South East New Territories (SENT) Landfill Extension

Restoration and Ecological Enhancement Plan

PREPARED FOR

翠谷工程有限公司
Green Valley Landfill, Limited

Green Valley Landfill Ltd

DATE
16 January 2026

REFERENCE
0465169

翠谷工程有限公司
Green Valley Landfill, Limited

South East New Territories (SENT) Landfill Extension

Environmental Certification Sheet
EP-308/2008/D and FEP-01/308/2008/D

Reference Document/Plan

Document/Plan to be Certified/Verified:	Restoration and Ecological Enhancement Plan for South East New Territories (SENT) Landfill Extension
Date of Report:	16 January 2026

Reference EP Condition

EP Condition:	Condition No. 2.6

Within six months after the commencement of construction of the Project, four hard copies and one electronic copy of a coherent restoration and ecological enhancement plan shall be submitted to the Director for approval showing details of restoration measures for the extension site including provision of 6 hectares of mixed woodland planting composting of about 20% non-native tree species to compensate the loss of shrubland and a mosaic of grassland and shrubland in the remaining areas of the extension. The plan(s), of scale 1 to 1000 or other appropriate scale as agreed by the Director, shall include details on locations, size, number and species of planting, implementation programme, maintenance and management schedules. The submission shall be certified by the ET Leader and verified by the IEC as conforming to the information, requirements and recommendations set out in the approved EIA Report. All measures recommended in the approved restoration and ecological enhancement plan(s) shall be fully and properly implemented in accordance with the details and programme set out in the submission.

ET Certification

I hereby certify that the above referenced document/plan complies with the above referenced EP requirement.

Terence Fong,
Environmental Team Leader,
ERM-Hong Kong, Limited

Date: 16 January 2026

IEC Verification

I hereby verify that the above referenced document/plan complies with the above referenced EP requirement.

Claudine Lee,
Independent Environmental Checker,
Meinhardt Infrastructure and Environment Ltd

Date: 20 January 2026

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South East New Territories (SENT) Landfill Extension

Restoration and Ecological Enhancement Plan

0465169

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1. INTRODUCTION

1.1 BACKGROUND

The SENT Landfill Extension (SENTX) forms an integral part in the Strategic Plan in maintaining the continuity of landfill capacity in the Hong Kong for the cost-effective and environmentally satisfactory disposal of waste. The Environmental Impact Assessment (EIA) Report and the associated Environmental Monitoring and Audit (EM&A) Manual for the construction, operation, restoration and aftercare of the SENTX (hereafter referred to as "the Project") have been approved under the Environmental Impact Assessment Ordinance (EIAO) in May 2008 (Register No.: AEIAR-117/2008) (hereafter referred to as the approved EIA Report) and an Environmental Permit (EP-308/2008) (EP) was granted by the Director of Environmental Protection (DEP) on 5 August 2008.

Since then, applications for Variation of an Environmental Permit (No. VEP-531/2017) were submitted to EPD and the Variation of Environmental Permits (EP-308/2008/A and EP-308/2008/B) were granted on 6 January 2012 and 20 January 2017, respectively, as the Hong Kong SAR Government has decided to reduce the scale of the design scheme of SENTX assessed in the approved EIA Report and SENTX will only receive construction waste. In May 2018, a Further Environmental Permit (FEP) (FEP-01/308/2008/B) was granted to the SENTX's contractor, Green Valley Landfill, Limited (GVL). Thereafter, Variation of Environmental Permits (EP-308/2008/C and FEP-01/308/2008/C) were granted to the Environmental Infrastructure Division of EPD and GVL in February 2024. Following that, Variation of Environmental Permits (EP-308/2008/D and FEP-01/308/2008/D) were granted to the Environmental Infrastructure Division of EPD and GVL in April 2025 regarding updates to the extension of the waste boundary of the SENTX area.

Per requirement of EP Condition 2.6, the Permit Holder shall, within six months after the commencement of construction of the Project, submit a coherent Restoration and Ecological Enhancement Plan (REEP) to the Director for approval. The submissions shall be certified by the Environmental Team (ET) Leader and verified by the Independent Environmental Checker (IEC).

ERM was appointed by GVL to prepare the REEP ("REEP") in accordance with Environmental Permit (EP-308/2008/D and FEP-01/301/2008/D) Condition 2.6, "a coherent restoration and ecological enhancement plan shall be submitted to the Director for approval showing details of restoration measures for the extension site…".

1.2 PURPOSE OF THE RESTORATION AND ECOLOGICAL ENHANCEMENT PLAN FOR SENTX

The purpose of this REEP for SENTX development is to show the details of restoration measures for the SENTX site including:

- provision of 6 hectares of mixed woodland planting composting of about 20% non-native tree species[1] to compensate the loss of shrubland and a mosaic of grassland and shrubland in the remaining areas of the extension;

1 The feasibility of 20% non-native species will be confirmed in accordance with the result of the trial nursery referring to EP Condition 2.7. Noting that this ratio was not reachable in the current SENT Landfill.

- plan(s), of scale 1 to 1000 or other appropriate scale as agreed by the Director, shall include details on locations, size number and species of planting; and
- implementation programme, maintenance and management schedules.

All measures recommended in the approved REEP shall be fully and properly implemented based on the details and programme set out in this submission.

Under the requirement of *Condition 2.6* of the FEP, the REEP shall be prepared and submitted to the DEP within six months after the commencement of construction of the Project.

1.3 STRUCTURE OF THE RESTORATION AND ECOLOGICAL ENHANCEMENT PLAN FOR SENTX

The remainder of the *REEP for SENTX* is structured as follows:

- *Section 2* presents the existing conditions and environment of the site;
- *Section 3* presents the requirements and approach to develop the REEP;
- *Section 4* presents the details of the REEP; and
- *Section 5* presents the implementation program, maintenance and management of the REEP.

2. CONDITIONS AND ENVIRONMENT OF THE SITE

2.1 SITE LOCATION

The SENTX is a piggyback landfill, located on the western side of the Clear Water Bay Peninsula without additional encroachment into the Clear Water Bay Country Park (CWBCP), occupying the southern part of the existing SENT Landfill and 13 ha of Tseung Kwan O (TKO) InnoPark (Area 137). A layout plan of the SENTX is shown in *Figure 2.1*.

2.2 TOPOGRAPHY AND LANDFORM

The geology of the peninsula is variable, comprising rocks of the Middle and Lower Jurassic Periods (pyroclastic rocks and acidic lavas) as well as smaller outcrops of granitic rocks and deposits of colluvium. This forms a rugged mountainous ridge (up to ~ 340mPD) along the Clearwater Bay Peninsula which falls steeply into the sea, occasionally forming steep cliffs. In addition, this ridge sends out lateral spurs towards the coast forming a series of steep-sided coves and bays.

The ridge, composed of alternate peaks and saddles, is angular and rugged in appearance, generally vegetated, but with rocky outcrops, especially around the tops of peaks. A feature of some importance to the SENT and SENTX sites is the saddle of land, formed between the two peaks of Ha Shan Tuk and Tin Ha Shan, which is a viewing point for a number of recreational users of the area. A number of small streams drain off the line of hills forming the peninsula, down shallow gullies formed in the hillsides and thence into Junk Bay.

The SENT/ SENTX Landfill site lies in and around what used to be Shek Miu Wan, a cove within Junk Bay. Junk Island (Fat Tong Chau) lies off Shek Miu Wan (see *Figure 2.1*). The Island is steep-sided, rising to 99mPD and plunging sharply into the sea. It is generally rocky with a patchy covering of shrub and trees. The infrastructure contract which preceded the SENT/ SENTX landfills has now joined Junk Island to the peninsula itself, effectively reclaiming the cove of Shek Miu Wan and turning the island into a rocky promontory (see *Figure 2.1*).

The SENT/ SENTX landfill, when completed, will together cover approximately 116 ha, of which about 50 ha will be reclaimed from Shek Miu Wan. It will form an extension to the lower hillsides of the western side of Clearwater Bay Peninsula.

Two footpaths pass close to the landfill sites (see *Figure 2.1*). One, formerly the land access to the two villages around the cove, runs from the car park at Clear Water Bay Second Beach over the saddle of land above the landfill site. From here, there are views down to the coast as well as over Junk Bay.

In addition, the High Junk Peak Hiking Trail, which is a much-used hill walking route, runs along the ridgeline down the centre of the peninsula and the new recreational facility on the site should have regard to the Trail and seek to create links with it in order to establish a comprehensive network of recreational facilities throughout the peninsula.

2.3 CLIMATE AND MICROCLIMATE

The SENT/ SENTX landfill sites lie on an exposed area of Hong Kong's south-east coast, which take the full force of Hong Kong's prevailing south-westerly winds between the months of August and June. This important factor has informed and guided the design of the restored areas. Mean annual rainfall is between 2,000mm and 2,400mm per year. Monthly mean temperatures are between approx. 14 degrees Celsius (January) and approx. 28 degrees Celsius (July), with mean monthly relative humidity varying between approx. 69% (December) to 83% (June).

Planting on areas of higher ground demonstrates the extent to which exposure to winds can inhibit plant establishment. Vegetation establishes less well on upper slopes that are not south or west facing, except in gullies or ravines. On lower slopes, more tree and shrub vegetation becomes established, since these areas are often less exposed.

The REEP seeks both to take cognisance of these conditions, optimise the establishment of vegetation as well as creating conditions that will be conducive to informal recreational activities which benefit from more sheltered locations. Planting and landform should be exploited to create a microclimate that will provide shelter over limited areas for picnic and other low-key informal activities.

2.4 VEGETATION AND ECOLOGY

A baseline vegetation assessment was carried out around Shek Miu Wan as part of the SENTX EIA (Section 9.7). The assessment identified five types of flora/ habitat in their study area at the SENTX site as follows:

Plantation

A total of 14 exotic species were found located within the boundary of the existing SENT Landfill and all of them are common species in Hong Kong. The plantation is largely exotic woodland, dominated by the tree species *Acacia confusa* with tree height around 3 to 5 meters and planted as part of the existing SENT Landfill restoration. In the meanwhile, the woodland is young in age and the understorey is occupied by weeds species such as *Leucaena leucocephala, Bridelia tomentosa, Lantana camara* and *Miscanthus sinensis* etc.

Shrubland

Shrubland habitat can be found on the hillsides located within the CWBCP in a continuous patch approximately 75.3 ha. The shrubland has a rocky substrate with evidence of occasional disturbance by hill fires. Shrubland found in the valleys are taller, usually 2m to 3m height while they are shorter on hill slopes, generally 0.3m to 1.5m height. There are 80 species were recorded which are commonly found in Hong Kong. The Shrubland is dominated by several native species, including *Rhaphiolepis indica, Rhodomrytus tomensora, Cratoxylum cochinchinense, Eurya nitida, Embelia laeta, Embelia ribes* and *Gardenia jasminoides.*

Grassland

Grassland was recorded at the southeast part of the SENTX area mainly located within the CWBCP (around 19.7 ha.). The grassland is found on the rocky hills and ridges and is occasionally disturbed by hill fire. A total of 30 species, including grassy and shrubby plants, were found in the habitat, all of which are common species in Hong Kong. The grassland was dominated by *Ischaemum aristatum, Rhynchelytum repens* and *Scleria harlandi*. For shrub species, *Wikstroemia chinensis, Rhus succedanea* and *Mimosa pudica* predominated.

Seasonal Stream

There were two seasonal streams found within the vicinity of SENTX area. One is located at Ha Shan Tuk and the other is located at Hin Ha Au. Both are small seasonal streams with limited water flows during the wet season and no water flow during dry season.

Disturbed/ Developed Areas

Disturbed area is the dominant habitat within the vicinity of SENTX, including TKO Area 137, TKOIE and the existing SENT Landfill. The total area is around 171.2ha. This habitat is highly disturbed with limited vegetation cover, and the plant species are commonly found in Hong Kong (mostly for landscape purpose). There are a total of 22 plant species dominated by weeds and landscape species, such as *Acacia auriculiformis* and *Leucaena leucocephala*.

2.5 THE SENT LANDFILL RESTORATION

The SENT Landfill restoration was produced following the SENT Landfill Final Restoration Landscape Masterplan Design Report (December 1996) and is shown in *Figure 2.2*. In Chapter 4 of the report, the objective of the restoration stated that:

…it was envisaged that the afteruse of the site would be as an informal recreational facility. Such a facility would complement recreational activity in Clear Water Bay Country Park. Only after the complete landfilling and restoration of the site would it be opened to the public.

It is likely that the restored site will act as a dual facility. With a car park perhaps located on the site of the current infrastructure area, visitors could either use the site as a transitional area permitting access to Clear Water Bay Country Park, or as a recreational facility in its own right. It is perceived that the facility should cater for the following activities:

- *Hiking and strolling;*
- *Mountain biking;*
- *Picnics;*
- *Kite and model aeroplane flying;*
- *Sitting out and taking in views of the seascape and landscape.*

The masterplan seeks to provide a range of visitor experiences, with woodland, shrub *and open grassland areas. It aims to create a variety of spatial scales and degrees of enclosure and intimacy. There are sitting areas where individuals or groups can gain some privacy as well as open meadows for activities where more space is required, such as kite flying. In particular, the value of the new peaks and high areas is maximised by locating pavilions on their summits, which can then be used as sitting areas or viewpoints.*

The landform as designed consists of a curved spur of land which runs down to the coast at gradients of 1:3, typical of gradients found elsewhere in the area. This spur leaves the uplands of the peninsula and turns west and south falling in a series of three high points. On the southern/ eastern side of the site, a ravine is created where the landfill site meets the former coast. At all points, the landform relates closely to the topography of the former coast, so that the landfill site appears as a natural extension of the landscape around it. Sufficient variety is created by peaks, spurs, ridges and valleys to provide a diverse and interesting experience for visitors (see *Figure 2.2*).

The restored site could offer potential links to the wider peninsula and to the High Peak Junk Trail as well as possessing a self-contained circulation pattern that allows the easiest possible access to the maximum part of the site.

The primary circulation system for the proposed recreational facility is a proposed network of maintenance tracks. Supplementing these tracks is a network of pedestrian paths designed to give comprehensive site access as well as access to viewpoints on the newly created peaks (see *Figure 2.2*).

The planting for the restored SENT site was designed to simulate natural patterns of hillside vegetation create the following types of vegetation:

- Woodland
- Shrubland
- Grassland
- Amenity Woodland
- Tree Stands
- Firebreak Woodland

The design of planting will follow the vegetation structure typical of natural hillside woodland, shrub and grassland in Hong Kong, so that an entirely natural effect will be created that is of maximum benefit to wildlife (see *Figure 2.3*).

During the preparation of this Restoration and Ecological Enhancement Plan for SENTX development, the above SENT Landfill Restoration works have been taken into account and made reference to, especially the existing established plant species of successful and high survival rate. Besides, trail nursery is also being undertaken (refer to **Section 4.2**) in accordance with EP Condition 2.7, that *"trial nursery for native plant species …to fine tune the planting matrix and management intensity of the recommended indigenous tree species"*. The trail nursery is still in progress, and only preliminary results were reviewed and discussed in **Section 4.2**, while the full monitoring results will be provided in later stage. Further details and result of the trial nursery works under both the SENT and SENTX projects will be adopted to refine the implementation of the SENTX REEP.

3. REQUIREMENTS AND APPROACH FOR THE RESTORATION AND ECOLOGICAL ENHANCEMENT PLAN (REEP)

3.1 REEP REQUIREMENTS

Specific design objectives and criteria for the SENTX REEP are set out in the following documents:

- EP (EP-308/2008/D and FEP-01/308/2008/D) Condition 2.6; and
- The ecological mitigation requirements of the SENTX Project EIA Report (Chapter 9).

3.2 ENVIRONMENTAL PERMIT (EP-308/2008/D and FEP-01/308/2008/D) CONDITION 2.6

According to EP Condition 2.6, "*Within six months after the commencement of construction of the Project , four hard copies and one electronic copy of a coherent restoration and ecological enhancement plan shall be submitted to the Director for approval showing details of restoration measures for the extension site including provision of 6 hectares of mixed woodland planting composting of about 20% non-native tree species to compensate the loss of shrubland[2] and a mosaic of grassland and shrubland in the remaining areas of the extension. The plan(s), of scale 1 to 1000 or other appropriate scale as agreed by the Director, shall include details on locations, size, number and species of planting, implementation programme, maintenance and management schedules. The submission shall be certified by the ET Leader and verified by the IEC as conforming to the information, requirements and recommendations set out in the approved EIA Report. All measures recommended in the approved restoration and ecological enhancement plan(s) shall be fully and properly implemented in accordance with the details and programme set out in the submission.*"

3.3 ECOLOGICAL MITIGATION REQUIREMENTS OF THE SENTX EIA

3.3.1 ECOLOGICAL MITIGATION REQUIREMENTS

Agreement No. CE 10.2005(EP) South East New Territories (SENT) Landfill Extension - Feasibility Study:

Environmental Impact Assessment Report (hereafter referred to as the approved EIA) defines a number of ecological (flora) mitigation measures that the restoration of the landfill must fulfil. Section 9.10.3 of the approved EIA Report addresses the issue of habitat mitigation. The following compensation planting is recommended as mitigation for the habitats affected due to the proposed SENTX site.

[2] The feasibility of 20% of non-native species will be confirmed in accordance with the result of the trial nursery referring to EP Condition 2.7. Noting that this ratio was not reachable in the current SENT Landfill.

- *Provision of 6 ha of mixed woodland planting to compensate for the loss of shrubland. To enhance the ecological value of the encroached area within CWBCP, mixed woodland will be planted on the affected areas (approximately 6 ha, originally shrubland)*[3]*; and*
- *Provision of a mosaic of grassland and shrubland in the remaining areas of the Extension Site.*

The mixture of grassland, shrubland and woodland habitats is recommended to diversify the habitats to support various wildlife, in particular butterflies, birds and herpetofauna and blend into the existing undisturbed ecological environment…This recommendation also complies with the mitigation measures proposed in the existing SENT Landfill EIA, which suggested compensatory planting of native woodland.

Indigenous plant species with a shallow root system, softwood in nature and adaptive to seashore habitat are recommended to be used in the restoration plan, such as Gordonia axillaris, Phyllanthus emblica, Celtis sinensis *and* Macaranga tanarius*, which have been well established in coastal areas with exposure to strong wind and salt spray, and with a sandy soil base.*

Indigenous tree species Celtis sinensis *and* Ficus microcarpa *have also been recorded in the SENT Landfill site (from years 2003 to 2006) and during the baseline surveys of this Project, although they occurred in low abundance in SENT Landfill and some individuals were distorted in tree form due to competition by exotic tree species on the crown layer.*

With special care and management in place and the optimal planting matrix with other plant species, native tree species could be used for restoration in landfill site. Taking into consideration the relatively poor substrate and the difficulties of establishment of some native trees in Hong Kong, it is recommended to include approximately 20% of non-native tree species in the compensatory woodland. The non-native tree species can serve as a nurse species to facilitate the establishment of the native tree species, especially the shading, and it can be replaced by established native tree species progressively. Plant species can also make reference to food plants of butterfly species (in particularly butterfly species of conservation interest recorded within the CWBCP)….

It is also recommended that a trial nursery for native plant species be set up in advance during the construction phase in order to fine tune the planting matrix and management intensity of the recommended indigenous tree species. It should be noted that native shrubs and tree species have been used for restoration of the existing SENT Landfill, native plant species that could not successfully be established on the existing SENT Landfill should be reviewed before the preparation of the compensatory planting list. Special care and intensive management of native plants should be implemented in order to ensure proper establishment of the native plants. Compensatory planting and restoration of the Extension can be implemented progressively according to the filling plan of the Extension. Planted and restored areas will serve their ecological function once completed.

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3 There will be no additional encroachment of the CWBCP under the current scheme of SENTX. As required in EP Condition 2.6 (EP-308/2008/D and FEP-01/308/2008/D), restoration measures for the SENTX site include provision of 6 hectares of mixed woodland planting composting of about 20% non-native tree species to compensate the loss of shrubland and a mosaic of grassland and shrubland in the remaining areas of the SENTX site.

Detail of location and commencement schedule of the trial nursery is shown in *Appendix A*.

3.4 PROPOSED APPROACH FOR THE REEP

According to the above requirements, the following describes the broad approach to the REEP for the SENTX restoration.

3.4.1 PLANTING DESIGN

The planting for the restored SENTX site is also illustrated in *Figures 3.1, 3.1.1, 3.1.2* and *3.1.3.* Planting design has been guided by the approved EIA Report Section 9 mitigation requirements (see *Section 3.3.1*).

In addition, the approved EIA Report Section 10 Mitigation Measure AM4 requires that:

The restored Extension will be substantially vegetated so as to mimic the patterns of natural vegetation on surrounding hills. At least 18.8ha of the area of the Extension Site will be planted with woodland mix planting at no less than 1.2m spacings. 80% of all plants planted will be native species. The remainder of the site will be planted as a grassland / shrub mosaic.

In summary, therefore, the planting requirements are for a minimum of 18.8ha of woodland and a mosaic of grassland and shrubland, which comprises 80% of native species.

In addition, the planting layout has been designed with considering the following factors:

- *Response to the established SENT restoration planting design;*
- *Existing planting and landscape design at SENT landfill; and*
- *Prevention of Fire.*

3.4.2 RESPONSE TO THE ESTABLISHED SENT RESTORATION PLANTING DESIGN

The ecological restoration design at SENTX aims to establish the beginnings of a vegetation structure which can develop and offer a wide range of ecological habitats for both flora and fauna, from grassland and shrubland through to woodland. However, this is neither a simple nor a short-term matter, as the development of habitats can take many years.

Ecological diversity is best encouraged by the planting of native plant species and communities. The numbers of non-native species used will be restricted to about 20% as required[4].

In order to establish a woodland that offers the widest possible range of opportunities for the natural development of habitats and ecological niches for wildlife, it is most effective to follow or mimic the natural process of woodland vegetation development.

Woodland development begins with the colonisation of a grassland or rocky site by dwarf shrub species. These in tum are followed by pioneer species, aggressive and opportunistic plants, surviving in locations which other plants find too exposed, too arid or where soils are too impoverished. These species develop quickly and are short-lived. They act as nurses, protecting the native tree and shrub species which colonise the site from wind and providing

[4] The feasibility of 20% of non-native species will be confirmed in accordance with the result of the trial nursery referring to EP Condition 2.7. Noting that this ratio was not reachable in the current SENT Landfill.

them with nutrients in the form of leaf litter and organic matter, which enriches the soil. This process is known as ecological succession.

The native trees and shrubs which colonise the site, eventually develop into what is termed a climax woodland community, the endpoint of a stable woodland ecosystem that will survive and persist for thousands of years unless there is external interference, such as fire.

A climax woodland community is composed of several layers of vegetation, each adapted to the various environmental conditions within the woodland (see *Figure 3.2*). The climax layer of vegetation is composed of the tallest woodland species, which tend to be the longest lived. These trees, 15 metres or more in height, capture most of the light falling on the woodland and maintain a competitive advantage over other species.

The sub-climax layer is composed of smaller trees 10 metres or more in height. These develop opportunistically in gaps left in the canopy layer, where sunlight penetrates and are also found at the edges of the woodland.

Below the sub-climax species is the understorey layer, composed of large shrubs up to five metres in height. Generally, these are suppressed by the low light levels near the woodland floor, but develop vigorously in pockets of light where older trees have died, and in sunny clearings. Many large shrubs demand high levels of light and develop along the edge of the woodland.

The herb layer is composed of large grasses and smaller shrubs up to two metres tall, which will generally tolerate lower light levels. Finally, the ground layer, is composed of smaller plants still, including mosses, low grasses and tree seedlings. These plants will generally have to tolerate extremely low levels of light.

The planting mix approach noted above is appropriate for the creation of a natural woodland structure. Using planting matrices (see *Figures 4.1 to 4.6*), different plant species can be laid out in the positions relative to each other so that they would normally occupy in a natural woodland.

3.4.3 EXISTING PLANTING AND LANDSCAPE DESIGN AT SENT LANDFILL

As noted in *Section 2.5*, the SENT landscape restoration masterplan provides for the following vegetation types

- Woodland
- Shrubland
- Grassland
- Amenity Woodland
- Tree Stands
- Firebreak Woodland

As these still conform to the EIA requirements and compatibility of the SENT Landfill, it is proposed to retain these broad vegetation types at SENTX.

3.4.4 PREVENTION OF FIRE

The prevention of fire, or at least the containment of any fires that may start, is one of the design criteria incorporated into the REEP. The control or containment of fire can be achieved in a number of ways:

- By creating man-made barriers to fire e.g. footpaths or roads or drainage channels;
- By clearing or limit the growth of vegetation by cutting; and
- By planting belts of vegetation that are resistant to fire.

Physical barriers may simply be areas of ground wide enough to prevent fire crossing. A width of every one metre can be sufficient to serve this purpose. In this regard, footpaths or roads can be useful, as can streams, drainage channels (*Appendix D*) or rock faces.

Clearance of vegetation can contribute to fire control. Areas can be kept permanently free of vegetation in order to stop the spread of fire. This method does however give rise to recurrent maintenance costs. The cutting of grassland on a biannual basis is essential in limiting the amount of biomass vulnerable to fire.

The planting of belts of trees resistant to fire is a further method of controlling fire. As the species traditionally used have often been non-natives, this has in the past produced areas of rather unnatural looking vegetation amongst the woodland cover. Recently however, native species such as *Ficus microcarpa* have been used as fire-breaks, reflecting concerns regarding the effect on ecology and wildlife stemming from the introduction of non-native species.

In the design for the REEP, the principal method of fire control is the exploitation of the numerous proposed on-slope U-channels draining the hillsides. Planting will be set-back along these channels to create 5 metre-wide belts free of vegetation which serve to subdivide blocks of woodland and which permit maintenance of the U-channels.

The main drainage gullies will fall from the main ridge of land to the east and west and will run through the principal woodland spine located in the main valley. This woodland has been designed so that the gully will serve to compartmentalise and separate areas of this woodland.

Generally, maintenance access tracks and footpaths will compartmentalise areas of woodland and help control spread of fire. On the boundaries of the site where it adjoins areas of advance planting, belts of fire-resistant woodland will be planted to prevent the spread of fire in and out of the site.

4. DEVELOPMENT OF THE RESTORATION AND ECOLOGICAL ENHANCEMENT

4.1 APPROACH TO PLANTING DESIGN

As required by the approved EIA Report and EP condition, three different types of vegetation are envisaged on the SENTX site in order to simulate the natural patterns of vegetation in the vicinity. These are:

- Woodland;
- Shrubland; and
- Grassland.

In addition, the following vegetation types will also be created to correspond to types currently in use at the SENT landfill restoration:

- Tree Stands;
- Amenity Woodland; and
- Firebreak Woodland.

The design of planting will follow the vegetation structure and relative distribution typical of natural woodland and shrub, so that an entirely natural effect is created that is of maximum benefit to wildlife.

As shown in *Figure 3.2*, **woodland** planting is concentrated on the lower slopes of the landfill and on intermediate slopes that might be partially sheltered by existing Clear Water Bay Country Park landforms, including the valley/ gulley on the eastern side of the SENTX Site. This creates a band of woodland on the lower western slopes of the SENTX landfill connecting with that at SENT, together with a second band of woodland following the valley created on the eastern side of the SENTX site where it adjoins the Clear Water Bay Country Park. Planting on the lower slopes will assist in screening the road and industrial estate from the lower slopes as well as providing sheltered spaces for picnics and sitting out.

As required by EP Condition 2.6 (EP-308/2008/D and FEP-01/308/2008/D), restoration measures for the SENTX site include provision of 6 hectares of mixed woodland planting composting of about 20% non-native tree species to compensate the loss of shrubland. Furthermore, aftercare phase mitigation measure AM4 of the approved EIA stipulates that at least 18.8 ha of the area of the SENTX will be planted with woodland mix planting at no less than 1.2m spacings, consisting of 80% native tree species. Accordingly, in the area of SENTX lying within the CWBCP, there will be 3.8 ha of woodland, including compensatory planting of 16,850 nos. of trees (refer to *Figure 3.1* for the location and area). In areas of SENTX lying outside of CWBCP, there will be 15.0 ha of woodland, including compensatory planting of 66,775 nos. of trees.

Elsewhere, at areas of higher elevation, areas of **shrubland** will be planted in fingers running up hillsides, as they would naturally occur. Shrubland is generally a pioneer habitat consisting of small trees and shrubs in a mosaic of grassland, taking advantage of sheltered locations or less exposed topography. In compliance with the approved EIA, there will be 2.56 ha of shrubland, consisting of 80% native species. The species list and size planting for shrubland is provided in Table 4.1 (Shrubland Mix A), while the number of plantings is provided in the table below.

Species	No. of plantings	Species	No. of plantings
Shrubland Mix A		**Shrubland Mix B (Food Plants of Butterfly included)**	
Acacia mangium	1,766	*Acacia auriculiformis*	3,278
Syzygium buxifolium	1,412	*Rhaphiolepis indica*	2,622
Ixora chinensis	1,059	*Lespedeza formosa*	2,622
llex asprella	1,059	*llex asprella*	1,967
Phyllanthus emblica L.	1,766	*Urena lobata*	2,622
Lespedeza formosa	1,766	*Vitex negundo L. var. cannabafolia*	3,278
TOTAL:	8,828	TOTAL:	16,389

Grassland will be established at areas of highest exposure/ elevation where it would naturally occur in the environment. Grassland will be created by hydroseeding using a mixture of grass species suited to the site and its conditions which will therefore establish quickly. Further grass species are likely to colonise the site at a later date. Grass will be allowed to develop naturally and will be cut each year to ensure that it poses no unnecessary fire risk.

To align with the preferred use of native species for shrubland and woodlands, the hydroseeding grass seed mix ensures a composition of 80% native species. Seed mix (A), designated for use from April to August inclusive, requires a minimum application rate of 25 g/sq m. Seed mix (B), between September and March, contains 50% of native species. To ensure effectiveness across seasons, the seed mix incorporates exotic species for cooler months, as native species achieve optimal growth primarily in warmer conditions. In total the size of grassland planting will be 94,918.03 m^2. It is also important to consider the commercial availability of grass seedlings, even though native species are preferred.

