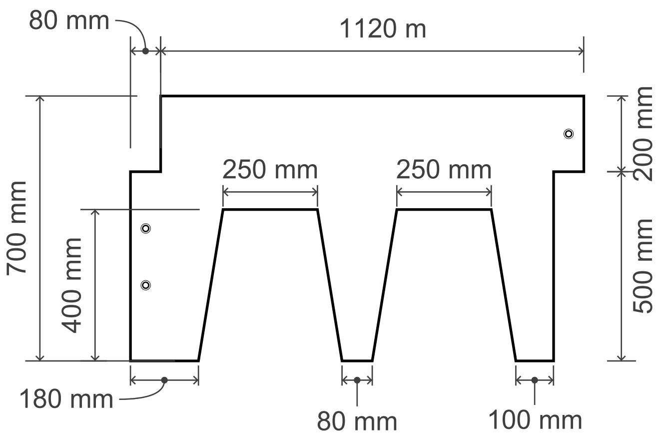
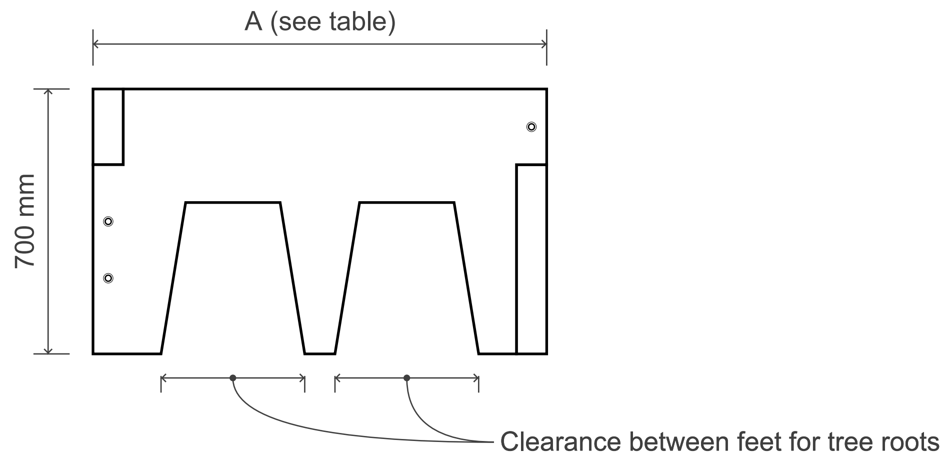


Base

Example component dimensions for Option 01



Component View



Side View (typ.)

References:
1. CoP Chapter 8 Utilities Services(to be released)
2. NZTA TNZ F/07
3. AT Urban Roading Typical Section - Drawing 2008/0102
4. AT Transport Design Manual Technical Standards
5. Stormwater Code of Practice - SW04
6. AC Treepit Construction Guide
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Notes:
Example Tree Surround for dimensions used in these designs.

If the Tree Surround is supplied in sections, they should be bolted together.

Tree surround size options			
	Option 01	**Option 02**	**Option 03**
Total Width (mm) - A	1200	1700	2200
Inner Width (mm) - B	1040	1540	2040

DRAWING NO: **09**
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DRAWING TITLE:
Tree Surround

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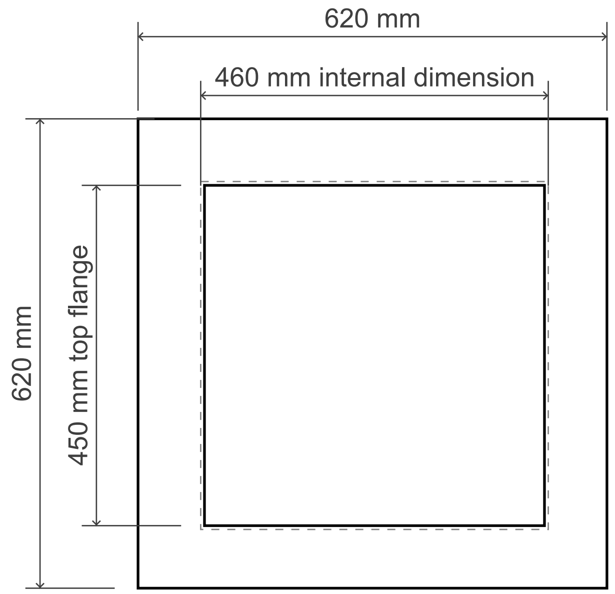
Te Kaunihera o Tāmaki Makaurau