Species	g/sq m	Species	g/sq m
Grassland Seed Mix A (Apr-Aug)		**Grassland Seed Mix B (Sep-Mar)**	
Cynodon dactylon	18-20	*Cynodon dactylon*	15
Paspalum notatu	3-5	*Paspalum notatu*	10
Chloris gayana	0-4	*Lolium perenne*	5
Eragrostis curvula (2% maximum)	0-4		
Cenchrus echinatus	0-4		

Tree Stands - Occasional tree stands will be planted across the site. These will be groups of trees with no significant understorey, which are to be employed primarily for scenic effect and which will help to create a parkland feel to areas of the site. They will be primarily native trees planted at light standard size.

Amenity Woodland - Though the emphasis of the project is on the use of native species and the creation of a natural structure of woodland and shrub habitats, a certain number of semi-ornamental species have been added to the ornamental woodland mix adjacent to the access road. These add interest and variety to areas frequently seen by the public whilst still performing an adequate screening function along the road edge. The planting structure will still be loose and informal, and species will be selected to prefer native or adapted non-native species and no invasive species will be selected.

Belts of Firebreak Woodland will be planted to the southeast of the SENTX site, dividing the restored woodlands from the indigenous woodlands of Clear Water Bay Country Park.

Having outlined the principal types and patterns of vegetation for the SENTX site, the following sections of the Report detail the technical aspects of the ecological restoration works.

The technical proposals in this section have also been informed by the experience gained at the SENT landfill restoration, which has been recorded during monitoring of planting.

4.2 SELECTION OF PLANTING SPECIES

The approach to species selection and vegetation structure on the restored SENT landscape proceeds from the objective of establishing as close an approximation as possible to a native woodland and shrub habitat. This will create planting that will appear natural but which also promotes wildlife and nature conservation.

The concept of the planting mix recognises that, just as is the case in the wild, different communities of plants will naturally colonise different areas, depending on the soil, microclimatic and hydrological conditions. Planting mixes were therefore developed for different areas around the site, depending on the type of plant community appropriate to that location, degree of exposure, and on the function which planting is to serve. The following mixes were developed:

Woodland Mix A	(a pioneer species orientated mix for exposed slopes)
Woodland Mix B	(a native species orientated mix for sheltered slopes)
Woodland Mix C	(a semi-ornamental mix of species for areas most frequented by the public)
Firebreak woodland	(a mix of tree species more resistant to fire)
Shrub Mix A	(for edges of woodland and exposed areas)
Shrub Mix B	(for edges of woodland and sheltered areas)
Tree Stand	(for open areas readily visible to the public)

Mixes are laid out according to a predetermined matrix (*Figures 4.1 to 4.6*) which seeks to recreate the kind of woodland vegetation structure found naturally.

It is well established that woodlands composed of species native to a given location are of most value to wildlife and to the ecology of a given area. For this reason, the palette of plants used at SENTX will be drawn predominantly (80% of the total) from the range of species native to Hong Kong.

However, it was recognised that a wholly native woodland might naturally take many decades to develop, particularly on such an exposed site as that at SENTX. In order to ensure a successful and reasonably rapid establishment of woodland, 20% non-native species have been incorporated into the planting. These tend to be faster growing pioneer species which will provide a degree of shelter for the slower-growing natives. However, the use of competitive and dominant species such as *Casuarina equisetifolia* and *Acacia confusa* will be limited.

Planting mixes are also informed by the recommended species in the mitigation section of Chapter 9 of the approved EIA Report.

The trial nursery details and results are also considered when selecting the planting species (Summary Report of Findings of the SENTX Trial Nursery refer to ***Appendix E***). From the Summary Report, one of the best exotic tree species in terms of survived rate, growth rate and health condition, was *Acacia auriculiformis*, which has been adopted as a pioneer tree in woodland mix. The second-best species were *Acacia confusa* and *Dalbergia odorifera*, where *Acacia confusa* is also adopted as a pioneer tree. For shrubland planting species, from the Summary Report, *Acacia auriculiformis* with good survival rate and health condition is adopted in the REEP as a shrubland mix pioneer species. **Table 4.1** presents all the selected species for SENTX.

TABLE 4.1 PROPOSED PLANTING MIXES FOR USE AT SENTX

		Species	**%**		**Species**	**%**
	Woodland Mix A (Exposed)					
Pioneer spp.	A1	*Acacia confusa*	20			
Climax spp.	A2	*Camellia crapnelliana*	16			
	A3	*Sapium sebiferum*	12			
	A4	*Rhaphiolepis indica*	12			
	A5	*Phyhllanthus emblica L.*	20			
	A6	*Celtis sinensis*	20			
		Total	**100**			
	Woodland Mix B (Sheltered) (outside CWBCP)			**Woodland Mix B (Sheltered) (within CWBCP)**		
Pioneer spp.	B1	*Acacia auriculiformis*	20	B1	*Acacia auriculiformis*	20
Climax spp.	B2	*Machilus breviflora*	16	B2	*Machilus breviflora*	16
	B3	*Ficus subpisocarpa*	16	B3	*Cratoxylum cochinchinense*	16
	B4	*Litsea glutinosa*	12	B4	*Litsea glutinosa*	12
	B5	*Ficus microcarpa*	16	B5	*Schefflera heptaphylla*	16
	B6	*Syzygium levinei*	20	B6	*Syzygium levinei*	20
		Total	**100**		**Total**	**100**
	Woodland Mix C (Amenity)			**Woodland Mix D (Firebreak)**		
Pioneer spp.	C1	*Acacia confusa*	20	D1	*Acacia confusa*	20
Climax spp.	C2	*Pongamia pinnata*	20	D2	*Ficus microcarpa*	60
	C3	*Rhodomyrtus tomentosa*	12	D3	*Schima superba*	20
	C4	*Ilex asprella*	12			

		Species	%		Species	%
	C5	*Phyllanthus emblica L.*	16			
	C6	*Rhodoleia championii*	20			
		Total	**100**		**Total**	**100**
	Shrubland Mix A			**Shrubland Mix B (Food Plants of Butterfly included)**		
Pioneer spp.	SA1	*Acacia mangium*	20	SB1	*Acacia auriculiformis*	20
Climax spp.	SA2	*Syzygium buxifolium*	16	SB2	*Rhaphiolepis indica*	16
	SA3	*Ixora chinensis*	12	SB3	*Lespedeza formosa*	16
	SA4	*llex asprella*	12	SB4	*llex asprella*	12
	SA5	*Phyllanthus emblica L.*	20	SB5	*Urena lobata*	16
	SA6	*Lespedeza formosa*	20	SB6	*Vitex negundo L. var. cannabafolia*	20
		Total	**100**		**Total**	**100**

4.3 SOILS AND SOIL AMELIORANTS

The soil medium is only one of a number of layers of material that will be deposited as part of the landfill and restoration of the SENTX site (see *Figure 4.7*). However, providing a good soil medium is important to the establishment and growth of planting in the restored areas.

Prior to first phase landscape restoration at SENT, a number of soil medium, soil conditioner and soiling method trials were carried out and it was determined that the optimal soiling method was to pit plant seedlings into the final cover layer composed of screened CDG and C&D Fines, and backfill them with soil mix to meet the specification of the Civil Engineering & Development Department (CEDD) of the HKSAR Government's General Specification for Engineering Works. The detail of the specification as follows (also see *Figure 4.7*):

CEDD GS Clause 3.30

(1) Soil-mix shall be ready and evenly mixed before delivery onto the Site.

(2) Soil-mix shall consist of friable, completely decomposed granite and soil conditioner in the proportions of 3:1 by volume. Soil-mix shall be free of grass or weed growth, sticky clay, salt, chemical contamination, and any other deleterious materials and stones exceeding 25 mm diameter in any direction, and shall possess the following properties: (a) PH value between 5.5 and 7.0; (b) Organic matter more than 10%; (c) Nitrogen content more than 0.2%; GS (2006 Edition) 3.10 (d) Extractable phosphorous (P) content more than 45 mg/kg; (e) Extractable potassium (K) content more than 240 mg/kg; (f) Extractable magnesium (Mg) content more than 80 mg/kg; (g) Soil texture content: Sand (0.05 - 2.0 mm): at the range of 20% - 75%; Silt (0.002 - 0.05 mm): at the range of 5% - 60%; Clay (less than 0.002 mm): at the range of 5% - 25%.

CEDD GS Clause 3.31(1)

Soil conditioner shall be organic material and shall be free of weed growth, impurities, foreign materials, contamination and substances injurious to plants. Soil conditioner shall have the following properties: (a)PH value between 5.0 and 7.5, (b) Moisture content

> *measured in accordance with Clause 6.78(2) between 30% and 50%, (c) Fine and freely flowing consistency, (d) Stable composition, (e) Not capable of raising the temperature of the treated soil more than 50° C above the temperature of the untreated soil, (f) Not giving off toxic nor obnoxious fumes, (g) Organic matter content not less than 85% (dry matter), and (h) Carbon: nitrogen ratio between 20 and 55.*

CEDD GS Clause7.98(1)

> *Biodegradable mats for erosion control shall be woven coir mesh mats or woven jute mats. The mats shall have the material properties stated in the Contract. (2) The mats must be produced by proprietary manufacturers and specifically designed for the erosion control of sloping ground.*

Topsoiling will involve depositing 1.5m of screen CDG as subsoil over the impermeable liner. CDG should be as described in Geoguide 3, *Guide to Rock and Soil Descriptions 1988*.

A Soil mix will be a free drainage material of sandy loam character, and should be evenly textured, fertile, and dark brown or black in colour. Soil mix will be free from pest, such as red imported fire ants. It should be delivered and backfilled on site which is tested for N/P/K value, organic matter content, pH value, physical content of sand, slit and clay, and water content, etc. The analysis should be carried out by a laboratory certified by the Independent Consultants and approved by the Employer's Representative.

Soil conditioner should be properly composted organic material. Composed organic material should be stable and should not be liable to decompose further generating heat. Certificate of analysis stating composition and physical and chemical characteristics of the soil conditioner. The analysis should be carried by a laboratory by the Employer's Representative.

A geotextile jute or coir matting will be laid together with the finished soil layer in order to ensure slope stability and prevention of erosion. This matting ensures erosion control and at the same time allows plants to grow through it. This will then decompose naturally and add to soil organic matter.

Seedling trees will then be pit planted into this medium with pits being a minimum of 300mmm x 300mm x 300mm. Slow release N:P:K fertiliser will also be added to the backfill.

Soil-mix will be used as a planting medium for compensatory planting in accordance with Section 3.30 of *General Specification for Civil Engineering Works (2020 Edition).* According to the Specifications, the soil-mix "*consists of friable, completely decomposed granite and soil conditioner in the proportions of 3:1 by volume. It is free of grass or weed growth, sticky clay salt, chemical contamination, and any other deleterious material and stones exceeding 25 mm diameter in any direction, and shall possess the following properties:*

a) PH value between 5.5 and 7.0;

b) Organic matter more than 10%;

c) Nitrogen content more than 0.2%

d) Extractable phosphorous (P) content more than 45 mg/kg;

e) Extractable potassium (K) content more than 240 mg/kg;

f) Soil texture content:

Sand (0.05 – 2.0mm)	*at the range of 20%-75%;*
Silt (0.002 – 0.05mm)	*at the range of 5% - 60%;*
Clay (less than 0.002 mm)	*at the range of 5% - 25%.*

4.4 METHOD OF PLANTING

Seedling trees and shrubs will be pit planted as described above in the soiling section of the report at 1.5m centres (see approved EIA Landscape Mitigation Measure AM4). Once soil mix has been backfilled, it will be firmed up and a slight depression created around the seedling to help catch runoff water.

For native species, a 300 x 300mm piece of synthetic weed mat will be pinned using U-pins around the seeding in order to suppress weed growth and competition.

Finally, for native species, a plastic microclimatic growth tube (MGT) of approved design will be placed around native species seedling to provide protection from wind burn and desiccation. The MGT will be fixed in place by one or more metal rebar stakes driven into the ground to a depth of at least 150mm (see *Figure 4.8*).

5. IMPLEMENTATION PROGRAM, MAINTENANCE AND MANAGEMENT

5.1 IMPLEMENTATION PROGRAM

Construction works will commence in 2019, two years prior to commencement of waste filling. The SENTX site will be developed and operated under four phases, and each will last for about two years (*Appendix B* for drawings of construction phases).

Upon the completion of each phase, the areas that reached the final profile will begin restoration immediately. Therefore a tentative programme for restoration and ecological enhancement is as follows:

- Construction Commencement: 2019
- Completion of Phase 1-2 Filling: 2025
- Completion of Phase 1-2 Capping & Earthworks Restoration: 2025
- Completion of Phase 1-2 Ecological Enhancement: 2026
- Completion of Phase 3-4 Filling: 2025
- Completion of Phase 3-4 Capping & Earthworks Restoration: 2025
- Completion of Phase 3-4 Ecological Enhancement: 2026
- Completion of Phase 5 Filling: 2026
- Completion of Phase 5 Capping & Earthworks Restoration: 2027
- Completion of Phase 5 Ecological Enhancement: 2028
- Completion of Phase 6 Filling: 2026
- Completion of Phase 6 Capping & Earthworks Restoration: 2026
- Completion of Phase 6 Ecological Enhancement: 2027
- Completion of Phase 8 Filling: 2026
- Completion of Phase 8 Capping & Earthworks Restoration: 2026
- Completion of Phase 8 Ecological Enhancement: 2027
- Completion of Final Restoration and Park Admin Office and Visitor Facilities: TBA

In accordance with condition no.7 in Annex II of Lands Department approval memo dated 27 December 2018, and in order to prepare for the restoration works for the return of land back to CWBCP after completion of landfill works, a restoration proposal including surface treatment, landform, slope profile, planting proposal, etc. shall be submitted to the Country and Marine Parks Authority (CMPA) 12 months before completion of the works.

Upon completion of Restoration and Aftercare Phase of the Project, the Project Proponent shall make for site hand-over arrangements and fulfil the special conditions imposed in the approval/ consent given by Lands Department and CMPA in respect of the restoration/ reinstatement works within CWBCP.

5.2 MANAGEMENT AND MAINTENANCE

Designing the REEP for SENTX and implementing that design is not enough to ensure that a diverse, functional and visually pleasing landscape and environment will develop. Only through a long-term programme of restoration and ecological enhancement management can the actions of the various parties who may be involved in maintaining the site, be co-ordinated and directed so as to ensure that habitats and planting develop as intended and that the amenity of the site is preserved for recreational users. The implementation party of the maintenance and management works is GVL.

Ecological diversity cannot be optimised by leaving a site solely to nature. The problem with this approach is that in the short-term, certain species that are naturally dominant will tend to outcompete or suppress less vigorous species. Natural woodland and shrub habitats can take decades to develop their full range of ecological niches and natural diversity, through a process of succession, decay and regrowth. Simple management techniques can assist in this process and effectively help to diversify woodland and shrub habitats sooner than might be the case if left to develop naturally.

Management is also important in creating and maintaining a recreational facility that is useable and attractive to the public. The clearance of paths and maintenance of essential features such as drainage channels and maintenance paths are all part of the management process.

For keeping topsoil layer quality, maintenance works such as watering, weeding, fertilization and aeration, etc. should be undertaken regularly. Removal of invasive weed/ weed trees should be supplemented in the routine maintenance works. On the other hand, if the exotic tree plantings are casting excessive shade on other planting, crown thinning should be carried out to the exotic tree plantings. Each session of the crown thinning should not remove more than 25% of live foliage of each tree, with at least 3-month interval in-between each session. If any dead and/or unsatisfactory tree and/or shrub is found, replacement of tree and/or shrub (may not necessarily be the same species) should be taken.

Ultimately the maintenance degree on restored and ecological enhanced site will be diminished year by year until the end of the 30-year aftercare period. The Project Proponent shall also make mutual agreement with the future maintenance department(s) for long-term maintenance and management of the proposed plantings after the 30-year aftercare period prior to the conclusion of the aftercare period. *Table 5.1* to *Table 5.4* show the ecological and landscape maintenance work schedule.

TABLE 5.1 ECOLOGICAL & LANDSCAPE MAINTENANCE WORKS SCHEDULE (WOODLAND AND SHRUB PLANTING AREAS)

Operation	Frequency of Operation (i.e. times per year)			
	Year 1	Year 2-5	Year 5-10	Year 10-30
Inspect planted areas and firm-up loose plants in all areas	12	4 (Years 2&3)	1	1
Inspect typhoon damage, firm up and remove damaged wood resulting	As required	As required	As required	As required
Remove invasive weeds and/ or plants from all planting areas	12	4 (Years 2&3) 2 (Years 4&5)	1	As required
Removal of invasive plant including *Leucacena leucocephala* from all planting areas	12	4 (Years 2&3) 2 (Years 4&5)	1	As required
Check, replace, reinstate MGTs and Weed Mat	12	12 (Year 3)	-	-
Remove litter	12	12	12	-
MGTs and Weed Mats	Install (Year 1)	Remove (Year 2)	-	-
Remove dead wood	As required	As required	-	-
Inspect plantings (incl. pests/ fungus and treat as necessary)	4	4	2	1
Thin plantation of non-native nurse species to favour native species	-	As required depending on success of native plant establishment	As required depending on success of native plant establishment	As required depending on success of native plant establishment
Cut back vegetation next to footpaths	-	1	1	2
Apply slow-release fertiliser	2 (March & June)	1 (March)	-	-
Watering planting areas	As required	As required	-	-
Grass cutting (with strimmer)	4	4	As required (depending on canopy closure)	-
Soil aeration	4	4	2	1
Crown thinning	As required	As required	-	-

Operation	Frequency of Operation (i.e. times per year)			
	Year 1	Year 2-5	Year 5-10	Year 10-30
Replacement of dead/ unsatisfied planting	As required	As required	-	-

TABLE 5.2 ECOLOGICAL & LANDSCAPE MAINTENANCE WORKS SCHEDULE (GRASSLAND PLANTING AREAS)

Operations (per Year)	Frequency of Operation (i.e. times per year)			
	Year 1	Year 2-5	Year 5-10	Year 10-30
Inspection hydroseeded areas	12	4	2	1
Remove litter	12	12	12	-
Inspection typhoon damage, make good erosion	As required	As required	As required	As required
Remove invasive weeds and/or plants from all hydroseeded areas	12	4	2	As required
Removal of invasive plant including *Leucacena leucocephala* from all planting areas	12	4 (Years 2&3) 2 (Years 4&5)	1	As required
Inspect for pests/ fungus and treat as necessary	4	4	2	1
Apply slow-release fertiliser	2 (March & June)	1 (March)	-	-
Watering	As required	As required	-	-
Grass cutting (with motorised mower)	1	1	1	1

TABLE 5.3 ECOLOGICAL & LANDSCAPE MAINTENANCE WORKS SCHEDULE (OTHER LANDSCAPE FEATURES)

Operations (per Year)	**Frequency of Operation (i.e. times per year)**			
	Year 1	**Year 2-5**	**Year 5-10**	**Year 10-30**
Drainage				
Clear drains of leaf litter and as required obstructions	As required	As required	As required	As required
Inspect and repair drains (as required)	4	4	4	4
Track and Access Roads				
Inspect surfaces, etc. for damage	4	4	4	4
Repair damage	As required	As required	As required	As required
Spray out weeds	2	2	2	2
Pavilions and Site Furniture				
Inspection for typhoon damage	As required	As required	As required	As required
Spray out weeds	4	4	4	4
Footpath				
Inspect and make good (as required)	4	4	4	4
Spray out weeds	2	2	2	2
Landscape on Retained Slopes and Natural Slopes				
Inspect and make good (as required)	4	4	4	4
Inspect for erosion after very heavy rainstorms	As required	As required	As required	As required

TABLE 5.4 ECOLOGICAL & LANDSCAPE MAINTENANCE WORKS SCHEDULE (MONITORING)

Operations (per Year)	**Frequency of Operation (i.e. times per year)**			
	Year 1	**Year 2-5**	**Year 5-10**	**Year 10-30**
Ecological monitoring	2	2	1	1
Monitor planting trials	2	2	1	1
Review Management Plan	1	1	1	As required
Soil monitoring	1	1	1	1
Fencing Around Trial Nursery Sub-Areas (Monitoring Blocks)	1 (install at Year 1)	-	1 (Remove at Year 5)	-
Check and make good fencing around Trial Nursery Sub-Areas (Monitoring Blocks)	4	4	-	-

FIGURES

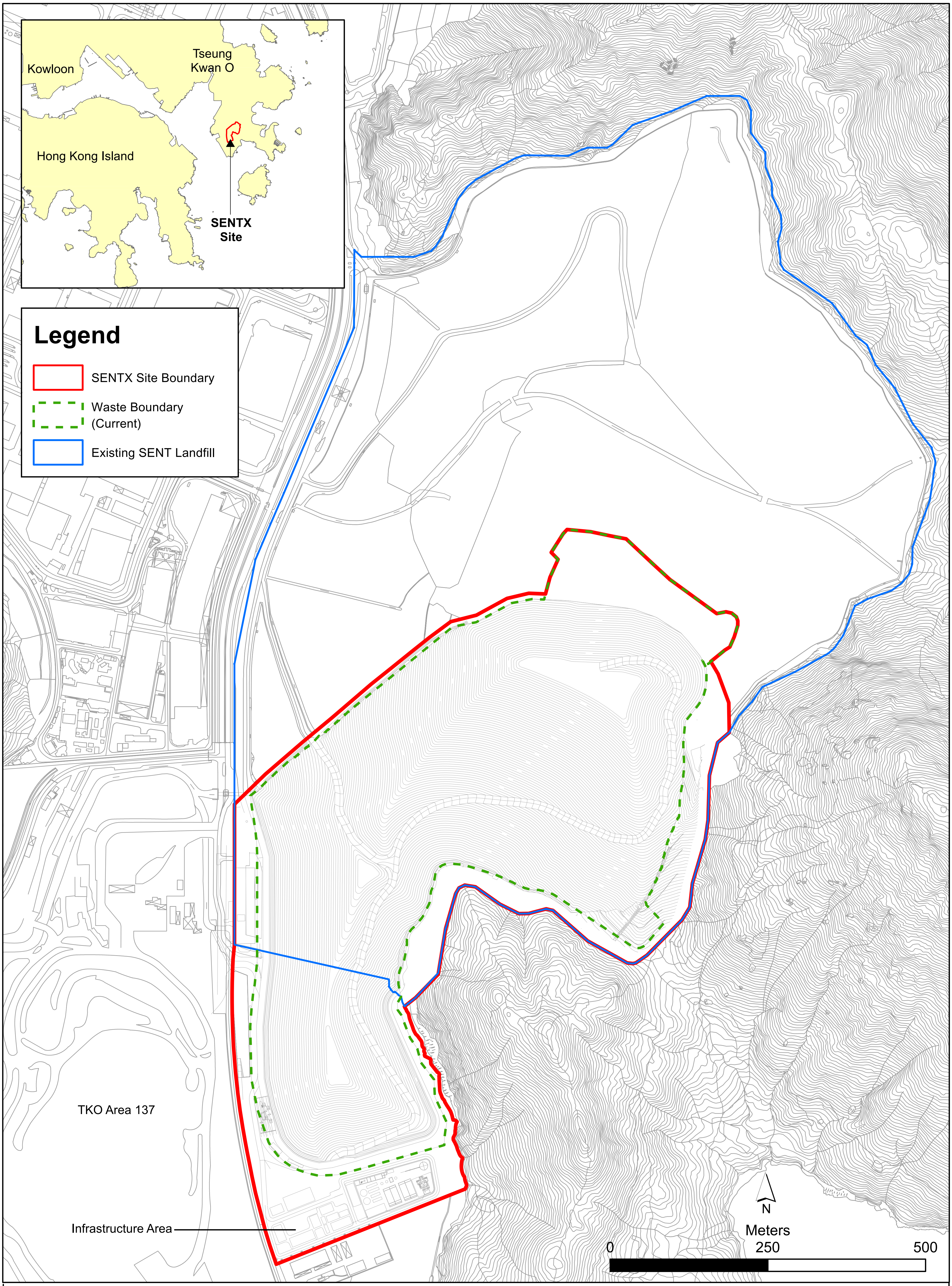


Figure 2.1

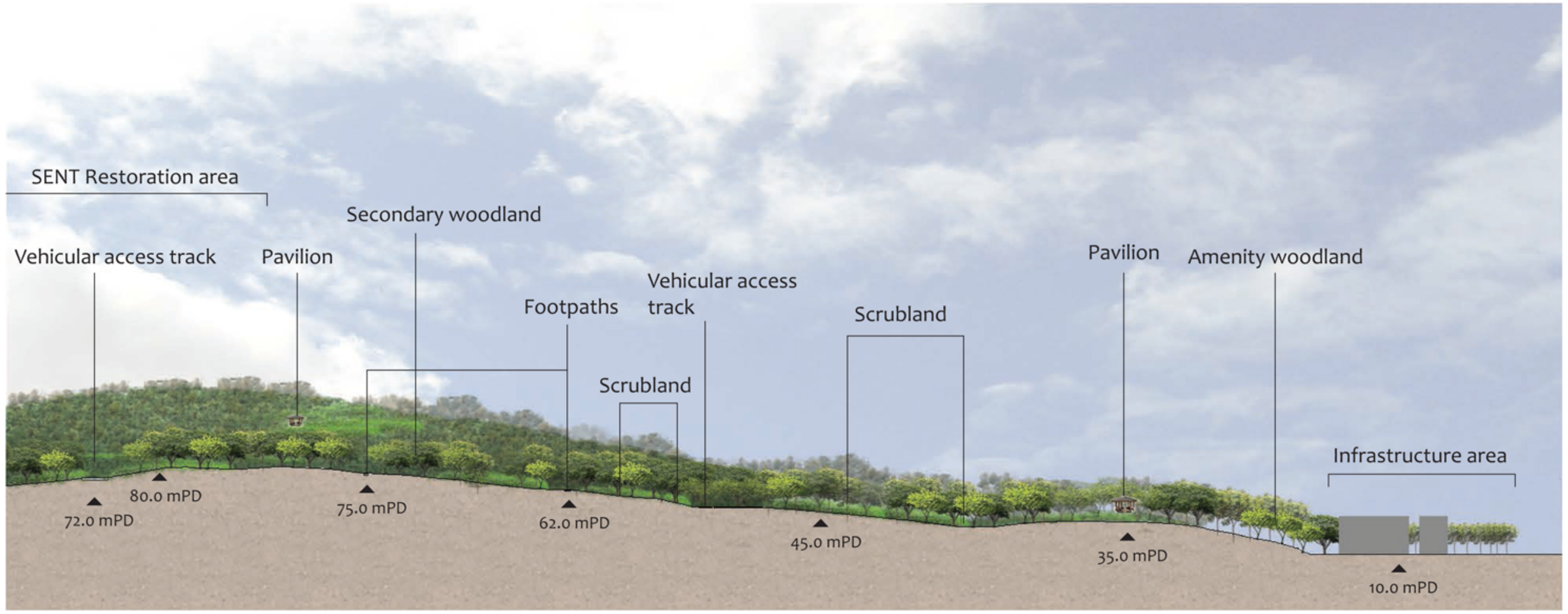
Layout Plan of SENTX

File: T:\GIS\CONTRACT\0354924\Mxd\0354924_Layout_Plan_of_SENTX.mxd
Date: 29/4/2025

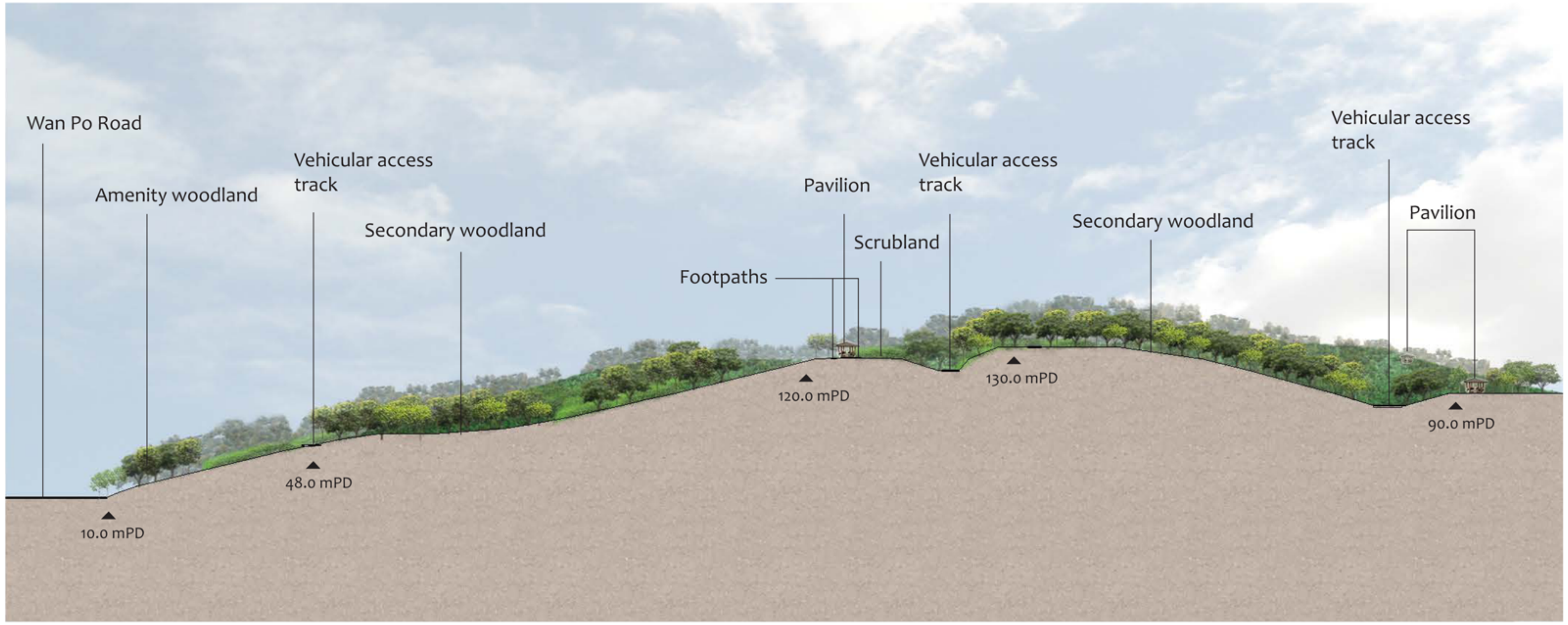
Figure 2.2

SENT Landscape Restoration Master Plan

Environmental Resources Management
ERM



A A'



B B'

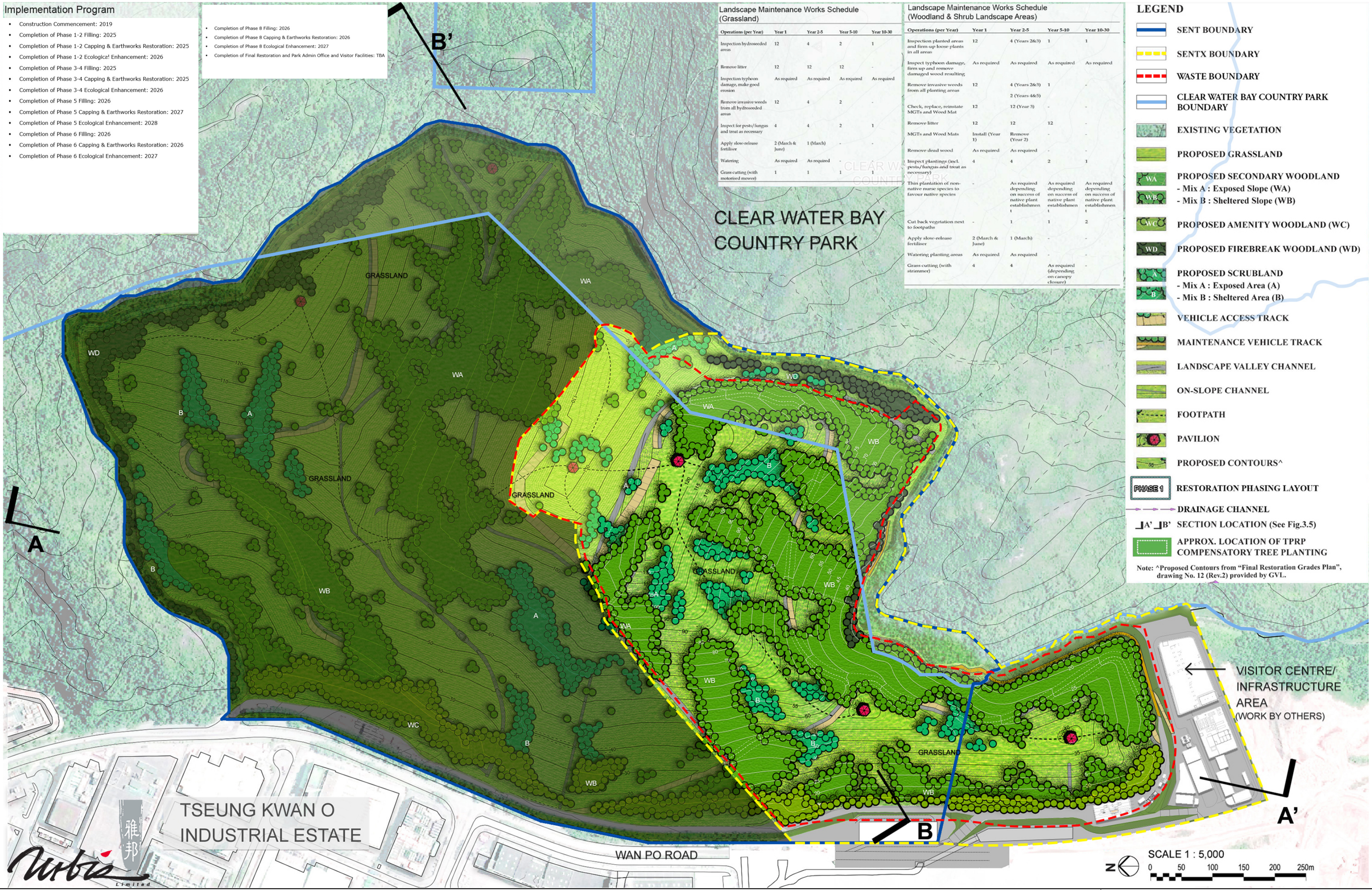
Scale: 1:5000

Figure 2.3

Sections through Restored SENTX Landfill

Environmental Resources Management

ERM



Landscape Maintenance Works Schedule (Grassland)

Operations (per Year)	Year 1	Year 2-5	Year 5-10	Year 10-30
Inspection hydroseeded areas	12	4	2	1
Remove litter	12	12	12	-
Inspection typhoon damage, make good erosion	As required	As required	As required	As required
Remove invasive weeds from all hydroseeded areas	12	4	2	-
Inspect for pests/fungus and treat as necessary	4	4	2	1
Apply slow-release fertiliser	2 (March & June)	1 (March)	-	-
Watering	As required	As required	-	-
Grass cutting (with motorised mower)	1	1	1	1

Landscape Maintenance Works Schedule (Woodland & Shrub Landscape Areas)

Operations (per Year)	Year 1	Year 2-5	Year 5-10	Year 10-30
Inspection planted areas and firm-up loose plants in all areas	12	4 (Years 2&3)	1	1
Inspect typhoon damage, firm up and remove damaged wood resulting	As required	As required	As required	As required
Remove invasive weeds from all planting areas	12	4 (Years 2&3) 2 (Years 4&5)	1	-
Check, replace, reinstate MGTs and Weed Mat	12	12 (Year 3)	-	-
Remove litter	12	12	12	-
MGTs and Weed Mats	Install (Year 1)	Remove (Year 2)	-	-
Remove dead wood	As required	As required	-	-
Inspect plantings (incl. pests/fungus and treat as necessary)	4	4	2	1
Thin plantation of non-native nurse species to favour native species	-	As required depending on success of native plant establishment	As required depending on success of native plant establishment	As required depending on success of native plant establishment
Cut back vegetation next to footpaths	-	1	1	2
Apply slow-release fertiliser	2 (March & June)	1 (March)	-	-
Watering planting areas	As required	As required	-	-
Grass cutting (with strimmer)	4	4	As required (depending on canopy closure)	-

Figure 3.1 SENTX Restoration and Ecological Enhancement Plan

Figure 3.1.1

SENTX Restoration and Ecological Enhancement Plan_1

ERM

File: T:\GIS\CONTRACT\0465169\mxd\EM&A\0465169_Restoration_Ecological_Enhancement_Plan_1.mxd
Date: 27/10/2025

scale 1:1000 @A0

Figure 3.1.2

SENTX Restoration and Ecological Enhancement Plan_2

ERM

File: T:\GIS\CONTRACT\0465169\mxd\EM&A\0465169_Restoration_Ecological_Enhancement_Plan_2.mxd
Date: 27/10/2025

scale 1:1000 @A0

Figure 3.1.3

SENTX Restoration and Ecological Enhancement Plan_3

ERM

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Date: 27/10/2025

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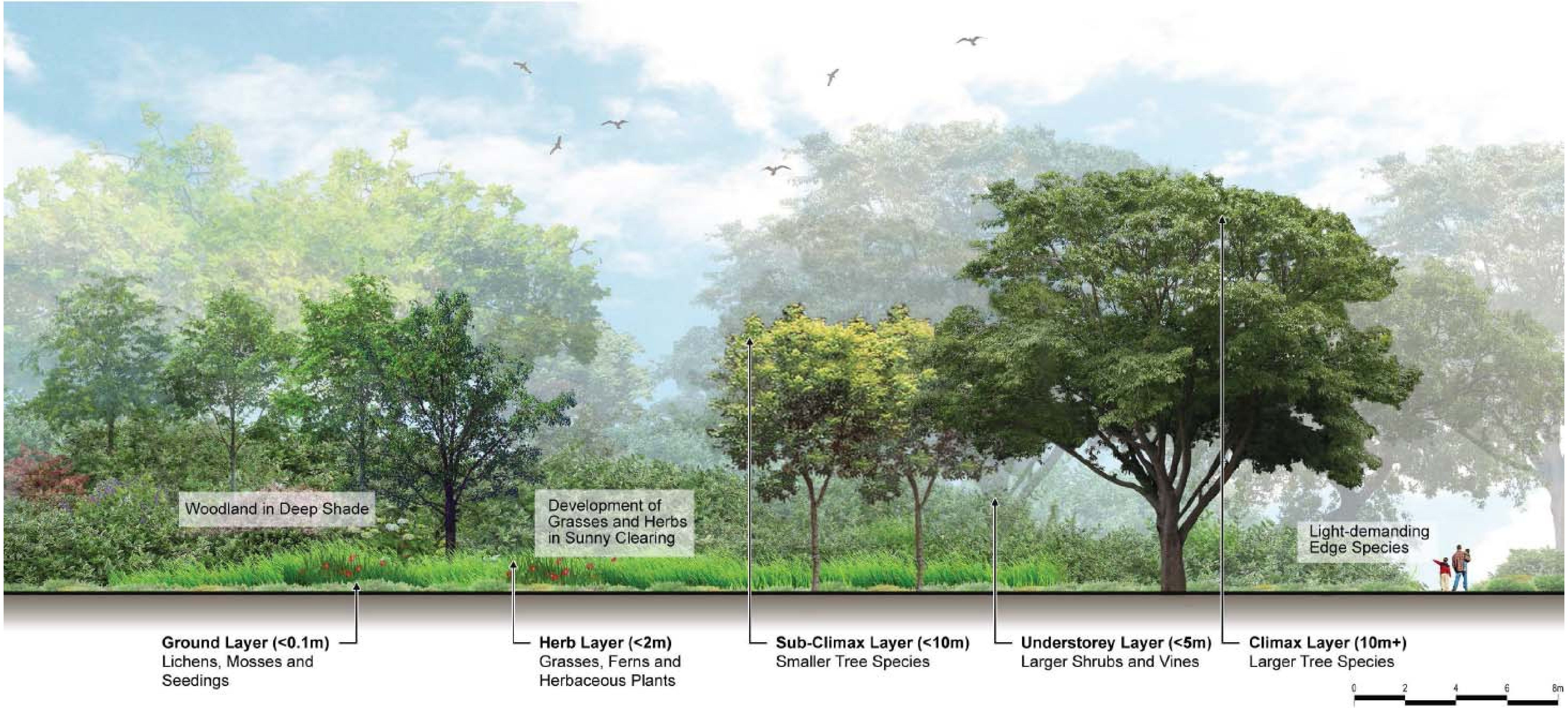

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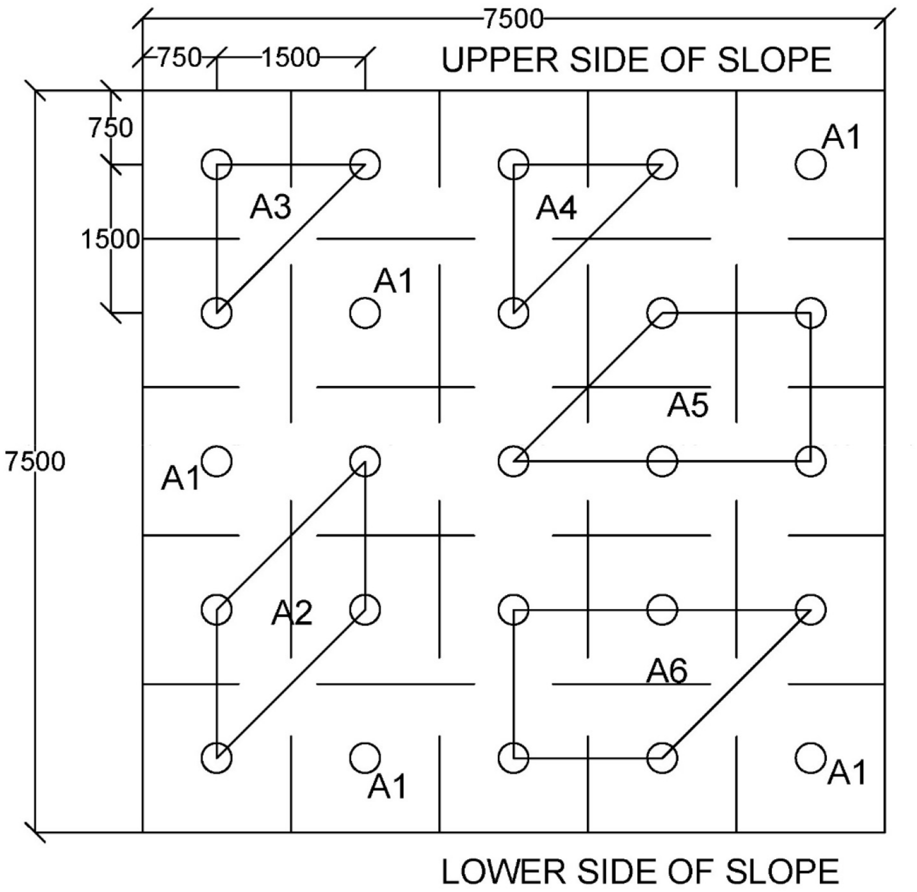
Figure 3.2

Typical Vegetation Structure in Hypothetical Climax Woodland

Environmental Resources Management

ERM



WOODLAND TYPE: A (EXPOSED)			
Code	Species	Percentage	Quantities
Pioneer spp.			
A1	Acacia confusa	20%	5
Climax spp.			
A2	Camellia crapnelliana	16%	4
A3	Sapium sebiferum	12%	3
A4	Rhaphiolepis indica	12%	3
A5	Phyllanthus emblica	20%	5
A6	Celtis sinensis	20%	5
		TOTAL:	25

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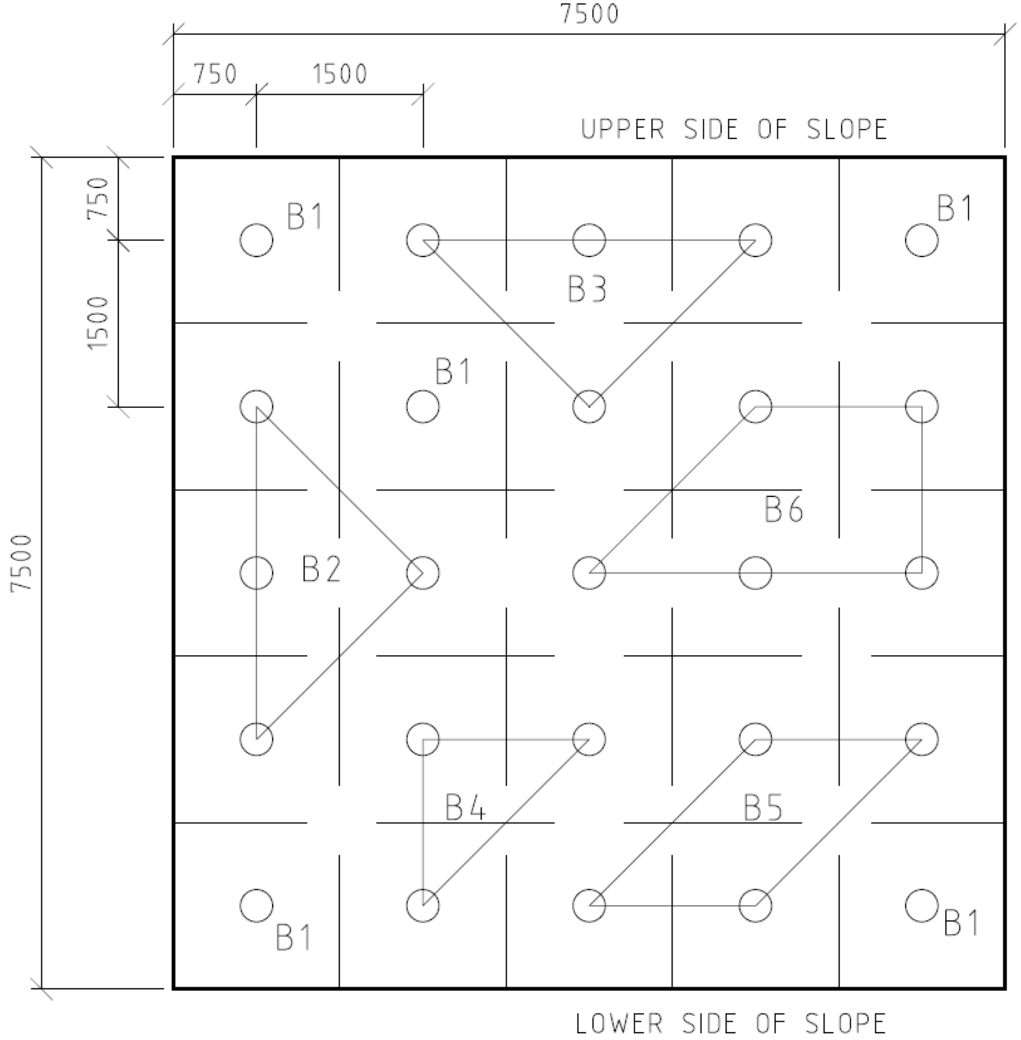
Figure 4.1

Planting Matrix- Woodland Type A (Exposed)

Environmental Resources Management

ERM



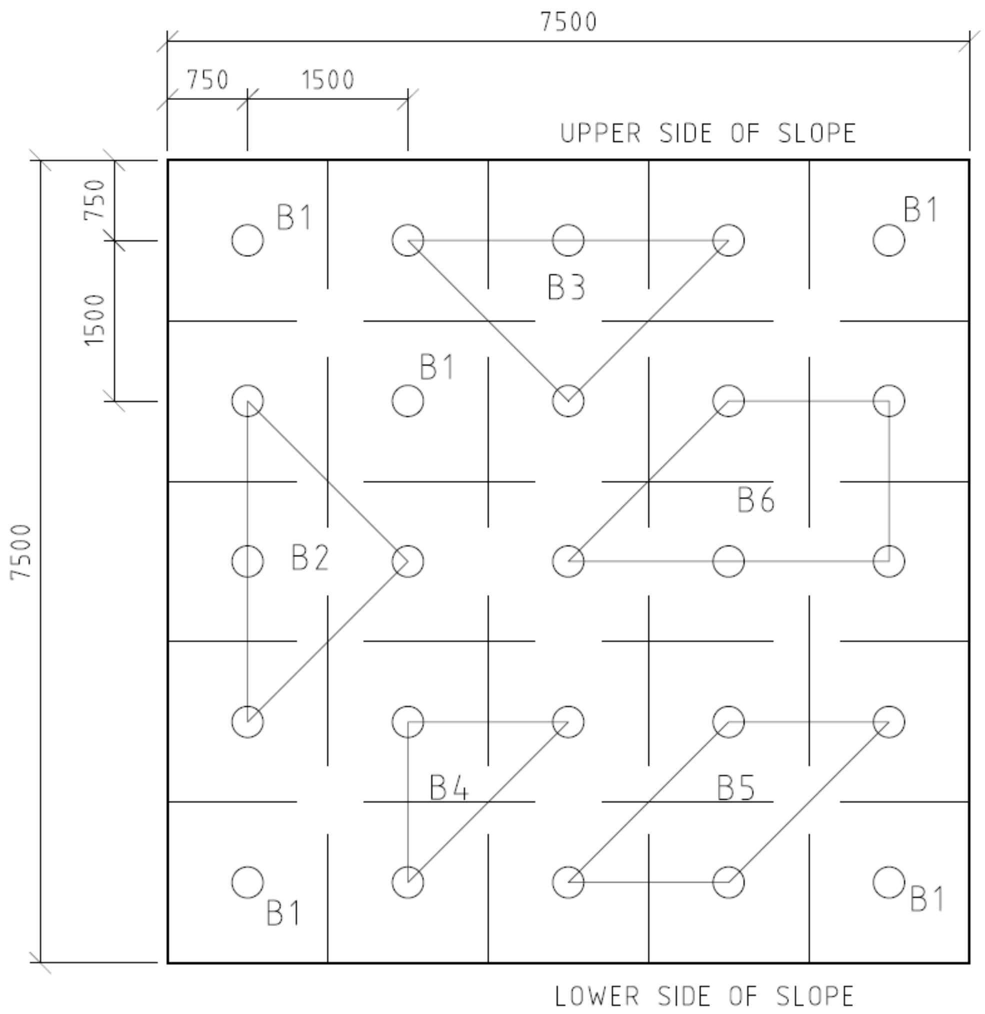
WOODLAND TYPE: B (SHELTERED)			
Code	Species	Percentage	Quantities
Pioneer spp.			
B1	Acacia auriculiformis	20%	5
Climax spp.			
B2	Machilus breviflora	16%	4
B3	Ficus subpisocarpa	16%	4
B4	Litsea glutinosa	12%	3
B5	Ficus microcarpa	16%	4
B6	Syzygium levinei	20%	5
	TOTAL:		25

Figure 4.2

Planting Matrix- Woodland Type B (Sheltered)

Environmental Resources Management

ERM



WOODLAND TYPE: B (SHELTERED)			
Code	Species	Percentage	Quantities
Pioneer spp.			
B1	Acacia auriculiformis	20%	5
Climax spp.			
B2	Machilus breviflora	16%	4
B3	Cratoxylum cochinchinense	16%	4
B4	Litsea glutinosa	12%	3
B5	Schefflera heptaphylla	16%	4
B6	Syzygium levinei	20%	5
		TOTAL:	25

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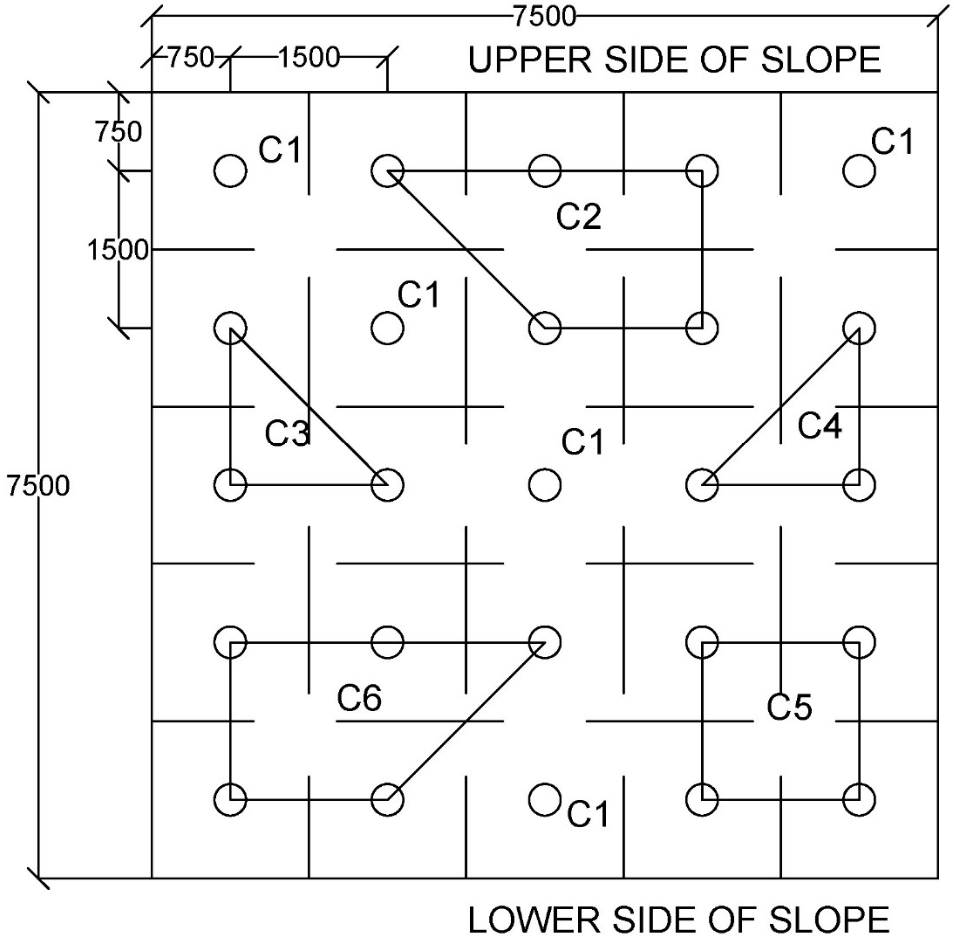
Figure 4.2a

Planting Matrix- Woodland Type B (Sheltered) (CWBCP)

Environmental Resources Management

ERM



WOODLAND TYPE: C (AMENITY)			
Code	Species	Percentage	Quantities
Pioneer spp.			
C1	Acacia confusa	20%	5
Climax spp.			
C2	Pongamia pinnata	20%	5
C3	Rhodomyrtus tomentosa	12%	3
C4	Ilex asprella	12%	3
C5	Phyllanthus emblica	16%	4
C6	Rhodoleia championii	20%	5
		TOTAL:	25

Figure 4.3

Planting Matrix- Woodland Type C (Amenity)

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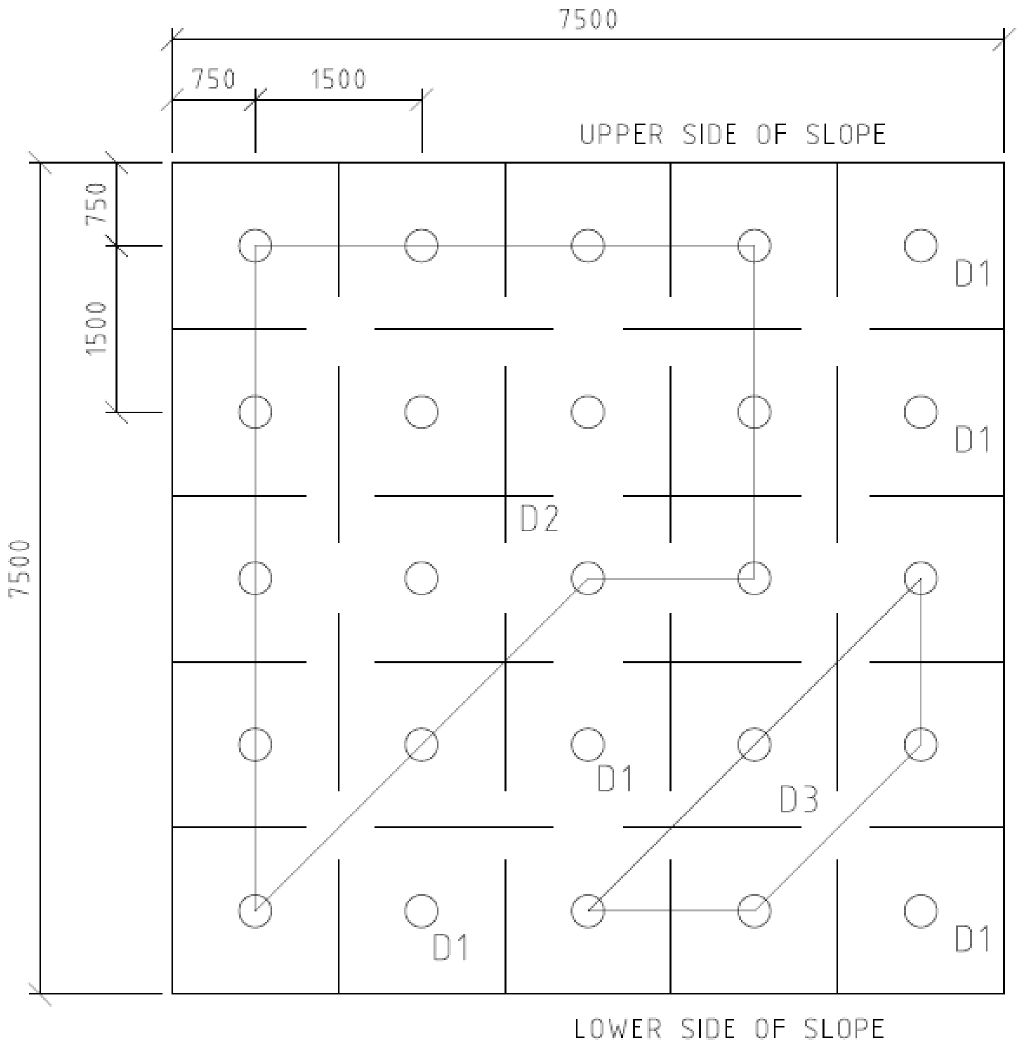
Environmental Resources Management

ERM



WOODLAND TYPE: D (FIREBREAK)			
Code	Species	Percentage	Quantities
Pioneer spp.			
D1	Acacia confusa	20%	5
Climax spp.			
D2	Cratoxylum cochinchinensis	60%	15
D3	Schima superba	20%	5
	TOTAL:		25

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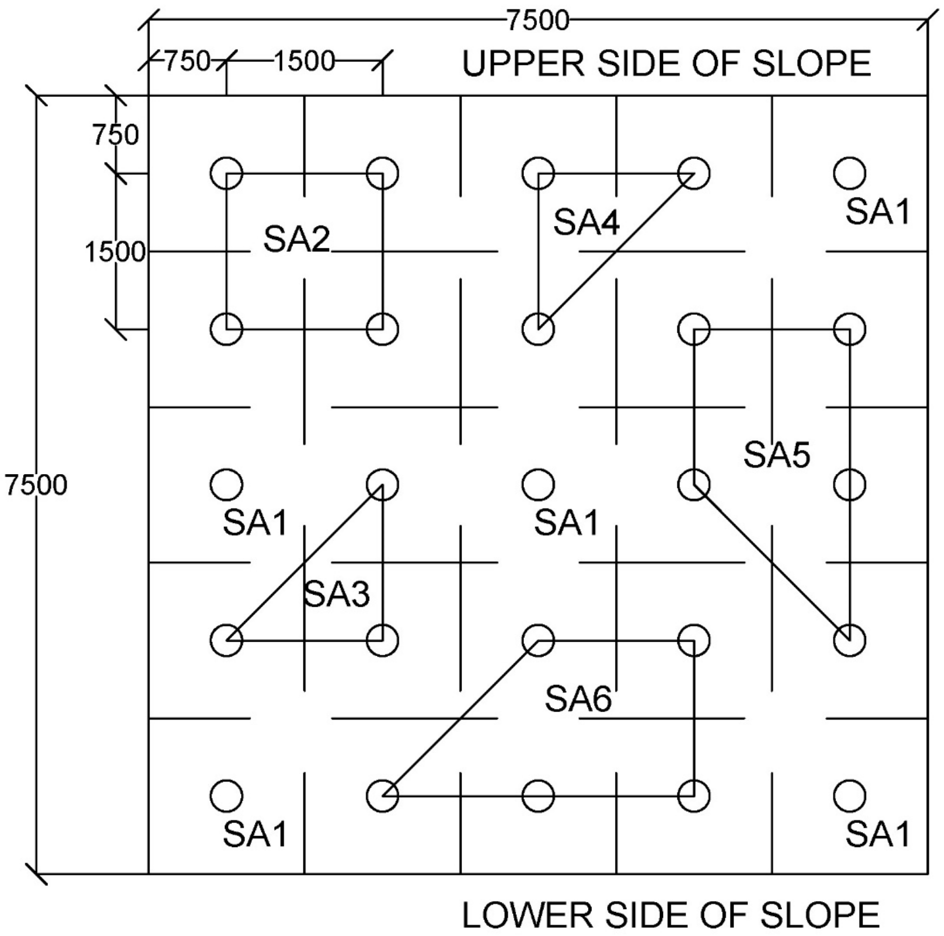
Figure 4.4