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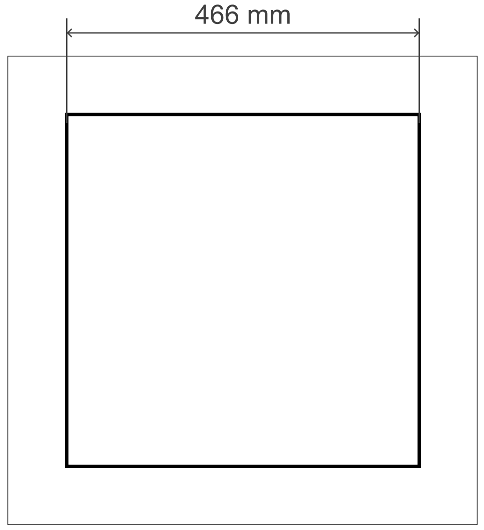

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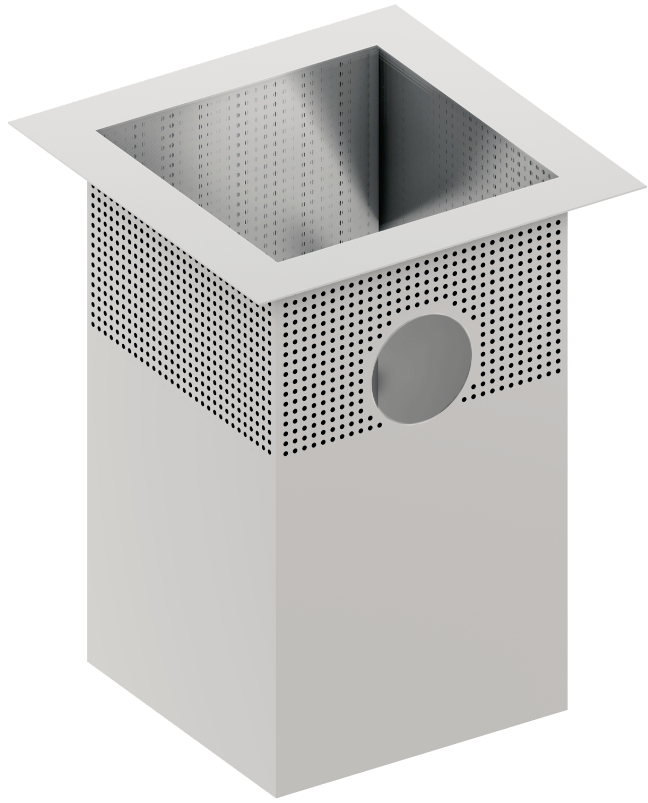
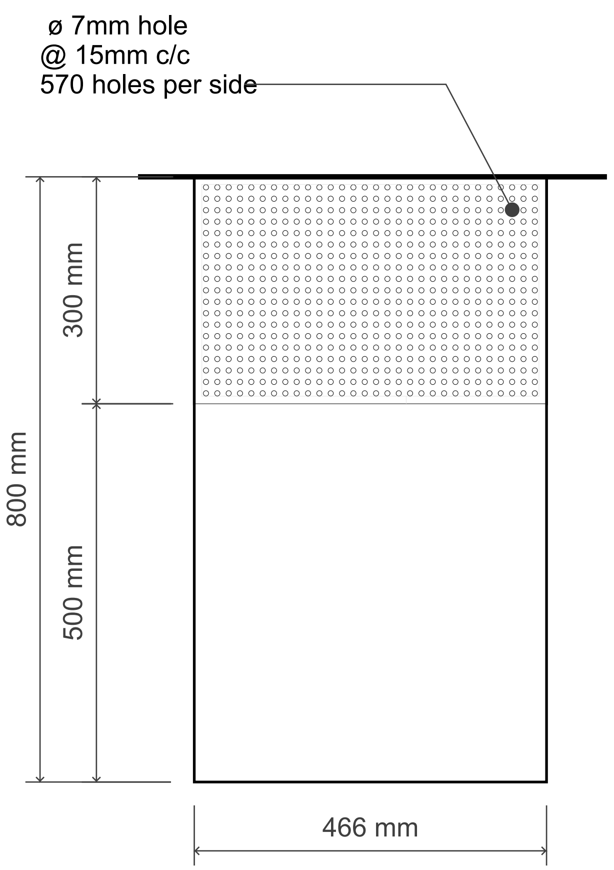
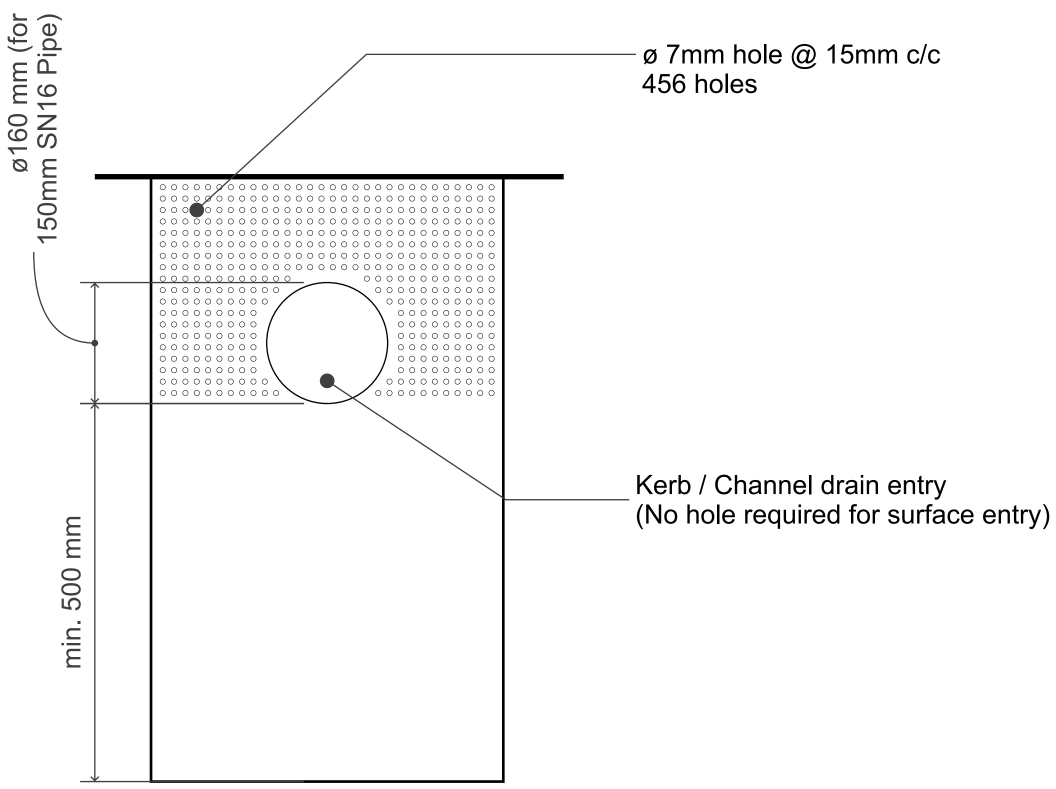




Side A, C & D



Side B

References:
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4. AT Transport Design Manual Technical Standards
5. Stormwater Code of Practice - SW04
6. AC Treepit Construction Guide
7. NZTA F2:2013 - Sub-Soil drain Construction

Notes:
3.2mm (min) 304 stainless steel Aeration well.
Flange not intended to be load-bearing. Load is transferred via concrete spacer to Structural soil.

Aeration well is laser cut and seam welded at the corners as a standard item.

Fits a standard 460mm x 460mm Spring-latched safety grate from AT Transport Design Manual.

DRAWING NO: **10**
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REVISION: **00**

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DRAWING TITLE:
Aeration well

Auckland Council
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