Planting Matrix- Woodland Type D (Firebreak)

Environmental Resources Management

ERM



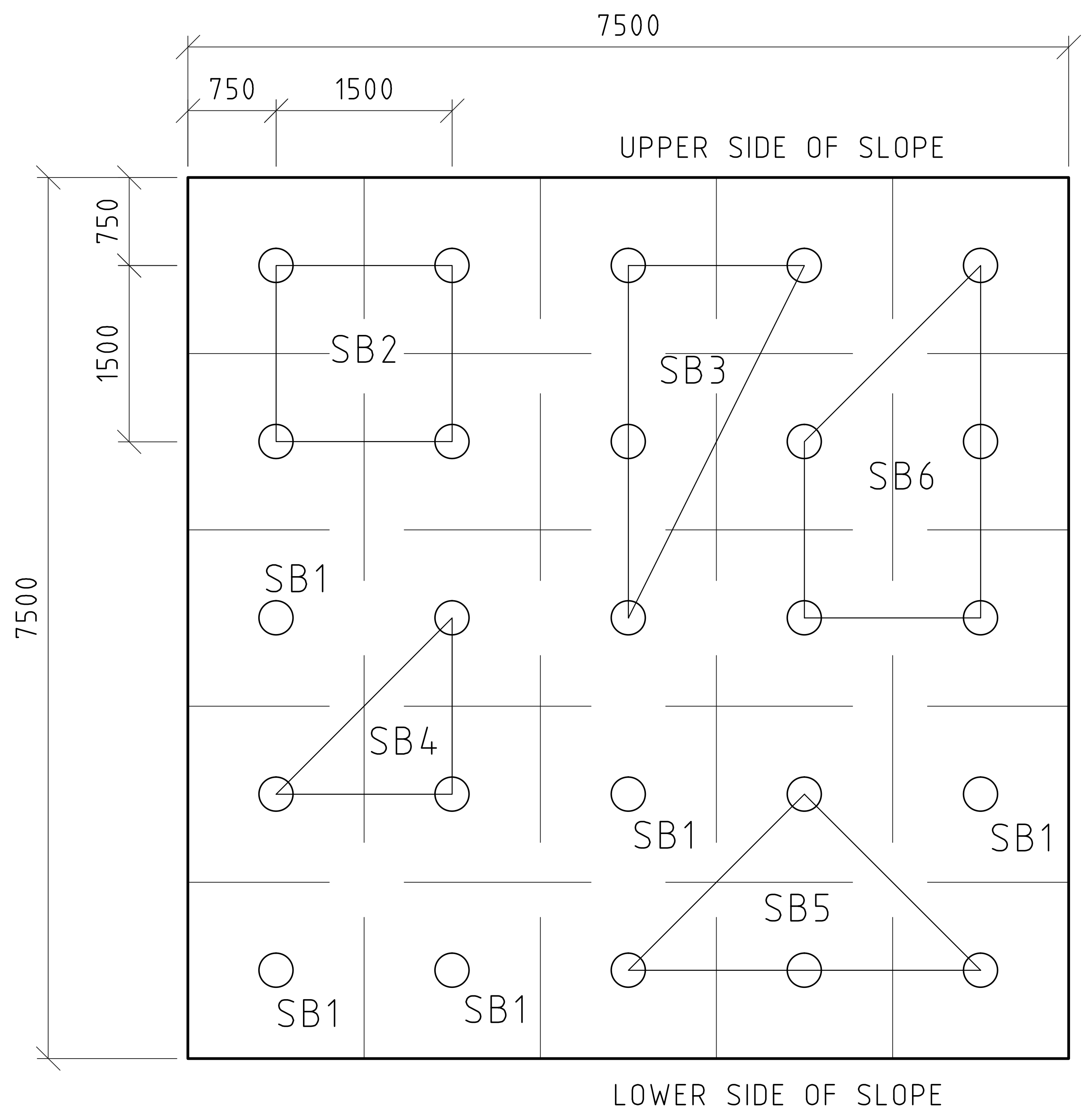
SHRUBLAND TYPE: A			
Code	Species	Percentage	Quantities
Pioneer spp.			
SA1	Acacia mangium	20%	5
Climax spp.			
SA2	Syzygium buxifolium	16%	4
SA3	Ixora chinensis	12%	3
SA4	Ilex asprella	12%	3
SA5	Phyllanthus emblica	20%	5
SA6	Lespedeza formosa	20%	5
		TOTAL:	25

Figure 4.5

Planting Matrix- Shrubland Type A

Environmental Resources Management

ERM



SHRUBLAND TYPE: B (FOOD PLANTS OF BUTTERFLY INCLUDED)			
Code	Species	Percentage	Quantities
Pioneer spp.			
SB1	Acacia auriculiformis	20%	5
Climax spp.			
SB2	Rhaphiolepis indica	16%	4
SB3	Lespedeza formosa	16%	4
SB4	Ilex asprella	12%	3
SB5	Urena lobata	16%	4
SB6	Vitex negundo r. cannabafolia	20%	5
		TOTAL:	25

Fig 4.6 Planting Matrix - Shrubland **Type B (Food Plants of Butterfly Included)**

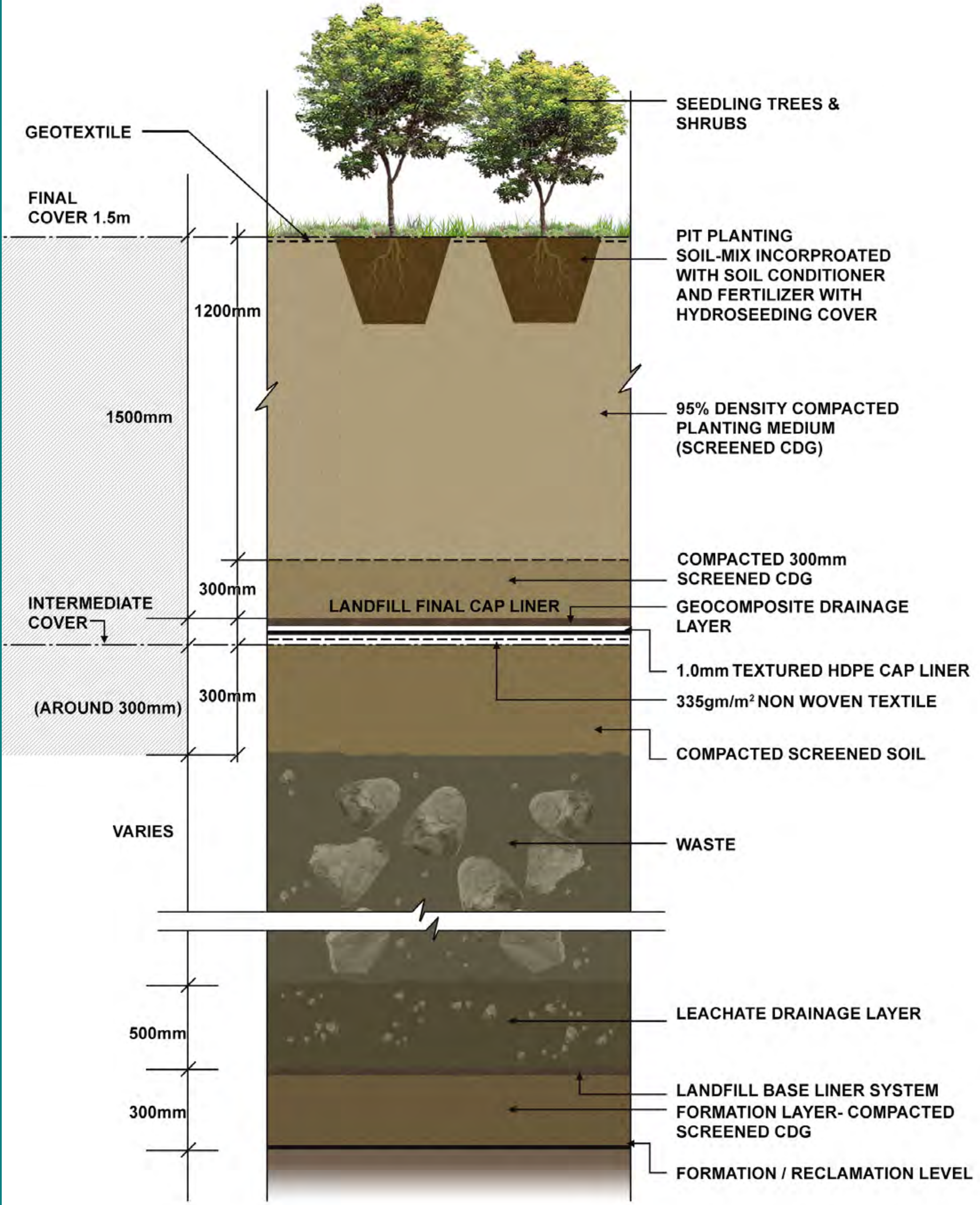


Fig 4.7 Detailed Cross-Section through Landfill Site

NOTES:

1. DO NOT SCALE FROM THIS DRAWING.
2. PLEASE FOLLOW THE INSTRUCTIONS FROM MANUFACTURER FOR THE APPLICATION OF FERTILIZER.

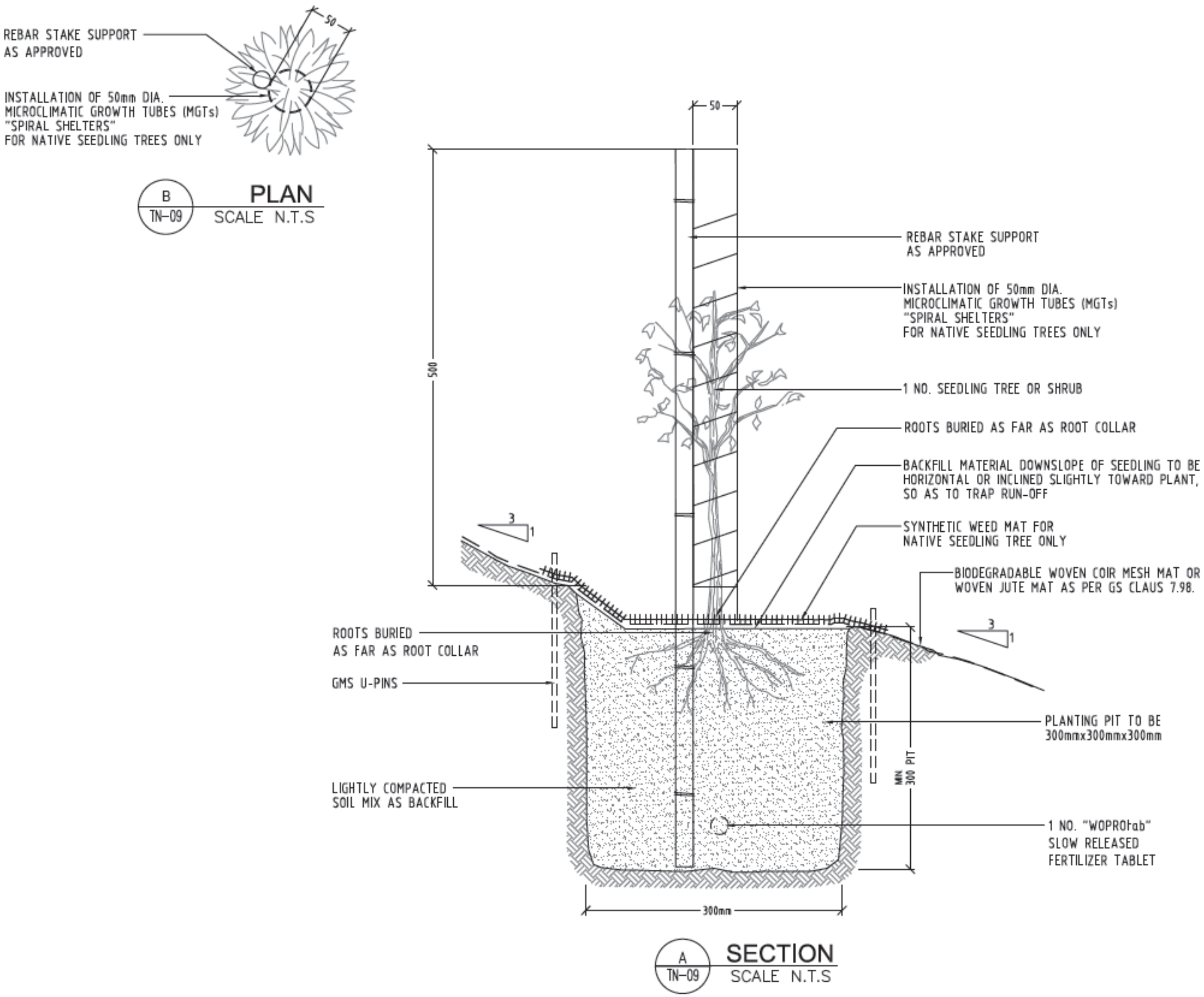


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Figure 4.8

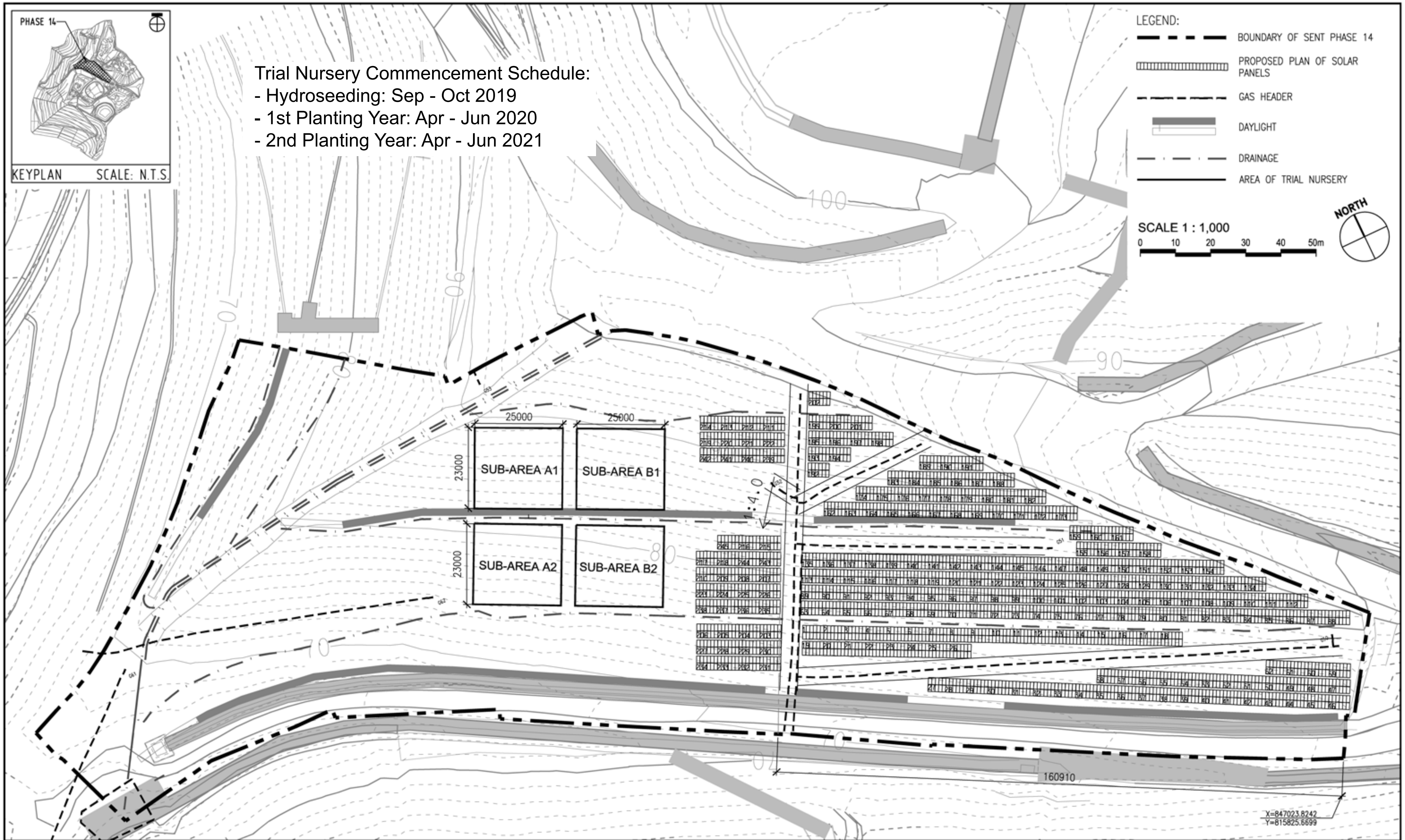
Pit-Planting Detail

Environmental Resources Management

ERM

APPENDIX A TRIAL NURSERY LOCATION AND COMMENCEMENT SCHEDULE

Trial Nursery Commencement Schedule:
- Hydroseeding: Sep - Oct 2019
- 1st Planting Year: Apr - Jun 2020
- 2nd Planting Year: Apr - Jun 2021



Amendment No.	Date	Description	Drawn by	Checked by	Approved by

Job Title
Contract No. EP/SP/10/91
SOUTH-EAST NEW TERRITORIES LANDFILL EXTENSION

Drawing Title
TRIAL NURSERY LOCATION KEY PLAN

Drawing No. GVL16-TN-01

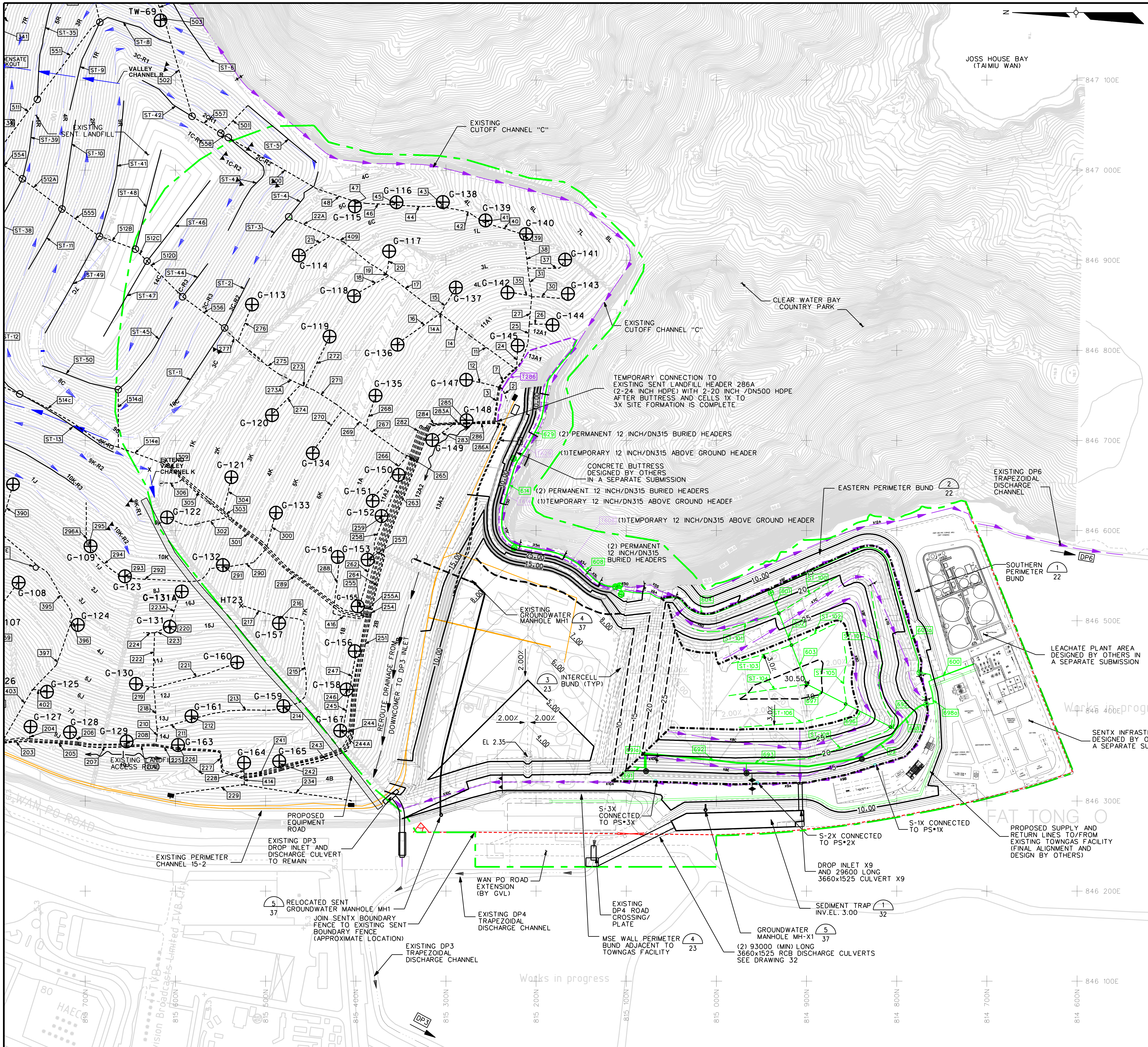
Scale 1:1000

Drawn by	TW	Checked by	BL	Approved by	-	Date	JUL 2018	Job. No.	GVL16

Urbis Limited 雅邦
Planning, Urban Design, Landscape, Golf & Environmental Consultants
Urbis Limited, 11/F Siu On Centre, 188 Lockhart Road, Wan Chai, Hong Kong. Tel : 2802 3333 Fax : 2802 8662

G:\DAVID\GVL16\Deliverables\Trial Nursery\CAD\GVL16-TN-01.dwg, Layout1, 02-11-2018 12:13:22, Vanessa, Adobe PDF, 1:1

APPENDIX B CONSTRUCTION PHASE OF SENTX LANDFILL



LEGEND

- EXISTING MAJOR CONTOURS
- EXISTING MINOR CONTOURS
- EXISTING SPOT ELEVATION
- PERMITTED SENTX SITE BOUNDARY
- PROPOSED SENTX BOUNDARY FENCE (APPROXIMATE LOCATION)
- EXISTING SENT LANDFILL DUAL-CONTAINMENT (150/250) LEACHATE FORCEMAIN
- EXISTING/APPROVED SENT LANDFILL GAS MANAGEMENT SYSTEM (SEE NOTE 4)
- SENT - BURIED SUBSURFACE TRANSFER HEADER
- SENT - BURIED PERFORATED COLLECTION TRENCH
- G136(S) SENT - BURIED SUBSURFACE COLLECTION WELL
- 5.00 SENTX SITE FORMATION MAJOR CONTOUR (5M)
- 4.00 SENTX SITE FORMATION CONTOUR (1M)
- 20 SENTX FINAL RESTORATION MAJOR CONTOUR (5M)
- SENTX FINAL RESTORATION CONTOUR (1M)
- PROPOSED TEMPORARY HEADERS
- R142 PROPOSED REMOTE WELLHEAD
- PROPOSED ABOVE CAP SOLID HDPE TRANSFER HEADER
- PROPOSED BELOW CAP PERFORATED COLLECTION TRENCH
- PROPOSED SUBSURFACE COLLECTION TRENCH HEAD
- PROPOSED LANDFILL GAS CONTROL VALVE
- PROPOSED LANDFILL GAS CONDENSATE KNOCKOUT
- PROPOSED SENTX STORMWATER CHANNEL (SEE NOTE 9)
- APPROVED SENT REDESIGN STORMWATER CHANNELS (SEE NOTE 9)
- FINAL RESTORATION AREA (CURRENT PHASE)

GROSS VOID VOLUME	1,037,190 CU.M
SENTX FINAL RESTORATION AREA	44,553 SQ.M
SUBTRACT SENTX RESTORATION CAP (AREAx1800 THICK)	- 80,195 CU,M
SENT RESTORATION SOIL STRIPPING AREA	0 SQ.M
ADD SENT RESTORATION SOIL STRIPPING VOLUME (AREAx1000 THICK)	+ 0 CU.M
NET VOID VOLUME	956,995 CU.M

NOTE: GROSS VOID VOLUME CALCULATED FROM TOP OF SENTX DRAINAGE LAYER, TOP OF SENTX BUTTRESS, AND SENT RESTORATION SURFACE TO THE SENTX PRE-SETTLEMENT TOP OF INTERMEDIATE AND FINAL RESTORATION GRADES

GENERAL NOTES:

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4. FINAL APPROVED LANDFILL GAS MANAGEMENT SYSTEM OF THE SENT LANDFILL HAS BEEN INDICATED.
5. APPROVED SENTX SITE BOUNDARY TAKEN FROM ARUP DRAWING 24 3618/01/01, REV B.
6. DETAILED EXISTING SENT COMBINED SERVICES (UTILITIES) ARE PROVIDED ON DRAWING CU-2018-001, REV 1 (GVL REF"EZ/FL/60362/t8/tt).
7. THE EASTERN BUTTRESS, THE MSE WALL, THE SENTX LEACHATE PLANT, AND THE SENTX INFRASTRUCTURE ARE INDICATIVE ONLY AND FINAL DESIGN WILL BE PROVIDED UNDER SEPARATE SUBMISSIONS.
8. SEE DRAWING 06 FOR INDICATIVE UTILITY TYPE, LOCATION AND ROUTING.
9. SEE DRAWING 14 FOR STORMWATER MANAGEMENT SYSTEM LAYOUT.

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REV.	DESCRIPTION	DATE	APPROVED
⚠	FINAL RESTORATION SUBMISSION	5.2019	

ENVIRONMENTAL PROTECTION DEPARTMENT

SIGNED : ( )

FOR ENVIRONMENTAL PROTECTION DEPARTMENT

DATE :

MEINHARDT INFRASTRUCTURE AND ENVIRONMENT LTD

VERIFICATION BY INDEPENDENT CONSULTANTS

SIGNED :

FOR MEINHARDT INFRASTRUCTURE AND ENVIRONMENT LTD

DATE :

ENVIRONMENTAL PROTECTION DEPARTMENT
HONG KONG GOVERNMENT

CONTRACT EP/SP/10/91

DEVELOPMENT AND MANAGEMENT OF SOUTH-EAST NEW TERRITORIES LANDFILL EXTENSION (SENTX)

翠谷 GREEN VALLEY LANDFILL, LIMITED

AECOM

PHASE 1 FILLING AND PHASE 2 CONSTRUCTION PLAN

DESIGNED	BPS	DRAWN	RAZ
CHECKED	KDM	APPROVED	
SCALE	AS SHOWN	CADD DATE	5.2019
DRAWING NO.	09	REV ⚠	SHEET NO

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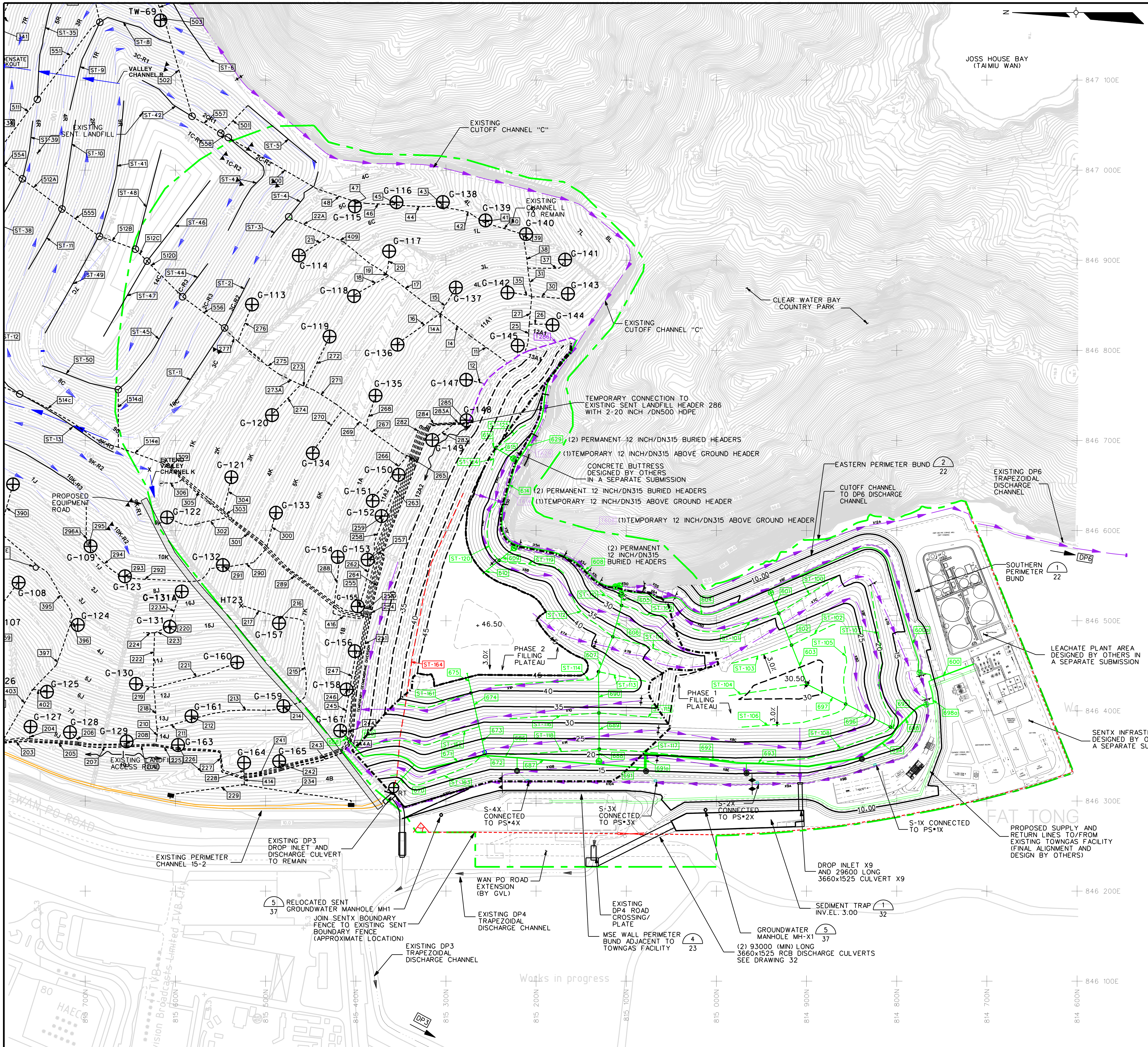

LEGEND

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- PROPOSED SENTX BOUNDARY FENCE (APPROXIMATE LOCATION)
- EXISTING SENT LANDFILL DUAL-CONTAINMENT (150/250) LEACHATE FORCEMAIN
- EXISTING/APPROVED SENT LANDFILL GAS MANAGEMENT SYSTEM (SEE NOTE 4)
- SENT - BURIED SUBSURFACE TRANSFER HEADER
- SENT - BURIED PERFORATED COLLECTION TRENCH
- G136(S) SENT - BURIED SUBSURFACE COLLECTION WELL
- SENTX SITE FORMATION MAJOR CONTOUR (5M)
- SENTX SITE FORMATION CONTOUR (1M)
- SENTX FINAL RESTORATION MAJOR CONTOUR (5M)
- SENTX FINAL RESTORATION CONTOUR (1M)
- PROPOSED TEMPORARY HEADERS
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- PROPOSED SUBSURFACE COLLECTION TRENCH HEAD
- PROPOSED LANDFILL GAS CONTROL VALVE
- PROPOSED LANDFILL GAS CONDENSATE KNOCKOUT
- PROPOSED SENTX STORMWATER CHANNEL (SEE NOTE 9)
- APPROVED SENT REDESIGN STORMWATER CHANNELS (SEE NOTE 9)
- FINAL RESTORATION AREA (CURRENT PHASE)

GROSS VOID VOLUME	2,045,168 CU.M
SENTX FINAL RESTORATION AREA	62,680 SQ.M
SUBTRACT SENTX RESTORATION CAP (AREAx1800 THICK)	- 112,824 CU,M
SENT RESTORATION SOIL STRIPPING AREA	26,280 SQ.M
ADD SENT RESTORATION SOIL STRIPPING VOLUME (AREAx1000 THICK)	+ 26,280 CU.M
NET VOID VOLUME	1,958,624 CU.M

NOTE: GROSS VOID VOLUME CALCULATED FROM TOP OF SENTX DRAINAGE LAYER, TOP OF SENTX BUTTRESS, AND SENT RESTORATION SURFACE TO THE SENTX PRE-SETTLEMENT TOP OF INTERMEDIATE AND FINAL RESTORATION GRADES

GENERAL NOTES:

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8. SEE DRAWING 06 FOR INDICATIVE UTILITY TYPE, LOCATION AND ROUTING.
9. SEE DRAWING 14 FOR STORMWATER MANAGEMENT SYSTEM LAYOUT.

REV.	DESCRIPTION	DATE	APPROVED
1	FINAL RESTORATION SUBMISSION	5.2019	

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METRES 1:2000

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HONG KONG GOVERNMENT

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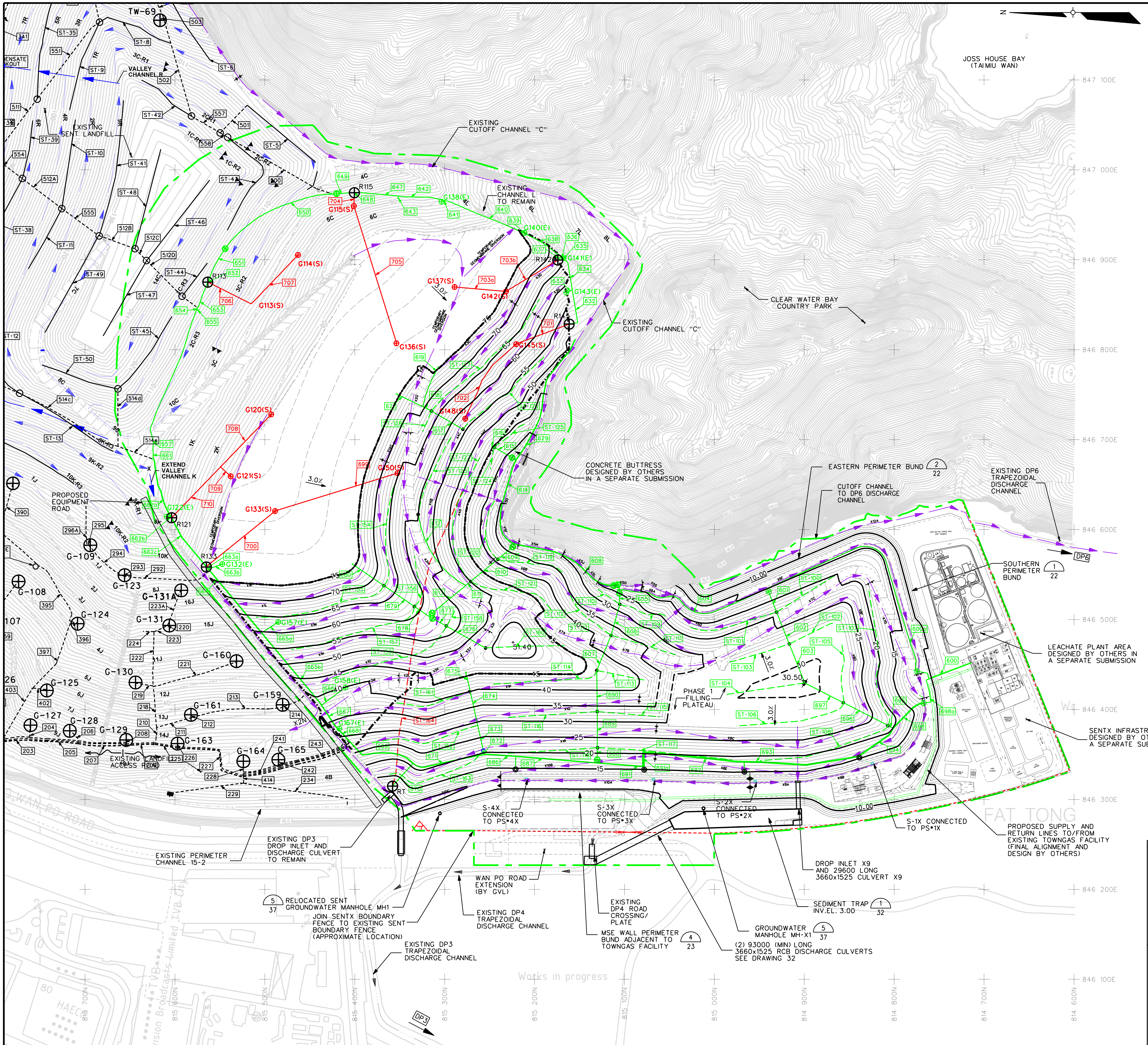
翠谷 GREEN VALLEY LANDFILL, LIMITED

AECOM

PHASE 2 FILLING AND PHASE 3 CONSTRUCTION PLAN

DESIGNED	BPS	DRAWN	RAZ
CHECKED	KDM	APPROVED	
SCALE	AS SHOWN	CADD DATE	5.2019
DRAWING NO.	10	REV 1	SHEET NO



METRES
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- PROPOSED LANDFILL GAS CONDENSATE KNOCKOUT
- PROPOSED SENTX STORMWATER CHANNEL (SEE NOTE 9)
- APPROVED SENT REDESIGN STORMWATER CHANNELS (SEE NOTE 9)
- FINAL RESTORATION AREA (CURRENT PHASE)

GROSS VOID VOLUME	2,004,741 CU.M
SENTX FINAL RESTORATION AREA	86,587 SQ.M
SUBTRACT SENTX RESTORATION CAP (AREAx1800 THICK)	- 155,856 CU,M
SENT RESTORATION SOIL STRIPPING AREA	110,346 SQ.M
ADD SENT RESTORATION SOIL STRIPPING VOLUME (AREAx1000 THICK)	+ 110,346 CU.M
NET VOID VOLUME	1,959,231 CU.M

NOTE: GROSS VOID VOLUME CALCULATED FROM TOP OF SENTX DRAINAGE LAYER, TOP OF SENTX BUTTRESS, AND SENT RESTORATION SURFACE TO THE SENTX PRE-SETTLEMENT TOP OF INTERMEDIATE AND FINAL RESTORATION GRADES

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HONG KONG GOVERNMENT

CONTRACT EP/SP/10/91

DEVELOPMENT AND MANAGEMENT OF SOUTH-EAST NEW TERRITORIES LANDFILL EXTENSION (SENTX)

GREEN VALLEY LANDFILL, LIMITED

AECOM

ENVIRONMENTAL PROTECTION DEPARTMENT

SIGNED : ( )

FOR ENVIRONMENTAL PROTECTION DEPARTMENT

DATE :

MEINHARDT INFRASTRUCTURE AND ENVIRONMENT LTD

VERIFICATION BY INDEPENDENT CONSULTANTS

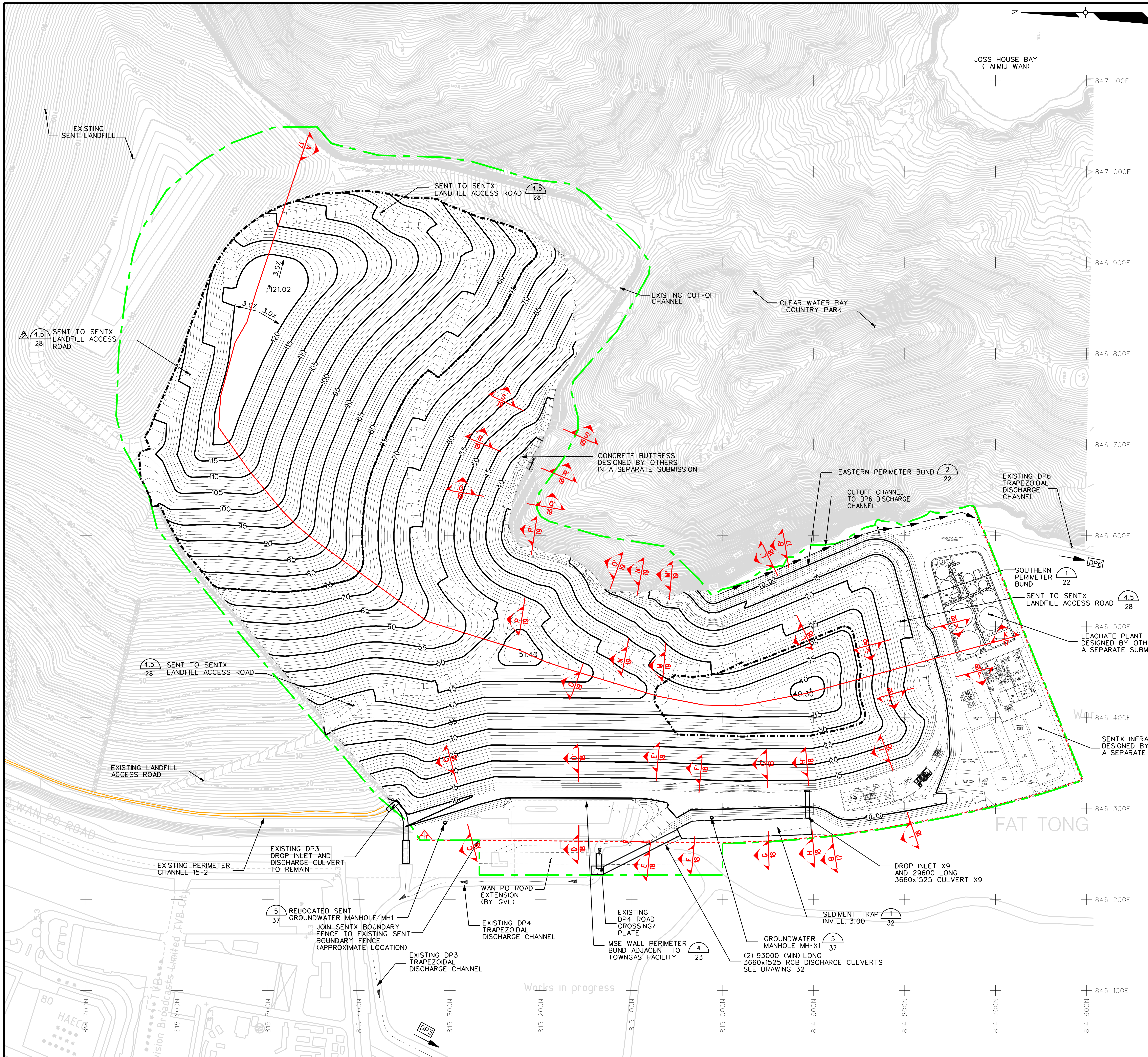
SIGNED :

FOR MEINHARDT INFRASTRUCTURE AND ENVIRONMENT LTD

DATE :

PHASE 3 FILLING AND PHASE 4 CONSTRUCTION PLAN

DESIGNED	BPS	DRAWN	RAZ
CHECKED	KDM	APPROVED	
SCALE	AS SHOWN	CADD DATE	5.2019
DRAWING NO.	11	REV 1	SHEET NO



LEGEND

20	EXISTING MAJOR CONTOURS
	EXISTING MINOR CONTOURS
× 70.1	EXISTING SPOT ELEVATION
35	SITE PRE-SETTLEMENT RESTORATION MAJOR CONTOUR (5M)
	SITE PRE-SETTLEMENT RESTORATION MINOR CONTOUR (1M)
	SENTX SITE BOUNDARY
F / 10, F' / 10	CROSS SECTION MARKER LOCATION
	PROPOSED SENTX BOUNDARY FENCE (APPROXIMATE LOCATION)
	FINAL RESTORATION AREA (CURRENT PHASE)

△2	GROSS VOID VOLUME	1,907,170 CU.M
	SENTX FINAL RESTORATION AREA	118,064 SQ.M
	SUBTRACT SENTX RESTORATION CAP (AREAx1800 THICK)	- 212,515 CU,M
	SENT RESTORATION SOIL STRIPPING AREA	56,661 SQ.M
	ADD SENT RESTORATION SOIL STRIPPING VOLUME (AREAx1000 THICK)	+ 56,661 CU.M
△2	NET VOID VOLUME	1,751,316 CU.M

NOTE: GROSS VOID VOLUME CALCULATED FROM TOP OF SENTX DRAINAGE LAYER, TOP OF SENTX BUTTRESS, AND SENT RESTORATION SURFACE TO THE SENTX PRE-SETTLEMENT TOP OF INTERMEDIATE AND FINAL RESTORATION GRADES

GENERAL NOTES:

1. EXISTING 2016 TOPOGRAPHY PROVIDED TO AECOM, INC. BY GVL IN CAD FILE "PRE2018B.DGN". EXISTING TOPOGRAPHY IN PROPOSED BUTTRESS AREA UPDATED BY GVL MARCH 2016.
2. AS-BUILT LOCATIONS FOR EXISTING UTILITIES, LEACHATE FORCEMAIN, LANDFILL GAS WELLS, LANDFILL GAS PIPING, ETC. PROVIDED BY GVL.
3. APPROVED FINAL RESTORATION OF THE SENT LANDFILL HAS BEEN INDICATED.
4. APPROVED SENTX SITE BOUNDARY TAKEN FROM ARUP DRAWING 24 3618/01/01, REV B.
5. DETAILED EXISTING SENT COMBINED SERVICES (UTILITIES) ARE PROVIDED ON DRAWING CU-2018-001, REV 1 (GVL REF"EZ/FL/60362/18/tt).
6. THE EASTERN BUTTRESS, THE MSE WALL, THE SENTX LEACHATE PLANT, AND THE SENTX INFRASTRUCTURE ARE INDICATIVE ONLY AND FINAL DESIGN WILL BE PROVIDED UNDER SEPARATE SUBMISSIONS.
7. SEE DRAWING 06 FOR INDICATIVE UTILITY TYPE, LOCATION AND ROUTING.
8. SEE DRAWING 14 FOR STORMWATER MANAGEMENT SYSTEM LAYOUT.
9. SEE DRAWING 15 FOR LANDFILL GAS MANAGEMENT SYSTEM LAYOUT.

REV.	DESCRIPTION	DATE	APPROVED
△2	ADDED ACCESS ROAD, REV. FINAL GRADES, REV. AIRSPACE VOLUME	8.2019	
△1	FINAL RESTORATION SUBMISSION	5.2019	

40 0 40 80
METRES
1:2000

ENVIRONMENTAL PROTECTION DEPARTMENT

SIGNED : ( )

FOR ENVIRONMENTAL PROTECTION DEPARTMENT

DATE :

MEINHARDT INFRASTRUCTURE AND ENVIRONMENT LTD

VERIFICATION BY INDEPENDENT CONSULTANTS

SIGNED :

FOR MEINHARDT INFRASTRUCTURE AND ENVIRONMENT LTD

DATE :

ENVIRONMENTAL PROTECTION DEPARTMENT
HONG KONG GOVERNMENT

CONTRACT EP/SP/10/91

DEVELOPMENT AND MANAGEMENT OF SOUTH-EAST NEW TERRITORIES LANDFILL EXTENSION (SENTX)

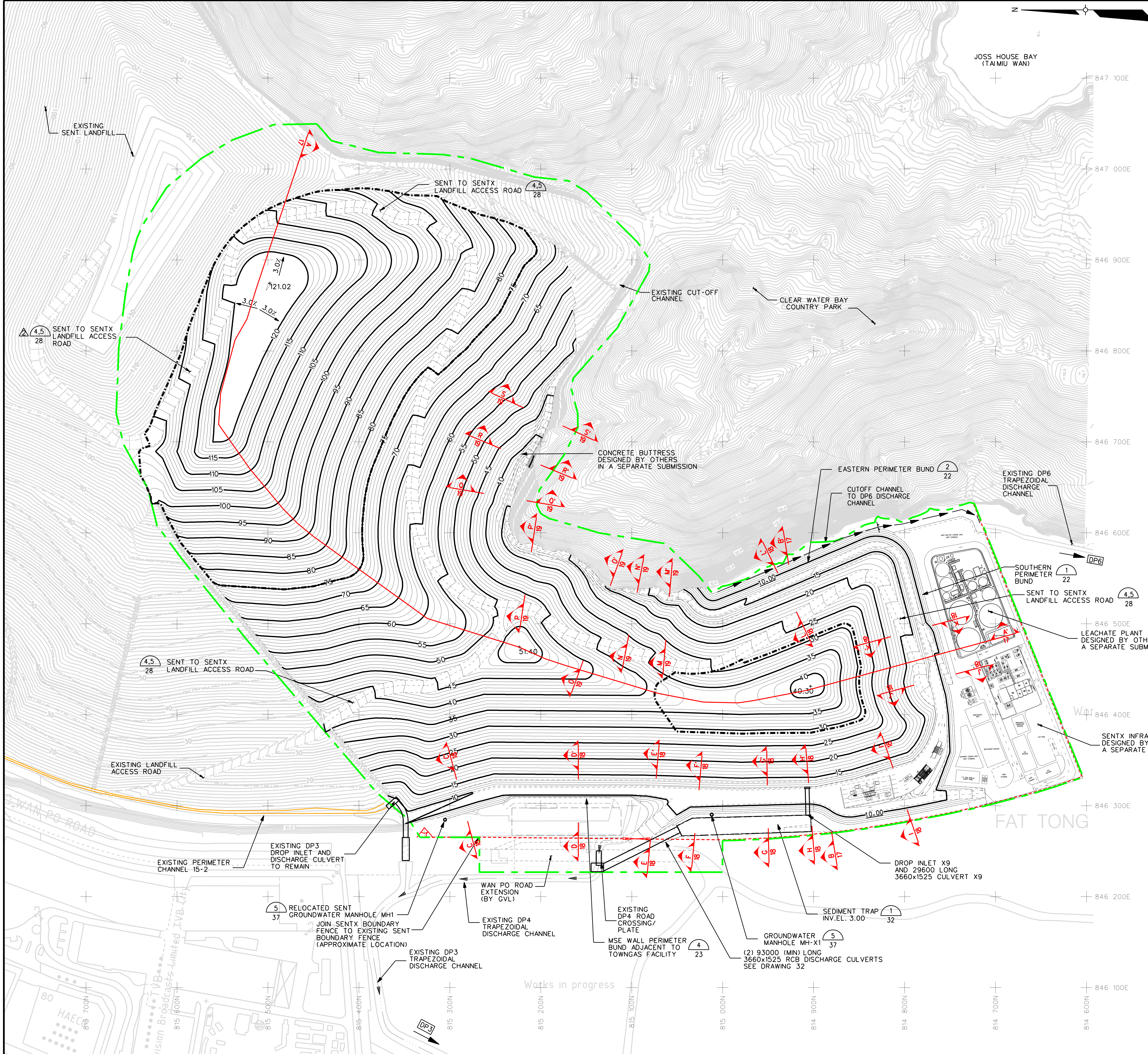
翠谷 GREEN VALLEY LANDFILL, LIMITED

AECOM

FINAL RESTORATION GRADES (PRE-SETTLEMENT PLAN)

DESIGNED	BPS	DRAWN	RAZ
CHECKED	KDM	APPROVED	
SCALE	AS SHOWN	CADD DATE	12.2018
DRAWING NO.	12	REV △2	SHEET NO

APPENDIX C FINAL RESTORATION GRADES (PRE-SETTLEMENT PLAN)



LEGEND

- 20 — EXISTING MAJOR CONTOURS
- EXISTING MINOR CONTOURS
- × 70.1 — EXISTING SPOT ELEVATION
- 35 — SITE PRE-SETTLEMENT RESTORATION MAJOR CONTOUR (5M)
- SITE PRE-SETTLEMENT RESTORATION MINOR CONTOUR (1M)
- SENTX SITE BOUNDARY
- F 10 / F' 10 — CROSS SECTION MARKER LOCATION
- PROPOSED SENTX BOUNDARY FENCE (APPROXIMATE LOCATION)
- FINAL RESTORATION AREA (CURRENT PHASE)

⚠	GROSS VOID VOLUME	1,907,170 CU.M
	SENTX FINAL RESTORATION AREA	118,064 SQ.M
	SUBTRACT SENTX RESTORATION CAP (AREAx1800 THICK)	- 212,515 CU.M
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NOTE: GROSS VOID VOLUME CALCULATED FROM TOP OF SENTX DRAINAGE LAYER, TOP OF SENTX BUTTRESS, AND SENT RESTORATION SURFACE TO THE SENTX PRE-SETTLEMENT TOP OF INTERMEDIATE AND FINAL RESTORATION GRADES

GENERAL NOTES:

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9. SEE DRAWING 15 FOR LANDFILL GAS MANAGEMENT SYSTEM LAYOUT.

REV.	DESCRIPTION	DATE	APPROVED
⚠	ADDED ACCESS ROAD, REV. FINAL GRADES, REV. AIRSPACE VOLUME	8.2019	
⚠	FINAL RESTORATION SUBMISSION	5.2019	

40 0 40 80 METRES 1:2000

ENVIRONMENTAL PROTECTION DEPARTMENT

SIGNED : ( )

FOR ENVIRONMENTAL PROTECTION DEPARTMENT

DATE :

MEINHARDT INFRASTRUCTURE AND ENVIRONMENT LTD

VERIFICATION BY INDEPENDENT CONSULTANTS

SIGNED :

FOR MEINHARDT INFRASTRUCTURE AND ENVIRONMENT LTD

DATE :

ENVIRONMENTAL PROTECTION DEPARTMENT HONG KONG GOVERNMENT

CONTRACT EP/SP/10/91

DEVELOPMENT AND MANAGEMENT OF SOUTH-EAST NEW TERRITORIES LANDFILL EXTENSION (SENTX)

翠谷 GREEN VALLEY LANDFILL, LIMITED

AECOM

FINAL RESTORATION GRADES (PRE-SETTLEMENT PLAN)

DESIGNED	BPS	DRAWN	RAZ
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SCALE	AS SHOWN	CADD DATE	12.2018
DRAWING NO.	12	REV ⚠	SHEET NO

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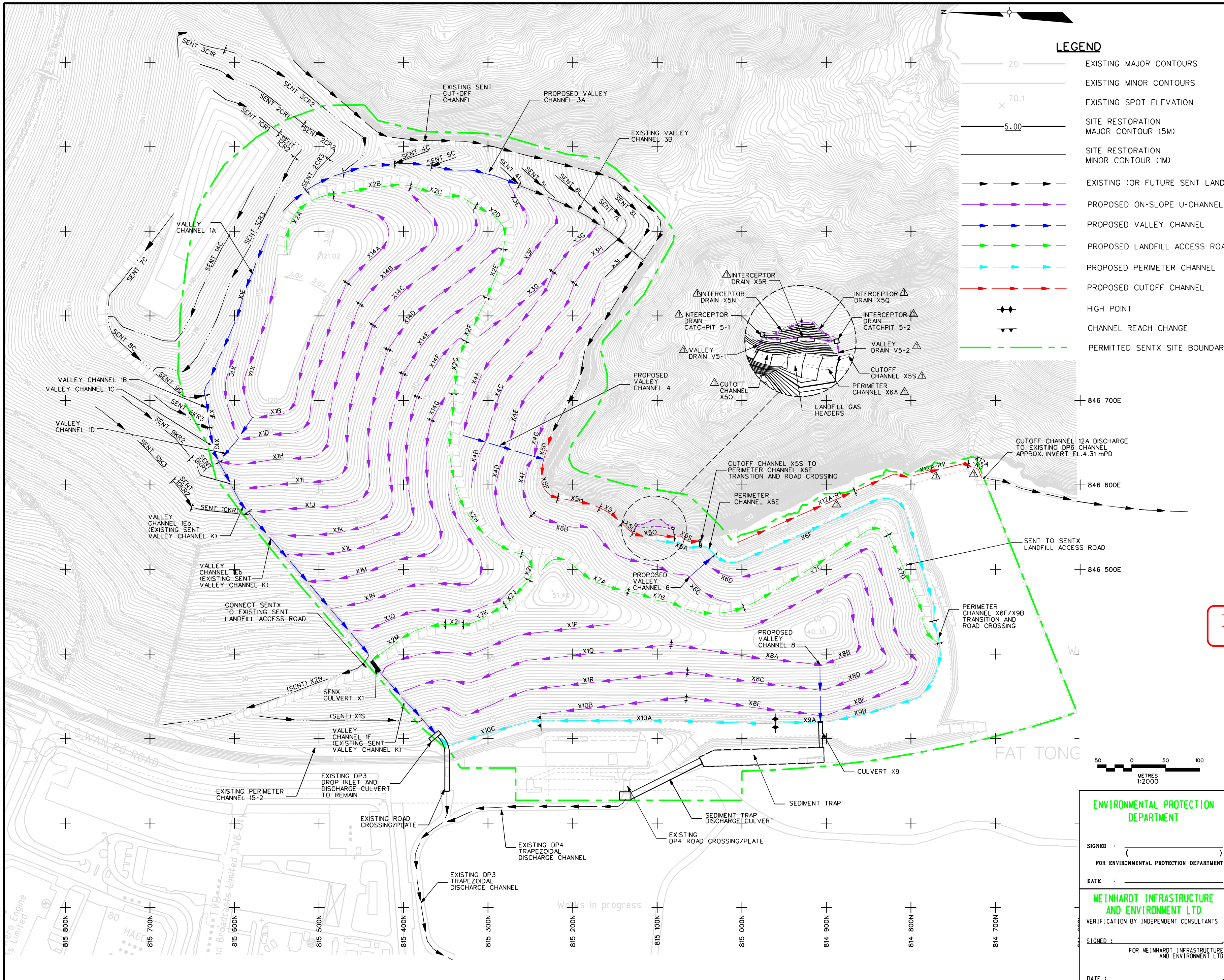
APPENDIX D SENTX DRAINAGE CHANNEL PLAN



For Construction

Consented On: 29/1/2019

REV.	DESCRIPTION	DATE	APPROVED
1	RESPONSE TO MEINHARDT HJC/SK/90343B.804/0074-GVL	12.2018	

ENVIRONMENTAL PROTECTION DEPARTMENT
HONG KONG GOVERNMENT

CONTRACT EP/SP/10/91

DEVELOPMENT AND MANAGEMENT OF SOUTH-EAST NEW TERRITORIES LANDFILL EXTENSION (SENTX)

GREEN VALLEY LANDFILL, LIMITED

AECOM

ENVIRONMENTAL PROTECTION DEPARTMENT

SIGNED : ( )
FOR ENVIRONMENTAL PROTECTION DEPARTMENT
DATE :

MEINHARDT INFRASTRUCTURE AND ENVIRONMENT LTD
VERIFICATION BY INDEPENDENT CONSULTANTS
SIGNED :
FOR MEINHARDT INFRASTRUCTURE AND ENVIRONMENT LTD
DATE :

SENTX DRAINAGE CHANNEL PLAN
PRE-SETTLEMENT
FINAL RESTORATION GRADES

DESIGNED	BPS	DRAWN	RAZ
CHECKED	KDM	APPROVED	
SCALE	AS SHOWN	CADD DATE	12.2018
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APPENDIX E SUMMARY REPORT OF FINDINGS OF THE SENTX TRIAL NURSERY

Contract No. EP/SP/10/91
South East New Territories Landfill Extension (SENTX)

Summary Report of Findings of the SENTX Trial Nursery (Rev.1)

(Doc. Ref.: GVL16-TN-DOC12)

Prepared by:

URBIS Limited

Prepared by:	***Freddy Wan / Kity Pang***	16 November 2023 Date
Checked by:	***Tran Tuan Huy***	16 November 2023 Date
Approved for issue by:	***David Morkel***	16 November 2023 Date

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- Drawing No. GVL16-TN_A2
- Drawing No. GVL16-TN_B1
- Drawing No. GVL16-TN_B2
- Drawing No. GVL16-TN-04
- Drawing No. GVL16-TN-05

Appendix B Evaluation of Individual Plant Species in Trial
Appendix C Various Versions of Proposed Planting Matrix Patterns
- Drawing No. GVL16-TN-SK01
- Drawing No. GVL16-TN-SK02

Appendix D Extracted pages from SENTX Contract
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- Appendix 36.3.3 in Appendix C Part A & Part B

KEY RECOMMENDATIONS IN THIS REPORT

The Trial Nursery was set up and operated at the South East New Territories Landfill (SENT), in Tseung Kwan O, Hong Kong in compliance with SENT Landfill Extension (SENTX) landscape restoration requirements as defined in the Government Contract with the landfill operator, Veolia.

The nursery was planted in 2020 and monitored by Landscape Architects, URBIS Limited for two years. This report provides a summary and analysis of the trials as well as recommendations for actions in future SENTX landscape restoration works and management.

Key recommendations include:

- adjustment of the phased planting schedule for pioneer and climax species;
- use of shrubs as pioneers;
- adjustments to planting matrix;
- adjustments to pioneer/ climax species ratio;
- variation in orientation of planting matrices;
- adjustment of growth tube application and dimensions;
- weed colonization prevention;
- adjustments to weed mat installation;
- adjustments to irrigation frequencies and methods;
- review of grass cutting schedule; and
- use of soil microbes/ fungi.

1 INTRODUCTION

1.1 PURPOSE OF THE REPORT

1.1.1 This Report provides the findings of the monitoring of a plant Trial Nursery which was set up and operated at the South East New Territories Landfill (SENT), in Tseung Kwan O, Hong Kong between 2020 and 2022. The location of the landfill is shown in Figure 1.1 below.

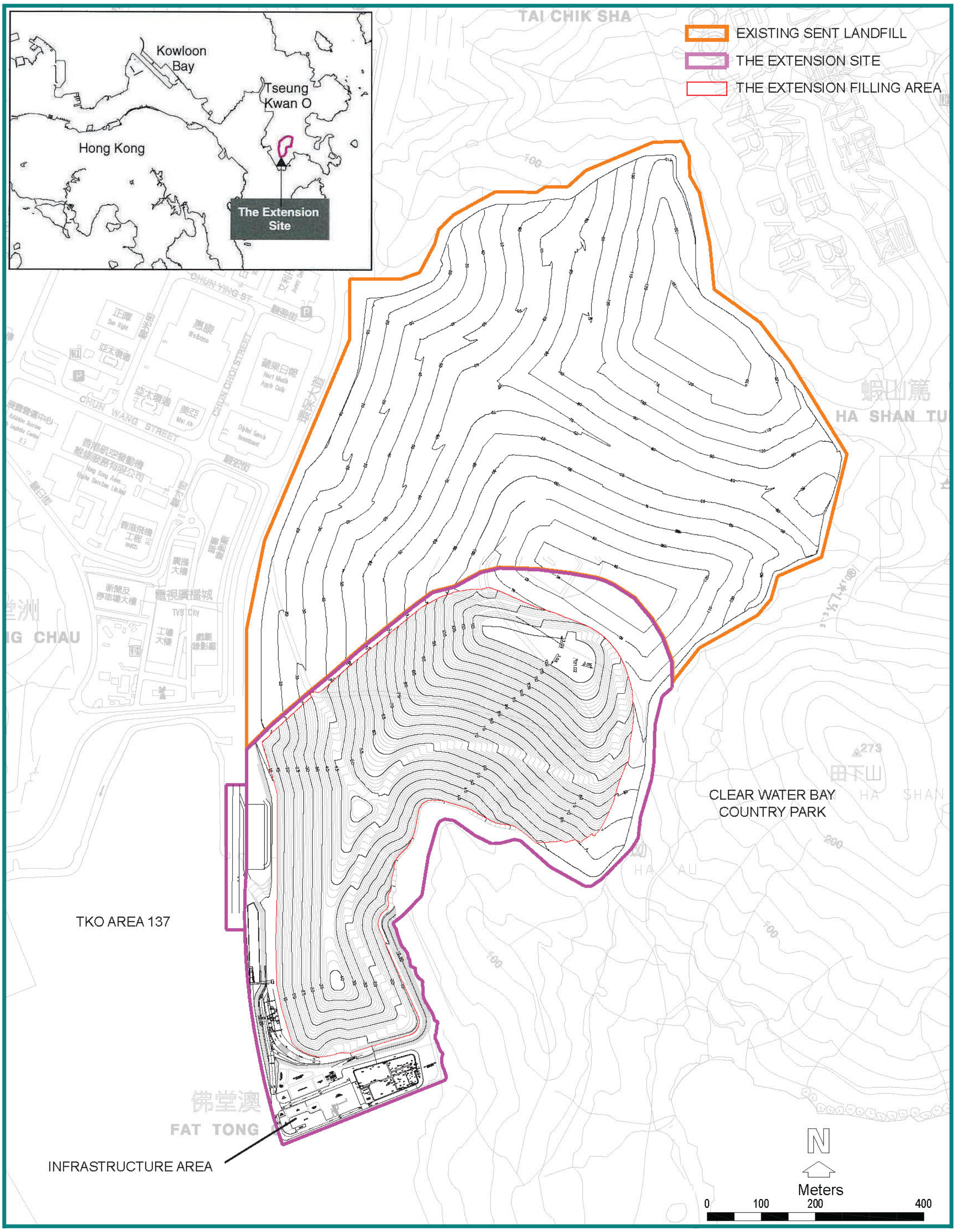

Figure 1.1: Location of SENT and SENTX Landfills

1.1.2 The Trial Nursery was established by the landfill operator, Veolia in accordance with requirements in their contract with the HKSAR Government in order to benefit the landscape restoration of the forthcoming SENT Landfill Extension (SENTX).

1.1.3 The Trial Nursery was planted in 2020 and monitored by Landscape Architects, URBIS Limited, for two years.

1.1.4 This Report is prepared in fulfilment of the requirements of the SENTX Landfill Contract between Veolia and the Hong Kong SAR Government. Prior to the restoration of the landfill, SENTX Contract requires to establish a Trial Nursery in order to test the performance and suitability of a wide number of plants that may be candidates for use in the landscape restoration.

1.1.5 This report provides a description and analysis of the SENTX planting trials at the Trial Nursery as well as recommendations for actions in future SENTX landscape restoration works and management.

1.2 BACKGROUND TO THE REPORT

SENT Landfill

1.2.1 The South East New Territories (SENT) Landfill is one of a number of regional landfills serving the waste disposal requirements of Hong Kong. The project EIA was fully approved in 1994 and Green Valley Landfill Limited was awarded the contract to design, construct and manage the landfill at SENT, as well as the restoration of the landscape of the site under Contract EP/SP/10/91. Landfilling operations commenced in September 1994 after reclamation and infrastructure works had been carried out.

1.2.2 The SENT project provides 43 million cubic metres of landfill waste volume and comprises nineteen phases of landfill and restoration (see Figure 1.1). Landfilling of the site was originally expected to take almost two decades. However, operation is now expected to extend to 2021 with an additional 2-3 years of restoration thereafter. At the time of writing, Phases 1 to 12 of the SENT site have been landfilled and restored and Phases 13 to 15 have finished wasted filling with restoration having commenced. Landscape restoration of succeeding phases will take place as they are landfilled and capped.

SENTX Landfill

1.2.3 In the early years of this century, in response to revised projections of future required landfill volume in Hong Kong the decision was taken to extend the area and airspace of the SENT Landfill in a project that was to become the South East New Territories Landfill Extension (SENTX). This project will provide approximately 6.5 million cubic metres of landfill volume in addition to those provided by the SENT project.

1.2.4 Agreement No. CE 10.2005(EP) South East New Territories (SENT) Landfill Extension - Feasibility Study: Environmental Impact Assessment Report Assessment was carried out in 2005/6 and the Project Environmental Permit (EP) issued in 2007. Green Valley Landfill was awarded the contract to operate and manage the SENTX project operation and restoration on 12th April 2018 under Contract EP/SP/10/91 Supplemental Agreement No.2.

1.2.5 The Extension is a 'piggyback' landfill, occupying the existing SENT Landfill infrastructure area, 15 ha of TKO Area 137 and approximately 5 ha of the Clearwater Bay Country Park. The new infrastructure area will be located to the south of the waste filling area and will house the landfill gas treatment facility and leachate treatment plant, offices, maintenance workshops, etc.

1.2.6 The Extension covers an area of around 50 ha (including all site infrastructure). Discounting the void space required for miscellaneous engineering works and daily and intermediate covers, the total net void capacity for waste is estimated to be around 17 million cubic metres. The operational lifespan of the Extension is estimated to be around 6 years, commencing infrastructure works in 2019 with final restoration in 2028.

1.2.7 The design of the Extension comprises the following key components:

- Landfill liner and capping;
- Landfill gas management system;
- Leachate management system;
- Surface water management system;
- Groundwater management system;
- Site infrastructure; and
- Restoration and Aftercare Works.

1.2.8 Upon completion of final filling and site restoration, the period of aftercare will begin and will last for 30 years. During this period, by-products from waste disposal will continue to be generated including leachate and landfill gas. The established leachate and landfill gas management control and treatment facilities will continue to operate throughout the aftercare period. Regular site maintenance will be required during the aftercare period to keep the incorporated systems functioning as designed. Site monitoring during the aftercare period will continue in accordance with the monitoring plan, but may be decreased if warranted and approved by the EPD. During the aftercare period, passive recreational after uses will be developed on the restored landfill for beneficial uses.

1.3 STRUCTURE OF THE REPORT

1.3.1 Based on the Trial Nursery Planting (referred to as 'the Trial' hereafter) Monitoring Data Collection Reports No. 1 to 11 which covered the monitoring period between June 2020 and July 2022, this Report summarises the findings from the eleven reports. It also provides analysis, conclusions and recommendations drawn from the Trial.

1.3.2 The following items will be discussed in this Report:

- The Trial Set-up and Monitoring Methodology (Section 2);
- Overview of Performance of the Trial (Section 3);
- Monitoring Findings and Analysis (Section 4); and
- Recommendations for Landscape Management Approaches (Section 5).

2 THE TRIAL SET UP AND MONITORING METHODOLOGY

2.1 TRIAL NURSERY OBJECTIVES AND SET-UP

2.1.1 Contract No. EP/SP/10/91 South East New Territories Landfill Extension (SENTX) requires that a Trial Nursery, i.e. the Trial be established in advance of landscape restoration works, in order to test the performance and suitability of a wide number of plants that may be candidates for use in the restoration.

2.1.2 Prior to the restoration of the landfill, SENTX 'Contract No. EP/SP/10/91 South East New Territories Landfill Extension (SENTX)' Contract Document EP_SP_10_91-SA2_Volume 2, Clauses 36.3.5.1 to 36.3.5.25 and its Appendix 36.3.3 (Part A & Part B) states the requirements for the establishment of a Trial Nursery. Clause 36.3.5 defines the objectives and parameters of the Trial Nursery and states:

"36.3.5 Trial Planting for Native Species

General

36.3.5.1 Pursuant to Condition 2.6 (Submission of Restoration and Ecological Enhancement Plan) of the EP, woodland planting for the Restoration works of SENTX shall consist of about 20% non-native tree species. Pursuant to Condition 2.7 (Setting up of Trial Nursery) of the EP, a trial nursery shall be set up for native plant species in advance during construction phase to fine tune the planting matrix and management intensity of the recommended indigenous tree species.

36.3.5.2 Further to Clauses 1.1.5.8 and 1.7.13 of this Specification, the Contractor shall, during the construction of the Initial Works for SENTX, set up a trial nursery, carry out trial planting according to the Drawings, and subsequently carry out establishment works to the plantings throughout the period of the Contract.

36.3.5.3 The planting matrix and management intensity of the SENTX Restoration phase woodland planting are subject to the outcome of this trial planting".

Location and Layout
36.3.5.4 The trial nursery shall provide collectively no less than 1936 square meter (sq.m) of area available for planting. The planting area shall consist of two (2) quadrants of equal area, of which each quadrant shall not be less than 968 sq.m in area".

2.1.3 The full set of clauses and Contract drawings for the Trial Nursery are included in Appendix D.

2.1.4 The Trial Nursery was set up and planted at Phase 14 of South East New Territories Landfill (SENT) in 2020. Monitoring of the Trial Nursery started in June 2020 and ended in July 2022.

2.1.5 The Trial Nursery was sub-divided into four Sub-Areas for the purposes of monitoring of the native seedling trees against two pairs of different trial variables:

- Variable Condition 1 – the use of either type of Microclimatic Growth Tubes (MGT), "SunFlex Greenhouse Grow Tube" or "Rigid Corflute"; and
- Variable Condition 2 – the existence or non-existence of exotic seedling trees as nurse species for the establishment of native seedling trees.

2.1.6 The design of Sub-Areas was as shown below:

Sub-Area A1: native seedling trees with MGT "SunFlex Greenhouse Grow Tube" and exotic nurse seedling trees;

Sub-Area A2: native seedling trees with MGT "Rigid Corflute" and exotic nurse seedling trees;

Sub-Area B1: native seedling trees with MGT "SunFlex Greenhouse Grow Tube" and without exotic nurse seedling trees; and

Sub-Area B2: native seedling trees with MGT "Rigid Corflute" and without exotic nurse seedling trees.

2.1.7 The detailed planting setup of the Sub-Areas is provided in Appendix A.

2.1.8 The basic planting approach applied in the Trial was to separate the planting of pioneer species (exotic trees and shrubs) and climax species (native trees) into two phases, with 1-year apart.

2.1.9 At the start of the 1st year of the Trial, exotic tree seedlings and shrubs were planted in Sub-Areas A1 and A2, and only shrubs were planted in Sub-Areas B1 and B2. After a year, at the start of the 2nd year of the Trial, all the native tree seedlings were planted in Sub-Areas A1, A2, B1 and B2.

2.1.10 It was expected to establish tree canopies from the 1st year planting of pioneer species to create shelter for fostering the growth of the 2nd year planting of climax species, mimicking the similar forest forming process found in nature.

2.1.11 Figure 2.1 illustrates the programme of the Trial and monitoring works for the SENTX Trial Nursery.

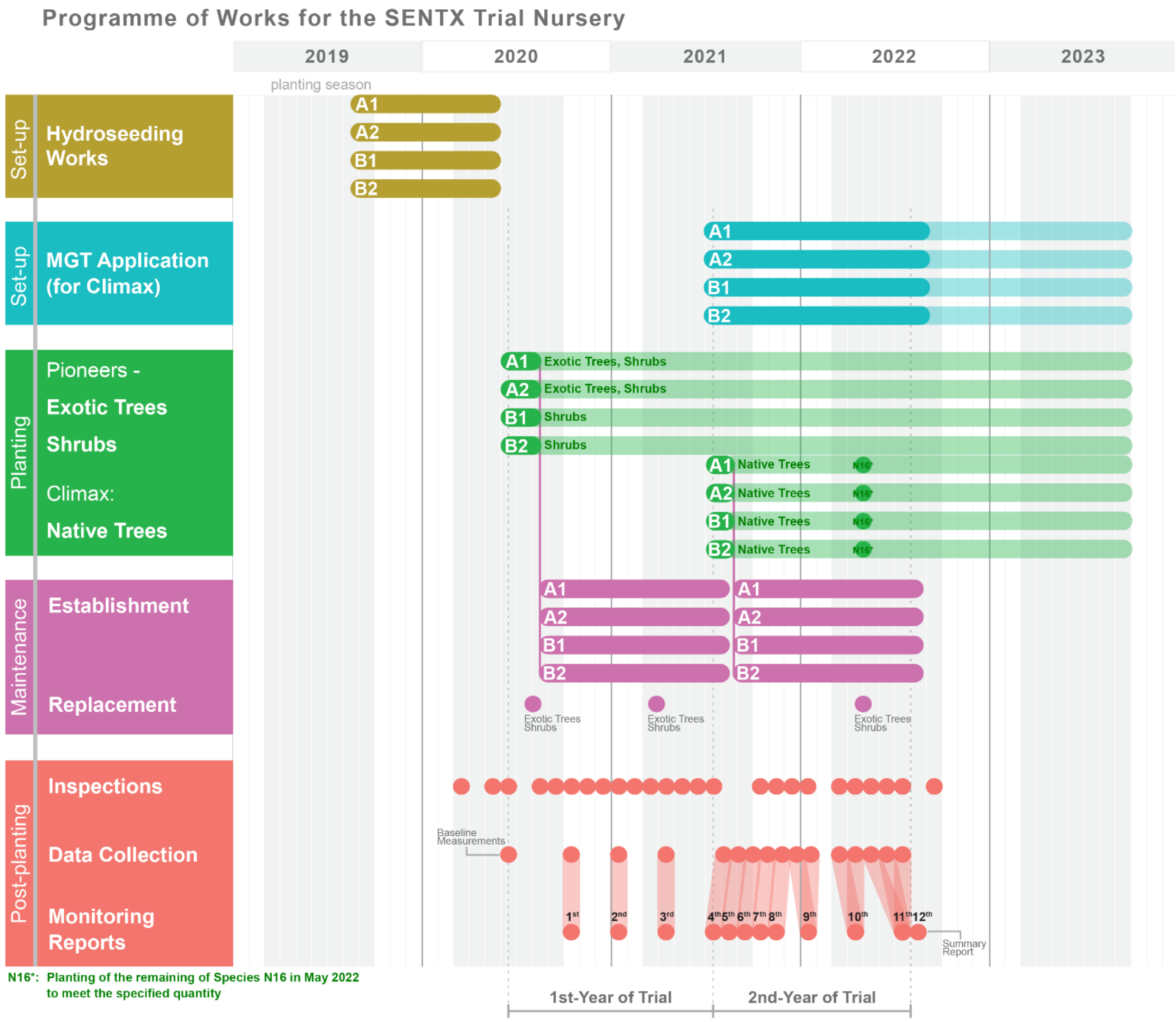

Figure 2.1: Programme of Works for the SENTX Trial Nursery

2.1.12 Plant species used in the Trial Nursery are shown in Table 2.1.

Table 2.1: Plant Species Used in the Trial Nursery

Exotic Tree Species	Shrubs	Native Tree Species
(E1) *Acacia confusa*	(S1) *Buxus sinica*	(N1) *Bridelia tomentosa*
(E2) *Cassia nodosa*	(S2) *Calliandra haematocephala*	(N2) *Celtis sinensis*
(E3) *Dalbergia odorifera*	(S3) *Hamelia patens*	(N3) *Cinnamomum camphora*
(E4) *Acacia auriculiformis*	(S4) *Ipomoea pes-caprae*	(N4) *Aquilaria sinensis#*
(E5) *Melia azedarach*	(S5) *Rhododendron simsii#*	(N5) *Ficus virens*
(E6) *Senna siamea*	(S6) *Pittosporum tobira*	(N6) *Hibiscus tiliaceus*
	(S7) *Rhaphiolepis indica*	(N7) *Ilex rotunda* var. *microcarpa*
	(S8) *Rhodomyrtus tomentosa*	(N8) *Liquidambar formosana*
	(S9) *Verbena rigida*	(N9) *Litsea glutinosa*
	(S10) *Lespedeza formosa*	(N10) *Machilus chekiangensis*
	(S11) *Vitex negundo*	(N11) *Macaranga tanarius*
	(S12) *Vitex rotundifolia*	(N12) *Myrica rubra*
		(N13) *Rhodoleia championi#*
		(N14) *Polyspora axillaris*
		(N15) *Pongamia pinnata*
		(N16) *Pyrus calleryana*
		(N17) *Reevesia thyrsoidea*
		(N18) *Rhus succedanea*
		(N19) *Sapium discolor*
		(N20) *Sapium sebiferum*
		(N21) *Camellia crapnelliana*
		(N22) *Sterculia lanceolata*
		(N23) *Syzygium hancei*
		(N24) *Viburnum odoratissimum*

Legend: # Protected species

2.1.13 The codes above will be used as species references throughout this Report.

2.2 TRIAL NURSERY MONITORING

2.2.1 According to Contract Document EP_SP_10_91-SA2_Volume 2, the monitoring of the Trial nursery should meet the requirements of the following clauses:

(i) <u>Clause 36.3.5.19</u>: the Contractor shall be responsible for carrying out periodic monitoring inspections of the Trial planting throughout the period of the Contract, and to submit each periodic trial planting monitoring report within 5 working days after each monitoring inspection to the Independent Consultants.

(ii) <u>Clause 36.3.5.20</u>: monitoring inspections shall be carried out at monthly intervals, unless otherwise directed by the Independent Consultants.

(iii) <u>Clause 36.3.5.22</u>: the Contractor shall submit details of the personnel responsible to carry out the monitoring and sought approval from the Employer. Unless otherwise agreed, the personnel responsible to carry out the monitoring shall have the following minimum requirements:

- *Have a bachelor's degree or higher in horticulture, or a related field such as botany, biology, forestry, arboriculture, landscape studies, landscape architecture, landscape management, landscape science, from a Hong Kong university, or equivalent; and*
- *Have a minimum of two years of proven full-time practical experience in soft landscaping, or a related field such as horticulture, arboriculture.*

(iv) <u>Clause 36.3.5.23</u>: detailed and accurate records of all establishment works and any other works related to the Trial planting shall be kept, so as to facilitate the studying of the management intensity required for proper establishment of the Trial planting.

(v) Clause 36.3.5.24: monitoring shall be carried out in a consistent and scientific manner. Information to be recorded for each monitoring session shall include, but not limited to, the items as listed in the sample worksheets as included in Part B of Appendix 36.3.3 of Contract Document EP_SP_10_91-SA2_Volume 2.

(vi) Clause 36.3.5.25: the monitoring reports shall be in a format approved by the Independent Consultants, and should include items specified in the clause.

2.2.2 The monitoring of the Trial Nursery was carried out in compliance with the requirements of SENTX Landfill Specification Appendix C Part A as follows:

(i) Periodic monitoring inspections of the Trial was carried out throughout the period of the Contract.

(ii) With regard to the frequency of monitoring, as the primary objective of the Trial was to review the suitability of different native species to be used in the landfill restoration, there was a focus on the performances of native species. Therefore, different monitoring programmes for native and exotic species were proposed, as shown below:

- for exotic species and shrubs planted in the first year of the setup of the Trial, monthly inspections were carried out to assess the maintenance needs and replacement of failed plants, while quarterly monitoring and data collection was carried out to capture plant performance;
- as native tree species were planted in the second year of the setup of the Trial, monthly inspections were carried out to assess maintenance needs, and monthly monitoring and data collection carried out to capture plant performance. (It should be noted that failed native plants were not replaced).

2.2.3 This approach aimed to capture mortality in early phases as well as noticeable changes in plant development in later years.

2.2.4 The Trial aimed to capture data on the efficacy of Micro-climatic Growth Tubes (MGT). Based on previous experience and landscape restoration monitoring results from SENT, MGTs were removed after 1 year to allow sufficient space for established plants' growth.

2.2.5 Monitoring inspections of the Trial were carried out over the course of two years (2020-2022) by a Certified Arborist who meets the requirements specified in Clause 36.3.5.22 of Contract Document EP_SP_10_91-SA2_Volume 2. Details of the arborist responsible to carry out the monitoring were submitted approval by the Employer.

2.2.6 Monitoring was carried out in a consistent and objective manner to observe and record the survival, health and growth conditions of the Trial plants. Information recorded at each monitoring visit will include the items listed in the sample worksheets as included in Part B of Appendix 36.3.3 of Contract Document EP_SP_10_91-SA2_Volume 3. The version of the worksheets in the Contract, were amended to include MGT and exotic nurse species variables as shown in Appendix B.

2.2.7 In order to act as a constant variable, establishment works for all Trial plots / quadrants were the same. Detailed and accurate records of all establishment works and any other works related to the Trial planting were kept, so as to facilitate the studying of the management intensity required for proper establishment of the Trial planting. The approved template of the establishment work record is included in Appendix D.

2.2.8 Analysis of data aimed to address each of the following combinations of variables:

- With "SunFlex Greenhouse Grow Tube" MGTs and with Exotic Nurse species;
- With "Rigid Corflute" MGTs and with Exotic Nurse species;
- With "SunFlex Greenhouse Grow Tube" MGTs and without Exotic Nurse species;
- With "Rigid Corflute" MGTs and without Exotic Nurse species.

2.2.9 For each of these combinations[1], then the following was recorded:

- % survival of all plants in plot;

$$\frac{\text{Number of survived plant}}{\text{Number of all plants}} \times 100\%$$

For example, in January 2021, in Sub-Area A1 555 nos. of surviving tree seedlings and shrubs were identified during the inspection. From previous records, based on the number of the planting locations allocated to all the exotic tree seedlings and shrubs, there should be originally 768 nos. of plants planted in that Sub-Area entering the monitoring month of January 2021.

A simple subset of records of all plants in Sub-Area A1 is provided below for demonstration:

	Jun 2020	Oct 2020	Jan 2021	Apr 2021
No. of surviving plants in the Sub-Area	543	689	555	544
No. of total plantin the Sub-Area (based on the number of planting locations allocated to the tree seedlings and the shrubs)	768	766	768	767
% Survival	71%	90%	72%	71%

The percentage survival (also termed 'survival rate' in this report) of all plants in Sub-Area A1 for January 2021 is therefore calculated as follows:

[1] Calculation methods of % survival of all plants in plot; % growth of all plants in plot; % survival of each species in plot; and % growth of each species in plot are included in Planting Monitoring Data Collection Report No.9, No.10 and No.11 (Doc. Ref.: GVL16-TN-DOC9, GVL16-TN-DOC10 and GVL16-TN-DOC11). (Elliott, 2013)

$$\frac{555 \text{ nos.}}{768 \text{ nos.}} \times 100\% = 72\%$$

It should be noted that in October 2020, two shrub plants were found to be the wrong species and not in accordance with the approved drawings. These incorrect species were excluded from the calculation. Similarly, in April 2021, one of the shrub plants was an incorrect species and was also excluded from the calculation.

- % growth of all plants in plot;

$$\frac{\text{Height of all plants (at the time of monitoring} - \text{at the time of planting)}}{\text{Height of all plants at the time of planting}} \times 100\%$$

- % survival of each species in plot;

$$\frac{\text{Number of survived plant of one species}}{\text{Total number of one species}} \times 100\%$$

For example, in January 2021, in Sub-Area A1 6 nos. of surviving E1 *Acacia confusa* were identified during the inspection. From previous records, based on the number of the planting locations allocated to the species, there should be originally 8 nos. of E1 *Acacia confusa* planted in that Sub-Area entering the monitoring month of January 2021. The other two planting locations for E1 were found to be empty, and therefore those two individuals were assumed to be dead. A simple subset of records of E1 *Acacia confusa* is provided below for demonstration:

	Jun 2020	Oct 2020	Jan 2021	Apr 2021
No. of surviving plants of the species	8	6	6	7
No. of total plants of the species (based on the number of planting locations allocated to the species)	8	8	8	8
% Survival	100%	75%	75%	88%

The percentage survival (also termed 'survival rate' in this report) of E1 *Acacia confusa* for January 2021 is therefore calculated as follows:

$$\frac{6 \text{ nos.}}{8 \text{ nos.}} \times 100\% = 75\%$$

In April 2021, 7 nos. of E1 *Acacia confusa* were identified during the inspection, and one planting location for the species was recorded as empty. The % survival of E1 *Acacia confusa* for April 2021 is therefore calculated as follows:

$$\frac{7 \text{ nos.}}{8 \text{ nos.}} \times 100\% = 88\%$$

As plant replacement had been carried out by the contractor between the end of March and early April 2021, the increased number of surviving plants of *E1 Acacia confusa* in April 2021 should be the result of the plant replacement. It should be noted that the number of planting locations allocated to the species remained unchanged.

- % growth of each species in plot;

$$\frac{\text{Height of one species (at the time of monitoring} - \text{at the time of planting)}}{\text{Height of one species at the time of planting}} \times 100\%$$

- Hydroseed cover;
- Observations on plant health generally and by species;
- Observations on pest and weed infestation;
- Observations on condition of the Trial;
- Establishment works carried out;
- Photographic record generally and by species;
- Observations on abnormal weather conditions;
- Other relevant observations.

2.2.10 With the data correlations between variables identified, conclusions were drawn with regard to the optimal combinations of establishment techniques and plant species for use in the final SENTX Landfill restoration.

3 OVERVIEW OF PERFORMANCE OF THE TRIAL

3.1 INTRODUCTION

3.1.1 This Section of the Report provides an overview of and general observations on the development of the Trial, in terms of canopy cover and plant growth.

3.2 OVERALL CONDITION

Overall Condition

3.2.1 Aerial photo records for the whole Trial Nursery were taken in March and July 2023. In each photo (see Figures 3.1-3.3), clockwise from the top-left corner are the Sub-Areas A1, B1, B2 and A2. The results illustrate the general condition of plants right after the winter and in the middle of growing season respectively for the purpose of a side-by-side comparison.

3.3 CANOPY COVERAGE

Canopy Coverage in March 2023

3.3.1 Following the winter, with many species being defoliated, the overall canopy coverage in March 2023 appeared to be low. It is estimated that approximately 15-20% of the area of Sub-Areas A1 and A2 (on the left) were covered by canopy. The dense vegetation clustered to the west of the Sub-Areas. On the other hand, it's estimated that approximately 2-3% of Sub-Areas B1 and B2 (on the right) were covered by canopy.

Canopy Coverage in July 2023

3.3.2 Plants typically grow fast in mid-summer. With many species resprouting into denser vegetation, the overall canopy coverage in July 2023 appeared to be higher. It is estimated that approximately 30-40% of the area of Sub-Areas A1 and A2 (on the left of Figures 3.1-3.3) were covered by canopy. While most dense vegetation was clustered to the west of the Sub-Areas, some vegetation resprouting was observed at the east as well. It is estimated that approximately 5-10% of Sub-Areas B1 and B2 (on the right of Figures 3.1-3.3) were covered by canopy. Various herbaceous plants and grasses also colonised these areas, with herbaceous colonies approaching 80%-95% in Sub-Areas A1 and A2, and 50%-80% in Sub-Areas B1 and B2.

Trend of Canopy Coverage

3.3.3 It is estimated that starting from the planting of seedlings, the canopy coverage of planting grew from virtually 0% to approximately 40% in Sub-Areas A1 and A2 with exotic tree seedlings in three years. On the other hand, it is estimated the canopy coverage grew from 0% to approximately 10% in three years for Sub-Areas B1 and B2 without exotic tree seedlings. When winter comes, it's estimated the canopy coverage reduced half, due to seasonal defoliation.

Figure 3.1: Aerial Photo in March 2023 (33 months after 1st year planting of exotic tree seedlings)

Figure 3.2: Aerial Photo in July 2023 (37 months after 1st year planting of exotic tree seedlings)

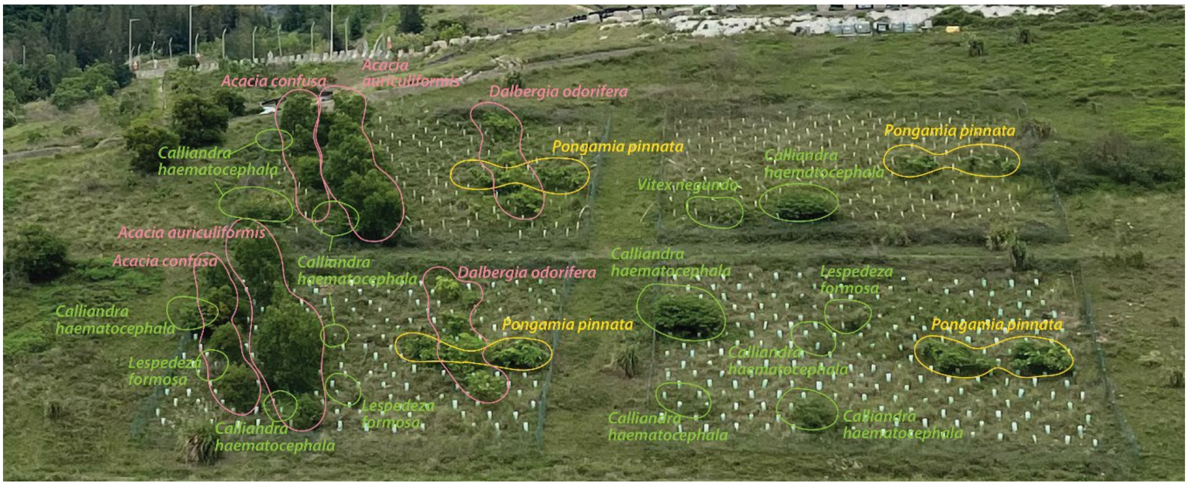

Figure 3.3: Photo with mark-up of Identified Colonies by Trial Plant Species: Exotic Tree Species (Pink); Shrub Species (Green); Native Tree Species (Yellow)

3.4 OVERALL TRENDS (DATA COLLECTED FROM JUNE 2020 TO JULY 2022)

Survival Rate Trends[2]

3.4.1 The survival rate trend of each plant category will be discussed with reference to Figure 3.4 below. The survival rate for plants in the Trial Nursery is equivalent to % Survival. Both terms are used interchangeably in this Report. It also worth noting that Mortality Rate = 1 - Survival Rate; or equivalently, %Mortality = 100% - %Survival.

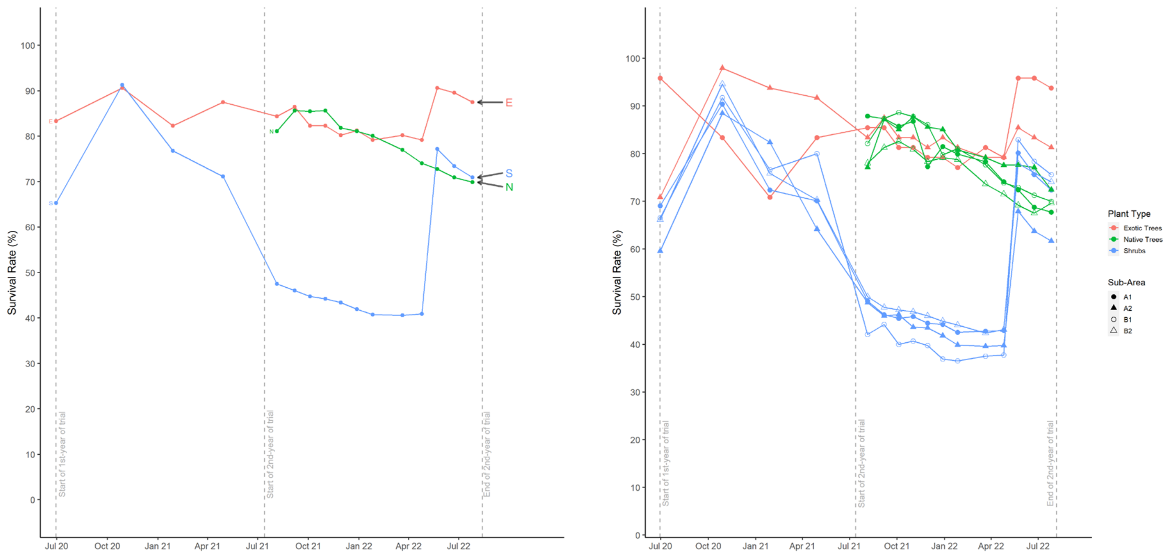

Figure 3.4: Trends in average overall survival rate by plant category (left) and average overall survival rate by plant category by Sub-Areas (blocks of different combinations of exotic trees and micro-climatic tube treatments) (right)

3.4.2 **Exotic Tree Species** (Red lines in Figure 3.4) – As shown on the left-hand graph of Figure 3.4, the overall survival rate of exotic tree species remained relatively steady at or above 80% (ranging between 80% to 90%) throughout the entire Trial. There was a drop in the overall survival rate in the first winter from October 2020 to January 2021, but it then recovered somewhat in the subsequent growing season of the 1st year of the Trial. As observed on the right-hand graph in Figure 3.4, the overall survival rate of exotic tree species in Sub-Area A1 started out very high at above 95%, while in Sub-Area A2, it started out at barely above 70%. The difference between these baseline measurements likely indicates that the general quality of plants in Sub-Area A1 was better than that in Sub-Area A2. This may be explained by the fact that Sub-Area A2 is located further from the main Trial Nursery access than Sub-Area A1, and the contractor might have picked the better plant stock to plant first in Sub-Area A1 and the worse ones later, Sub-Area A2. Alternatively, the contractor may have planted the more accessible area first and the more distant area later, and that the latter suffered more from dehydration as a result of hot weather in mid-June 2020 by virtue of the fact they had not has as long to establish.

3.4.3 As many plants were rejected due to the observed poor quality or death of plants soon after initial planting, and these defects were due to artificial causes instead of natural, the contractor was required

[2] Survival Rate is equivalent to %Survival. Both terms are used interchangeably in this Report. It also worths to note that Mortality Rate = 1 - Survival Rate; or equivalently, %Mortality = 100% - %Survival

to carry out replacement planting(3) in August 2020, as the uneven quantity of plants among Sub-Areas might lead to serious bias in later observations. The replacement planting led to a notable increase in survival rates in the next monitoring visit in October 2020. At that point, a survival rate of nearly 100% was evident in Sub-Area A2, but in Sub-Area A1 there was a drop to about 85% since not as many exotic tree seedlings as in Sub-Area A2 were replaced previously, and it turned out that some unadaptable plants in Sub-Area A1 died in the same period. In January 2021, the survival rates of exotic tree species in both Sub-Areas dropped. The drop was especially pronounced in Sub-Area A1. This indicates that the impact of winter weather was influential on the growth of exotic tree species in this exposed environment.

3.4.4 As many of the exotic tree seedlings and shrubs were dead after the winter of the 1st year of the Trial, leaving substantial bare areas on-site, a second replacement planting by the contractor took place at the end of March 2021 in an attempt to create the expected half-sheltered environment in which the native tree seedlings should have been nursed in the 2nd year of the Trial. Hence, there was a slow increase in overall survival rate for exotic tree species in April 2021. Although the plant replacements slightly affected the measured survival rate of plants, as revealed later in this Report, this slight, temporary deviation in survival rate over the several months that followed, hardly affects the eventual conclusions on recommended exotic tree and shrub species (it was later found that the same replaced species declined once again when adverse weather hit the site and a repeat replacement exercise and the repeated decline actually reinforced conclusions with regard to recommended plant species).

3.4.5 Entering the 2nd year of the Trial, the overall survival rate of exotic tree species tended to be steady between July 2021 and April 2022, and only gradually dropped from about 85% to 80% in the period. In May 2022, it was observed that a third replacement planting was carried out by the contractor, which affected the measurements in the last three months of the Trial.

3.4.6 As shown in the right-hand graph of Figure 3.4, up to the point of the replacement planting in May 2022, there was only a minor difference in average survival rate between Sub-Area A1 and Sub-Area A2 for exotic tree species in the 2nd year of the Trial. The drop in survival rates of exotic tree species in the second winter was also smaller than in the previous year. This could be because the winter weather was milder in the second year, and/or because the plants had matured compared to the previous year, and had become more capable of withstanding the cooler winter weather. The replacement planting in May 2022 was unintended for exotic tree species, as the contractor was only supposed to plant the remaining individuals of species (N16) *Pyrus calleryana* which was reported out of stock when the majority of native tree seedlings were planted in July and August 2021 at the start of the 2nd year of the Trial. However, there was unfortunately a miscommunication and the contractor carried out replacement planting for both exotic tree species and shrubs species, as well as native tree species N16 at the same time, in May 2022. As shown in the right-hand graph of Figure 3.4, the recorded survival rates of exotic tree species increased unnaturally in May 2022 and then the trend turned downwards in the last two months (mostly due to the deaths of the same unadaptable plant species, despite them being replaced).

3.4.7 Given that the survival rates of exotic tree species in both Sub-Areas A1 and A2 had stabilized by April 2022 when the growing environment is favourable to plants, it could be safely assumed that if replacement planting in May 2022 had not occurred, the survival rates of exotic tree species recorded in April 2022 and July 2022 (end of 2nd year of the Trial) would have been quite similar, as demonstrated during the stable stage prior to April 2022. Therefore, it is suggested to treat the survival rates of

3 Replacement planting of exotic pioneer trees and shrubs were carried out at the planting phase of 1st year of the Trial in August 2020, after the first winter in March 2021, and also May 2022. As the objective of having the pioneers and shrubs are to form shelter from sun and wind to the native species. The planting and trial on native species will not be fair and useful without the replaced planting of the exotic tree seedlings and shrubs.

exotic tree species recorded in April 2022 as the final measurements of the Trial.

3.4.8 The notable gap between the survival rates of exotic tree species in Sub-Areas A1 and A2 after the third replacement planting in May 2022 once again indicates that Sub-Area A1 appeared to have advantages over Sub-Area A2, most likely because of the differences in contractor's working habits in different Sub-Areas due to the layout and accessibility of the Trial Nursery.

3.4.9 **Shrub Species** (Blue lines in Figure 3.4). As shown on the left-hand graph in Figure 3.4, the overall survival rate of shrub species was initially about 65%. Many plants in Sub-Area A2 were rejected due to their poor quality or death soon after initial planting. Like the exotic tree seedlings mentioned above, this was generally due to external factors rather than natural causes and this would affect the analysis and conclusion of the Trial. The contractor was therefore required to replace the plants in August 2020. After the first replacement planting, the overall survival rate was found to be about 90% by October 2020, but after that, it dropped sharply in the subsequent winter months as well as in the first growing months of 2021. By down July 2021 at the start of the 2nd year of the Trial, survival rates were below 50%. This decline occurred despite the fact that there had been replacement planting of shrub species and exotic tree seedlings in March 2021 in an attempt to create a half-sheltered environment for native tree seedlings in the 2nd year of the Trial. Entering the 2nd year of the Trial, the decline in survival rates of shrub species continued, but slowed gradually, and stabilized at about 40% by April 2022. Like the exotic tree species, due to the unintended third replacement planting in May 2022 described above, the survival rates of shrubs species unnaturally exhibited a very sharp increase at the end of the Trial.

3.4.10 From the right-hand graph in Figure 3.4, the general trends of survival rates of different shrub species can be seen to be very similar to each other across all Sub-Areas. Like to the exotic tree species, there initially appeared to be a divergence in survival rates of shrub species in Sub-Area A2 and other Sub-Areas, indicating that Sub-Area A2 consistently suffered disadvantages in receiving replacement planting, possibly due to differences in the contractor's approach and working habits discussed above. On the other hand, after the general trend stabilized in the 2nd year of the Trial, shrub species in Sub-Area B1 appeared to have a slightly lower survival rate when compared to other Sub-Areas. This appeared to suggest there were certain locational factor(s)5 leading to these differences.

3.4.11 Although some of the plants had been replaced after the third replacement planting in May 2022, in general there was a drop in the survival rates of shrub species from May to July 2022 in each Sub-Area, indicating that many of the newly replaced shrub species died after replacement. This observation shows that shrub species unadaptable to the exposed environment would likely die despite repeated replacements, and that therefore, only after a change to the environment could the desired climax species be successfully grown and established.

3.4.12 **Native Tree Species** (Green lines in Figure 3.4) – Native tree species were planted in July and August 2021 at the start of the 2nd year of the Trial. At that stage, the shelter from the canopies of exotic tree species and shrub species had partly established. The survival rates of native tree species were

[5] If it was either or both of the factors of interest in this Trial, namely, the existence or not of the companion planting of exotic tree seedlings, and/or the type of MGT used to protect the native tree species, that had been the major contributor(s) to the inferior survival rate of shrub species in Sub-Area B1 compared to other Sub-Areas, one would find that either Sub-Area B2 (lack of companion planting of exotic tree species like Sub-Area B1) or Sub-Area A1 (where the same MGT type was used as in Sub-Area B1) to be the two next lowest survival rate of shrub species. However, in this Trial the next lowest survival rate in shrub species turned out to be observed in Sub-Area A2 (which shared the least similarity of trial treatment with Sub-Area B1) during the stabilized period in the 2nd year of the Trial. This suggested that other confounding factors had more influential effect to the result than the two factors of interest in this Trial. From the set-up of the Trial Nursery, the planting treatments with regard to the existence or not of companion exotic tree species and the MGT type were dependent to the designated location of the Sub-Area, it is therefore believed that locational factor(s) was a major confounding factor to the observed results of survival rates.

recorded starting from the 2nd year of the Trial.

3.4.13 As seen on the left-hand graph of Figure 3.4, initial survival rates were about 80%. In the first month of monitoring, there was a minor increase in the survival rate of native tree species as the contractor carried out replacement planting for those plants rejected due to poor quality at initial planting and those dying immediately. The survival rate of native tree species then remained steady for several months at about 85%. However, starting from the end of November, the survival rate of the native tree species experienced a gradual but prolonged decline until the end of the Trial monitoring in July 2022, when it was found to be approximately 70%.

3.4.14 As shown in the right-hand graph in Figure 3.4, the overall trends of survival rates of native tree species in each Sub-Area were generally similar. The survival rates of native tree species in all but Sub-Area A1 increased in the first month of the trial, due to replacement planting being carried out soon after initial planting. The subsequent trends of survival rates of native tree species were exactly the same barring occasional minor differences within several percentage points among Sub-Areas. The survival rates in all Sub-Areas declined at some point over winter, but the exact month of the most notable drop was slightly different between Sub-Areas, occurring in November 2021 in Sub-Areas A1 and B2, December 2021 in Sub-Area B1, and January 2022 in Sub-Area A2. The trends after winter were all very similar, and eventually the survival rates of native tree species were all very close to 70%.

3.4.15 It should be noted that there was no replacement planting for native tree seedlings after the second month of 2nd year of the Trial. Species (N16) *Pyrus calleryana* was reported to be out of stock at the time of initial planting in August 2021 and therefore only part of the specified quantity of that species had been planted initially. They were monitored as usual from August 2021 to April 2022. The contractor eventually sourced the remaining individuals of N16 and planted them in May 2022. However, due to a miscommunication, they also replaced the N16 individuals that had been noted as dead in previous monitoring. From the right-hand graph in Figure 3.4, it can be seen that as the numbers of replaced individuals of N16 were similar in all Sub-Areas, the overall impact of the N16 planting work in May 2022 was found to be minor in terms of the overall declining trend of survival rates across all Sub-Areas. The survival rates and the trends were still comparable across all Sub-Areas from May to July 2022. Therefore, it is suggested that the survival rates of native tree species recorded in July 2022 be treated as the final measurements of the Trial, except for N16, where the April 2022 measurement should be taken as final.

Health Trends

3.4.16 As shown in Figure 3.5, the average overall health rating[6] was around the range of 3±0.5 (i.e. "Fair") for all plant categories. It is notable that each winter, there was a temporary drop in the average health rating, but entering the subsequent growing seasons, the rating rose steadily. The drop observed in the second-year planting was gentler than the first. This could be a result of the warmer winter in the second year and/or the sheltering effect of the first-year planting starting to be effective. In general, the exotic tree species exhibited the best health rating, followed by the shrubs, and then the native tree seedlings. The overall health ratings patterns in each Sub-Area were similar, implying that any variations created by the use of MGT or by exotic trees were not obvious.

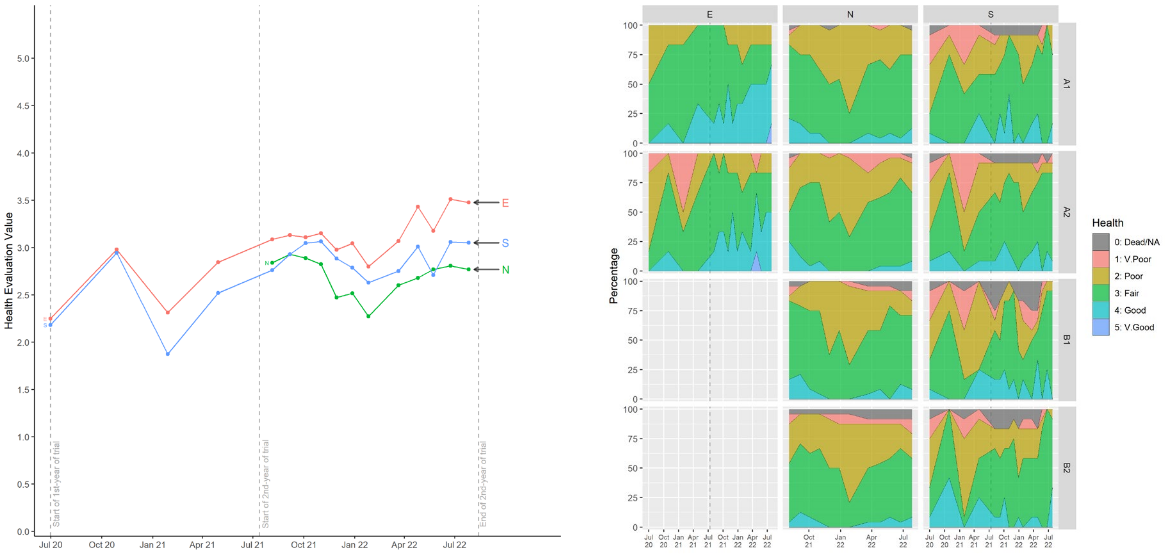

Figure 3.5: Trends in average overall health rating by plant category (left) and overall proportion of health condition by combinations of plant category and Sub-Areas (blocks of different combinations of exotic trees and micro-climatic tube treatments) (right)

3.4.17 **Height Trends** – As shown on Figure 3.6, the average height of exotic tree species and the average height of shrub species remained steady over initial months of the 1st year of the Trial. After the winter in late 2020, the exotic tree seedlings grew quickly and achieved up to 140cm height on average by the end of the Trial. Most shrub species grew very slowly and remained at an average height of around 40cm throughout the whole of the Trial period.

3.4.18 The overall height trends of exotic tree species were similar between the two Sub-Areas and were similar to each other within the category of exotic tree species. Similarly, the overall trends of average height of shrub species were similar to each other across all Sub-Areas, despite appearing to be more fluctuation from month to month, due to differences generated from random sampling of individuals for measurement.

3.4.19 Native tree seedlings, following the planting at the start of the 2nd year of the Trial, generally exhibited a gentle decline in overall average height, from approximately 60cm to approximately 50cm. This observation was probably a result of dieback and decline in many native tree species, especially after major dieback was triggered in the winter month of January 2022 in some of the larger native tree seedlings (as shown in Figure 4.7 later in this report). This possibly suggests that shelter from

[6] As required in Clause 36.3.5.24 and Part B of Appendix 36.3.3 of the Contract Document, "General Health" was part of the Trial Planting Monitoring Worksheet and required to be recorded in a range of (*-V.Poor; *****-V.Good). For convenience of practical operations during analytical calculations and communication in text, in this Report a health rating system of (1: V.Poor; 2: Poor; 3: Fair; 4: Good; 5: V.Good) is adopted.

surrounding exotic trees and shrubs was still inadequate to nurse native tree seedlings in the 2nd year of the Trial.

3.4.20 For native tree seedlings, a positive relationship was observed between plant height and MGT height. There appeared to be an observable difference between the effects of MGT types, with a final average plant height of around 60cm for Sub-Areas A1 and B1 (which used 60cm-tall circular MGT type, shown as green circles in the right-hand graph of Figure 3.6), and an average plant height of around 45cm for Sub-Areas A2 and B2 (which used 45cm-tall triangular MGT type, shown as green triangles in the right graph of Figure 3.6).

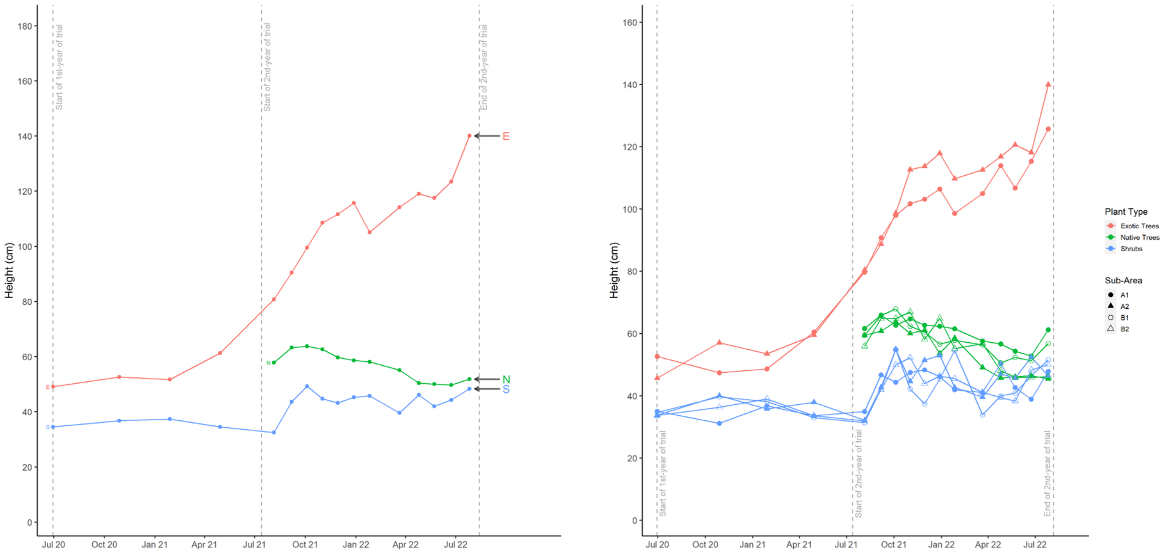

Figure 3.6: Trends in average height by plant category (left) and average height by plant category by Sub-Areas (blocks of different combinations of exotic trees and micro-climatic tube treatments) (right).

3.4.21 Having concluded this overview, the following section of the report will provide more specific analysis of trial results.

4 MONITORING FINDINGS AND ANALYSIS

4.1 INTRODUCTION

3.4.22 This section of the Report provides a detailed review of the Trial findings as well as analysis of these findings.

4.2 PLANT SPECIES SELECTION AND APPLICATION

3.4.23 A detailed evaluation of individual plant species with reference to their survival rate, health and height is provided in Appendix B. Based on the evaluation in Appendix B and the long-term observations during the Trial, an overall summary of the findings and recommendation for future use is consolidated in Table 3.1 below:

Table 3.1: Species Recommended for Use in Future Landscape Restoration as a Result of the Trial

Species	Recommendation for Future Use in Landscape Restoration	Potential Role / Application in Landscape Restoration
Exotic Tree Species		
(E1) *Acacia confusa*	***	Evergreen pioneer tree species
(E2) *Cassia nodosa*	*	
(E3) *Dalbergia odorifera*	***	Deciduous pioneer tree species
(E4) *Acacia auriculiformis*	***	Evergreen pioneer tree species
(E5) *Melia azedarach*	*	
(E6) *Senna siamea*	*	
Native Tree Species		
(N1) *Bridelia tomentosa*	*	
(N2) *Celtis sinensis*	**	Deciduous climax tree species
(N3) *Cinnamomum camphora*	**	Evergreen climax tree species
(N4) *Aquilaria sinensis#*	*	
(N5) *Ficus virens*	**	Deciduous climax tree species
(N6) *Hibiscus tiliaceus*	***	Evergreen climax tree species
(N7) *Ilex rotunda* var. *microcarpa*	**	Evergreen climax tree species
(N8) *Liquidambar formosana*	**	Deciduous climax tree species
(N9) *Litsea glutinosa*	**	Evergreen climax tree species
(N10) *Machilus chekiangensis*	*	
(N11) *Macaranga tanarius*	*	
(N12) *Myrica rubra*	**	Evergreen climax tree species
(N13) *Rhodoleia championi#*	*	
(N14) *Polyspora axillaris*	*	
(N15) *Pongamia pinnata*	***	Deciduous pioneer tree species
(N16) *Pyrus calleryana*	**	Deciduous climax tree species
(N17) *Reevesia thyrsoidea*	*	
(N18) *Rhus succedanea*	**	Deciduous climax tree species
(N19) *Sapium discolor*	*	
(N20) *Sapium sebiferum*	***	Deciduous climax tree species
(N21) *Camellia crapnelliana*	*	

Species	Recommendation for Future Use in Landscape Restoration	Potential Role / Application in Landscape Restoration
(N22) *Sterculia lanceolata*	*	
(N23) *Syzygium hancei*	**	Evergreen climax tree species
(N24) *Viburnum odoratissimum*	**	Evergreen climax tree species
Shrubs		
(S1) *Buxus sinica*	*	
(S2) *Calliandra haematocephala*	***	Evergreen pioneer shrub species
(S3) *Hamelia patens*	*	
(S4) *Ipomoea pes-caprae*	*	
(S5) *Rhododendron simsii#*	*	
(S6) *Pittosporum tobira*	*	
(S7) *Rhaphiolepis indica*	**	Evergreen climax shrub species
(S8) *Rhodomyrtus tomentosa*	**	Evergreen climax shrub species
(S9) *Verbena rigida*	*	
(S10) *Lespedeza formosa*	***	Deciduous climax shrub species
(S11) *Vitex negundo*	***	Deciduous climax shrub species
(S12) *Vitex rotundifolia*	**	Evergreen climax shrub species

Legend:
\# Protected species
* Not recommended
** Considerable, subject to some factors
*** Recommended

Exotic Trees (Pioneer nurse species)

3.4.24 Pioneer species are the first plants to be planted in each phase of restoration, and are expected to grow to a certain size to provide shelter for neighbouring native seedlings, which are planted a year later. Ideally this group of plants should be fast-growing and tolerant to harsh conditions.

3.4.25 The plant species evaluation found that species (E1) *Acacia confusa*, (E3) *Dalbergia odorifera* and (E4) *Acacia auriculiformis* are suitable for this purpose. These plants featured a symbiotic partnership with soil microbes and clearly benefited from their ability to fix atmospheric nitrogen nutrients for their growth. (E1) and (E4) were found to be evergreen on-site, while (E3) was a winter deciduous species.

3.4.26 While evergreen species provide shelter for neighbouring plants throughout the year, it was observed that the canopy of deciduous species opens out in winter months. Although deciduous species have such disadvantages, they are still considered important to the overall planting assembly, as their leaf litter replenishes organic matter and releases nutrients back to the soil. More detail about soil will be provided and discussed in later sections.

3.4.27 As shown in Figures 3.1 and Figure 3.2, to avoid leaving large gaps in the canopy, both evergreen and deciduous exotic tree species should be evenly distributed across the whole planting area, to form sheltered pockets within which wind speed is reduced and the air remains relatively still.

3.4.28 The spacing between individual exotic tree seedlings should also be carefully adjusted. Considering that the exotic tree seedlings grew to approximately 1.3m on average after two years, and with the nominal spacing of exotic tree seedlings in Sub-Area A1 and A2 at 4m (refer to as-built planting drawing in Appendix A), they are generally unable to form a closed canopy effective for sheltering other plants (Species (E4) *Acacia auriculiformis* was an exception. It grew to approximately 3m at the end of the 2nd year).

3.4.29 Therefore, given that a variety of moderately fast-growing exotic tree seedlings will be generally used – so that a monoculture is avoided – and that they will be evenly distributed at a spacing of 4m in future phases, it is reasonable to predict that a more or less closed canopy coverage should be achieved by the end of the 3rd year. By then, the sheltered ground between the established exotic tree seedlings should be suitable for infill planting in the second phase of native tree planting. The west side of the Trial in Sub-Areas A1 and A2 in Figure 3.1 and Figure 3.2 demonstrates such a growing environment.

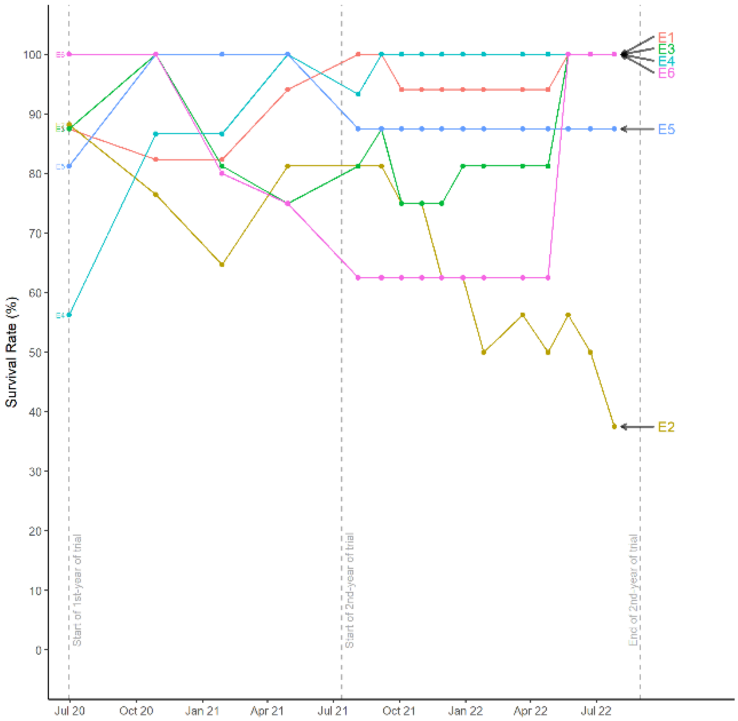

Figure 4.1: Average Survival Rate Trends in Individual Exotic Tree Species

Figure 4.2: Average Health Rating Trends in Individual Exotic Tree Species

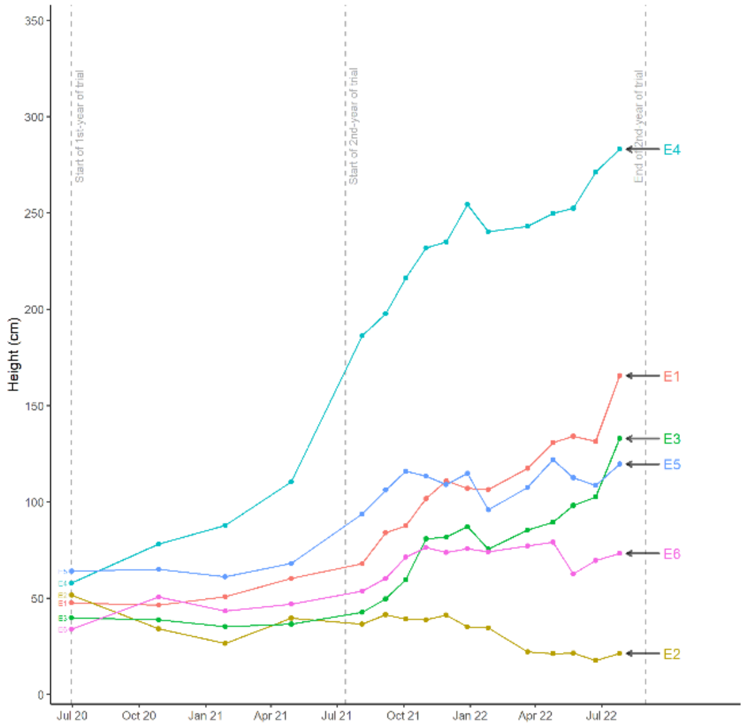

Figure 4.3: Average Height Trends in Individual Exotic Tree Species

Typical condition of (E1) *Acacia confusa* as of May 2023

Typical condition of (E3) *Dalbergia odorifera* as of May 2023

Typical condition of (E4) *Acacia auriculiformis* as of May 2023

Figure 4.4: Photos of Typical Condition of Several Notable Exotic Tree Species

Native Trees (Climax species)

3.4.30 Native trees are the main focus of the landscape restoration project and of the Trial, as ultimately the goal is to create a self-sustaining natural native woodland, ideally high in biodiversity. Adaptable native woodland species that grow steadily in the long-term are preferred for this purpose. In addition, a minimum of 2% of total plant numbers will be protected native plant species as per Contract requirements.

3.4.31 Due to a number of factors, slow growth rates appear to be common for many of the trialled native tree species. The photos below show the typical conditions of some native tree seedlings observed in May 2023.

3.4.32 Based on observations, (N15) *Pongamia pinnata* was the most successful native tree seedlings by May 2023. In fact, this is also in line with what graphs show up to July 2022, at the end of the 2nd year of the Trial. Although it is a native, its growing habit resembles the pattern of many exotic tree seedlings. It also featured a symbiotic partnership with soil microbes and clearly benefited from this ability to fix atmospheric nitrogen nutrients for its growth. This species is therefore recommended for future use in the restoration, and it appears that companion planting is not necessary for its growth. Of note, (N15) was the only native tree species that could be identified in the photos taken in July 2023 in Figure 3.2 (about 24 months after planting of the native tree seedlings). Also as shown in Figure 4.6 and Figure 4.7, (N15) was the only native tree species in the Trial that achieved a health rating of 4 (i.e. Good) throughout most of the Trial period, and demonstrated notable growth in height. As it is a deciduous plant, there was a brief decline in its average health rating during the winter.

3.4.33 From analysis in the graphs and from photos taken in May 2023, (N6) *Hibiscus tiliaceus* and (N20) *Sapium sebiferum* also exhibited relatively good performances. From the analysis in the graph recorded up to the end of the 2nd year of the Trial (July 2022, i.e. 12 months after planting of the native tree species), (N6) *Hibiscus tiliaceus* is the next best performing species after (N15) *Pongamia pinnata*. However, in May 2023, it appeared quite obvious that (N20) was growing better than (N6). It is believed that (N20) *Sapium sebiferum* had gradually become better adapted to the site environment over the long term.

3.4.34 Other species, such as (N8) *Liquidambar formosana*, (N11) *Macaranga tanarius*, (N16) *Pyrus calleryana*, (N18) *Rhus succedanea* and (N23) *Syzygium hancei* demonstrate the development of dependent species which rely on surrounding shelter provided by fast-growing exotic trees. In general, they barely grow in the Trial Nursery environment, emerging above the top of the microclimatic growth tubes in their 2nd year (May 2023). At exposed locations, they tend to have chlorotic foliage (e.g. (N8), (N18) and even other evergreen plants). When planted next to bushes or even in shade, they tend to exhibit better health and faster growth. (N16) *Pyrus calleryana* demonstrated its high vigour and the positive effects of neighbouring exotic tree species (E4) *Acacia auriculiformis*. The dappled light and shade provided by the nurse species appears to be favourable to the health and growth of these native tree seedlings.

3.4.35 (N12) *Myrica rubra* is a notable species. Since late 2021, its survival rate was approximately 20%, amongst the three native tree species with the lowest survival rates. In general, the individuals of this species either exhibited poor health or continued mortality. One specimen observed in May 2023 was exceptionally healthy and appeared to be growing well. It was believed that it had accidentally formed a symbiotic mutualism with soil microbes. This species is believed to demonstrate the importance of symbiotic soil microbes associated with its roots. The partnership protects each other, with the host plant providing a growing environment for the bacteria, while the latter fixes nitrogen and provides nutrients in exchange. In this way, the partnership survived the harsh environment on site, while other individuals (N12) suffered and died. In future, it is recommended that greater application of soil microbes during planting be researched. (Chen, 2022; He, 2004; Hiyoshi, 1988; Hong, 2023; Li, 2022; Ren, 2021; Tani, 2003)

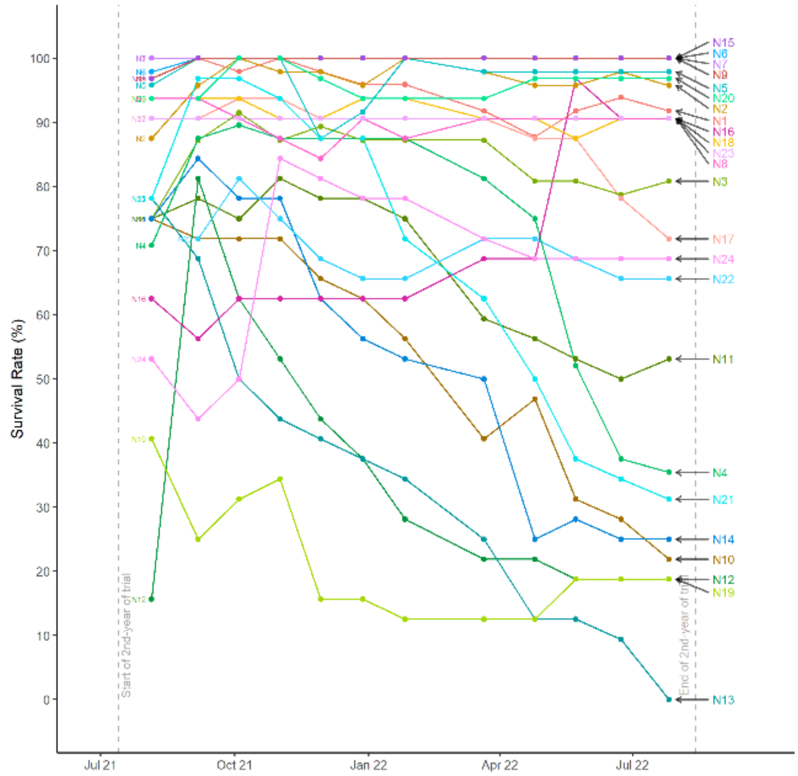

Figure 4.5: Average Survival Rate Trends in Individual Native Tree Species

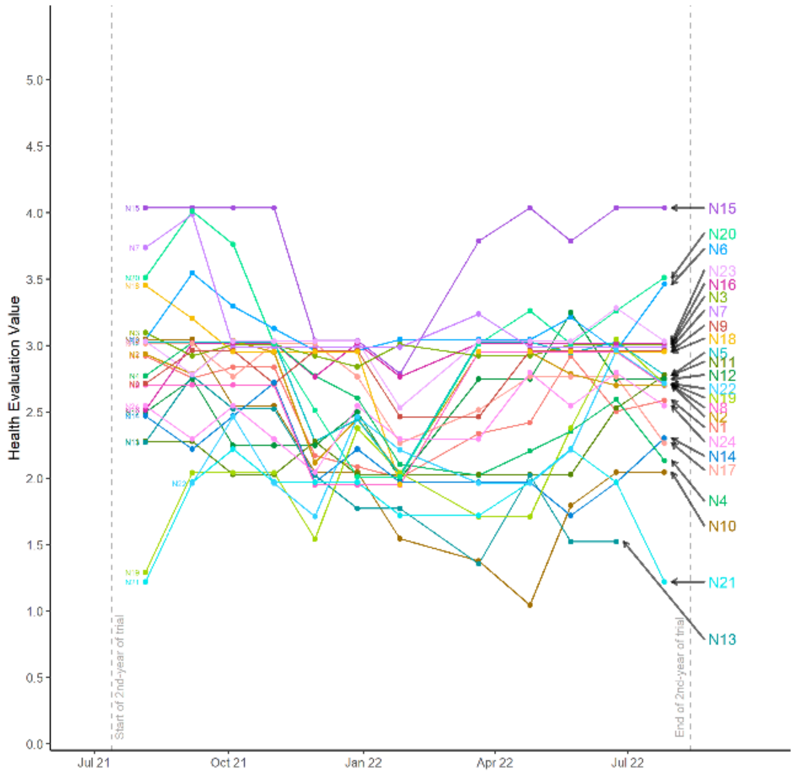

Figure 4.6: Average Health Rating Trends in Individual Native Tree Species

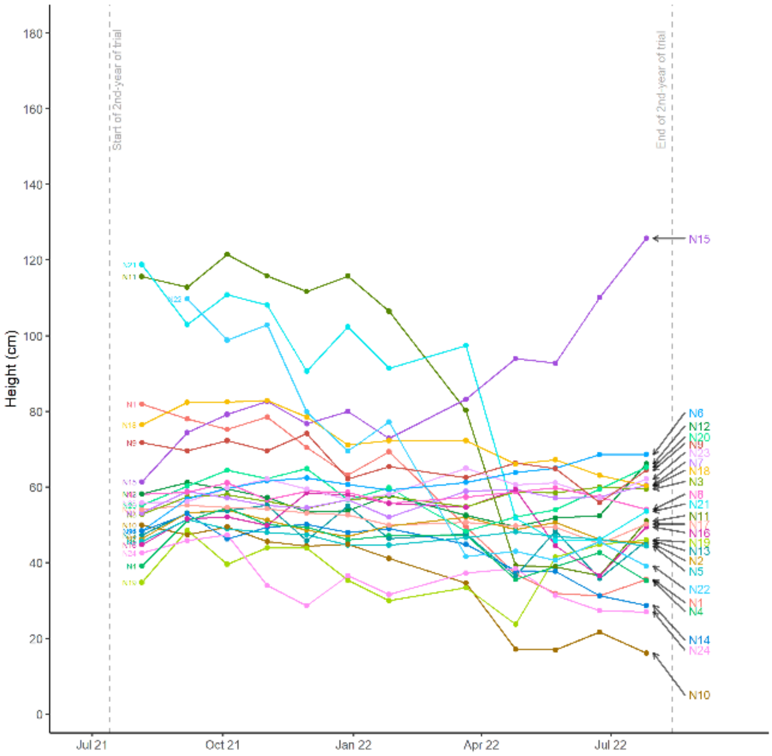

Figure 4.7: Average Height Trends in Individual Native Tree Species

Typical condition of (N6) *Hibiscus tiliaceus* as of May 2023

Typical condition of (N7) *Ilex rotunda* var. *microcarpa* as of May 2023

Typical condition of (N8) *Liquidambar formosana* as of May 2023

Typical condition of (N11) *Macaranga tanarius* as of May 2023

Typical condition of (N12) *Myrica rubra* as of May 2023

Typical condition of (N15) *Pongamia pinnata* as of May 2023

Typical condition of (N16) *Pyrus calleryana* as of May 2023

Typical condition of (N18) *Rhus succedanea* as of May 2023

Typical condition of (N20) *Sapium sebiferum* as of May 2023

Typical condition of (N23) *Syzygium hancei* as of May 2023

Figure 4.8: Photos of Photos of Typical Condition of Several Notable Native Tree Species

Shrubs

3.4.36 In this group were planted to help create a well-structured woodland habitat and thereby enhance biodiversity. Ideally, these should be native plants which provide shelter and food for local wildlife, and should be adaptable and fast-growing in harsh conditions.

3.4.37 Based on observations in May 2023, shrubs (S2) *Calliandra haematocephala* (exotic), (S10) *Lespedeza formosa* (native) and (S11) *Vitex negundo* (native) formed a notable cluster of bushes. In particular, (S2) and (S10) are leguminous plant species that feature a symbiotic partnership with soil microbes and clearly benefit from their ability to fix atmospheric nitrogen nutrients. Just like their counterparts amongst exotic and native tree seedlings, these plants were forming discernible colonies as shown in Figure 3.1 and Figure 3.2. While (S2) is evergreen, (S10) and (S11) are deciduous during winter months.

3.4.38 Whilst these relatively successful shrubs were observed to cluster in colonies, it is interesting to note that they either survived or died together in groups of the same species. It is believed that the close distances of their initial planting facilitated their root zones (rhizosphere) to interweave, enabling the sharing of soil microbes' inoculation of roots, which in turn benefited all individuals within the same plant colony. This phenomenon suggests that planting plants closer together, and forming larger plant groups at initial stages, could benefit the overall performances of shrubs, and probably all plants in general. (Bai, 2022; Brockwell, 2005; Johnson, 2007; Ng, 2009; Rodríguez-Echeverría, 2016; Rydlová, 2013; Vaario, 2021; Southworth, 2012)

3.4.39 While shrub species (S4) *Ipomoea pes-caprae* was found to be fast-growing, it had a form like that of a climbing plant and acted like a ground cover. Instead of growing upright with multiple layers of foliage canopies and forming a shaded and sheltered space underneath that is sufficient to accommodate a seedling (300mm minimum in height under the Contract Specification), (S4) was seen only forming a single thin layer of foliage close to the ground level as it spread and colonised neighbouring areas. With this growth habit, it differed from other successful shrub species which have a more upright growth form and multiple layers of foliage. (S4) was also found easily climbing onto other tree seedlings, potentially suppressing them, as shown in a photo (see Figure 4.12) taken in May 2023. (In that photo, the chlorotic plant in the MGT is (N23) *Syzygium hancei*). Although (S4) is relatively fast-growing compared to other shrub species in the Trial, its growth rate was still much slower than many weed/invasive species, which were usually exotic shrubs with more upright habits and multiple layers of foliage. Unless (S4) is densely planted in large number, it is unlikely that this shrub species would be able to cover the ground sufficiently to crowd out the weed/invasive species. By contrast, (S4) is potentially easily shaded out by the more aggressive exotic weed/invasive species, as the latter are commonly more aggressive and more upright in form. Due to all these considerations, (S4) it is suggested that may be not an ideal choice of shrub species in future restoration planting, except in cases where it meets a special need.

3.4.40 The use of shrub species in forest restoration deserves further research and exploration. As seen in the Trial Nursery, in the 2nd and 3rd year of the Trial, groups of fast-growing shrubs appeared to form sheltered environments for neighbouring plants, functioning like exotic nurse trees. When strategically arranged, they probably work better than micro-climatic growth tubes (MGT) for sheltering native tree seedlings. As the shrubs' mature height is usually around 3m or so, in the long-term, they should not become overly competitive with the native tree species in terms of growing space, sunlight and other resources. Even should these shrubs grow too densely and become an obstruction for the growth of native tree seedlings, thinning works are much more practical on shrubs than on established exotic trees, as the latter can grow to more than ten metres and the slow-growing native trees might take a great length of time to catch up after their removal.

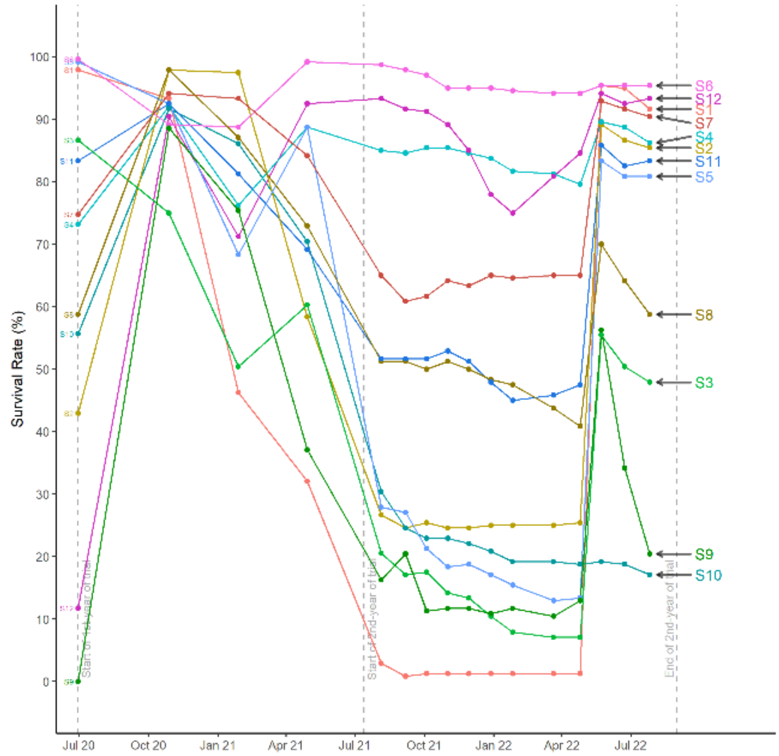

Figure 4.9: Average Survival Rate Trends in Individual Shrub Species

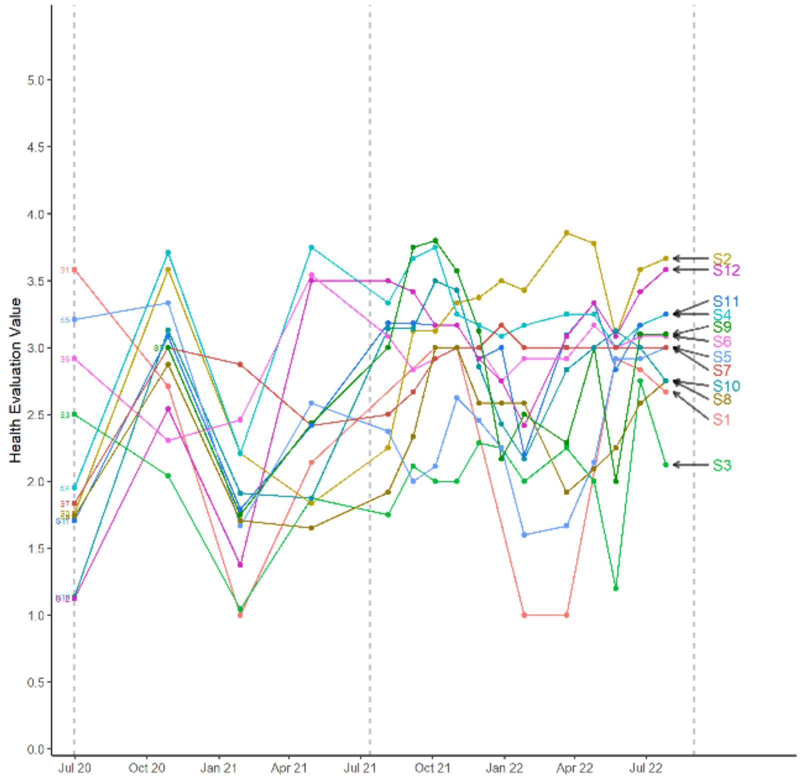

Figure 4.10: Average Health Rating Trends in Individual Shrub Species

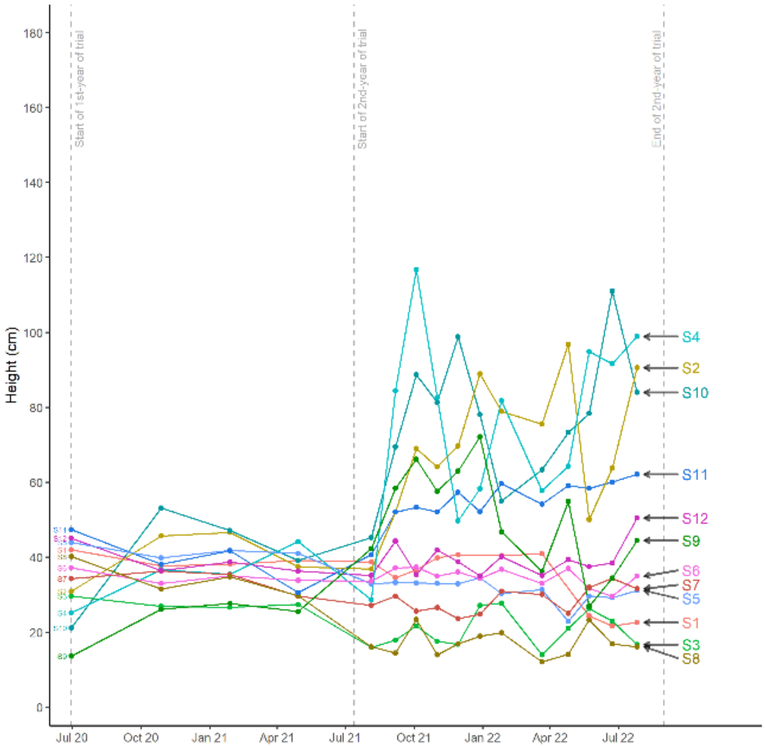

Figure 4.11: Average Height Trends in Individual Shrub Species

Typical condition of (S2) *Calliandra haematocephala* as of May 2023

Typical condition of (S4) *Ipomoea pes-caprae* as of May 2023

Typical condition of (S10) *Lespedeza formosa* as of May 2023

Typical condition of (S11) *Vitex negundo* as of May 2023

Figure 4.12: Photos of Typical Condition of Several Notable Shrub Species

4.3 SOIL BIOLOGY

3.4.41 Observations at the Trial Nursery found that soil microbes probably play a key role in determining the success of any species planted on-site. Leguminous species in general appeared to take advantage of fixing atmospheric nitrogen via a partnership with soil microbes, and hence demonstrated higher growth rates and survival rates. Examples of such associations were apparent in species (E1) *Acacia confusa*, (E3) *Dalbergia odorifera*, (E4) *Acacia auriculiformis*, (N15) *Pongamia pinnata*, (S2) *Calliandra haematocephala*, and (S10) *Lespedeza formosa*. While (N12) *Myrica rubra* is not a legume, It is believed that some individuals of *Myrica* sp. probably form partnerships with another group of soil bacteria, and fix nitrogen similarly. These phenomena suggested that the species that could establish partnership with their species-specific symbionts in soil, would be likely to succeed in progressing through the early stages of succession. In the Trial Nursery, it also appeared that such partnership with microorganisms may have happened only randomly for untreated seedlings.

3.4.42 While soil microbes might play a role in strengthening plant tolerance to abiotic factors such as winter weather, the low temperatures and dry weather could still adversely affect microbial soil activity. For this reason, many plants shed leaves in winter and remain dormant to protect themselves through the harsh winter environment. The resultant leaf litter releases nutrients back to the soil for the revival of soil microbes and other plants in the next growing season.

3.4.43 In conclusion, it is suggested that in future landfill restoration phases, artificial inoculation of soil microbes to plants could be explored, to give a better chance of successful early establishment. (Asmelash, 2016; Bloem, 2005; Bradshaw, 2003; Fitter, 2002; Helena Devi, 2021; Kalamulla, 2022; Khan, 2003; Larcher, 2003; Miller, 1992; Ng, 2008; U.S. Department of Transportation, 2017; van der Heijden, 1998)

3.5 CLIMATIC FACTORS (SEASONALITY)

3.5.5 From the overall performance of the exotic trees, native trees and shrubs in the Trial, there appeared that the weather in winter was a significant factor that led to the retarding of plant estbalishment. Most seedlings were planted in late summer, and performance in terms of health and survival rate was found to be stable during the initial stage of establishment, before the onset of the first winter.

3.5.6 Depending on the adaptability of any given plant species, and the vigour of each seedling in question, various degrees of decline were observed in winter. Recovery could start in the next spring (early-season), or the next summer (late-season), or in other cases, recovery did not seem to happen at all as unadaptable plants went on to decline or even die during the growing season. This pattern appeared to repeat in winter again in the second year, but the extent of the decline usually appeared to be less severe. This observed phenomenon in the second year might be a collective result of different weather conditions over both winters, better sheltering effects provided by increased plant size in the Trial Nursery, and/or more tolerance to abiotic factors, as the plants matured and possibly formed partnerships with microbial communities in the soil.

3.5.7 To mitigate the adverse impacts of sudden drop and low temperature in winter, the pioneers that provide screening should be arranged such that the winter monsoon wind could be retarded. For this site, the predominant winter monsoon wind comes from the northeast. It would therefore be logical to place large evergreen plants on the northeast of native species to form a windbreak. However, care should be taken to planting arrangements in order to prevent forming wind tunnels running from northeast to southwest.

3.5.8 Ideally, the **larger, fast-growing pioneer species should be spaced closely together,** to form stable air pockets between them. (Bardgett, 2010; Larcher, 2003; Beiler, 2015; Bingham, 2012; Chung, 2018; Eliott, 2013; Hammann, 2021; Hodgkiss, 1981; Holl, 2020; Lambers, 2020; Palmer, 2016; Ren, 2008; Schulze, 2019; Spittlehouse, 1990; Teste, 2008; U.S. Department of Transportation, 2017; Wong, 2016; Zemp, 2023)

4.4 USE OF GROWTH TUBES AND PLANTING TECHNIQUES

Timing of Planting

3.5.9 While planting in summer in the Trial Nursery resulted generally in successful initial establishment of seedlings, it is suggested that it would be more favourable to have them planted in spring instead, so that they benefit from the lower average temperature and evapotranspiration rate, and higher average humidity in that season. In that case, the plants and associated soil microbes could grow for a whole growing season, and establish a more solid symbiotic partnership to prepare for the subsequent winter.

3.5.10 **The ideal planting time within the planting season is between 1st March to 31st May**, and the Contractor should be advised to procure landscape works in advance to ensure planting could be carried out at the preferred time.

Shelter for Seedlings

3.5.11 In the Trial, some specimens of native tree species ((N4) *Aquilaria sinensis*, (N7) *Ilex rotunda* var. *microcarpa*, (N16) *Pyrus calleryana*, (N20) *Sapium sebiferum* and (N23) *Syzygium hancei* etc.) were allocated planting locations in the shade of more established plants from the first year of the Trial, namely ((E1) *Acacia confusa*, (E4) *Acacia auriculiformis* and (S2) *Calliandra haematocephala* etc.). In many cases, such as (N7), (N16) and (N20) (photos and descriptions of these species can be found in Appendix B), it was observed that the native tree seedlings generally established to be healthier and larger, and sometimes grew above the height of the MGT. This may indicate that planting of the native tree seedlings appeared to be more successful under the shade of other trees than in exposed areas.

3.5.12 This is a key characteristics of climax species in their natural habitat. Climax species tend to germinate and grow well only in late successional stages of a forest habitat, when the tree canopy has closed adequately.

3.5.13 Hence, apart from a few exceptions, such as the leguminous plants, it is recommended that **native tree seedlings should in future restorations be planted only after there is sufficient shelter created by neighbouring vegetation**.

Phased Planting

3.5.14 The basic planting methodology used in the Trial Nursery was to establish tree canopies for shelter in the 1st year of planting, by growing pioneer plants, which were primarily exotic tree species. Then at the start of the 2nd year, the native climax tree seedlings were inter-planted in the gaps between the establishing exotic trees.

3.5.15 In the Trial Nursery, the phased planting arrangement took this form of a 1-year lag for the native climax species to be planted after the exotic trees and shrubs were planted. By the time native climax seedlings were planted in the Trial Nursery, species (E4) *Acacia auriculiformis* had reached an average height of approximately 1.8m, although other exotic pioneer species were still less than 1m in height ((E5) *Melia azedarach* was close to 1m but its canopy tended to be sparse and contributed little to sheltering). This, combined with the failure of many (E2) *Cassia nodosa* and (E6) *Senna siamea*, meant that the canopy layer of exotic tree species in the Trial Nursery had not closed at the start of the second-year trial, (except near (E4) *Acacia auriculiformis*).

3.5.16 Given that the spacing of native climax seedlings was 1.5m, it is estimated that a 1.5m height should be the ideal target for pioneer seedlings in order to provide effective sheltering for nearby native climax species. From the data gathered in July 2022, it was found that (E1) *Acacia confusa* (166cm) and (E4) *Acacia auriculiformis* (283cm) reached such a height on average by the end of the second year, and that (E3) *Dalbergia odorifera* (133cm) came close. Therefore, depending on the choice of exotic tree species used as pioneers, **a 2-year or 3-year lag in the planting programme could be considered** in future restoration phases as a means of establishing a closed canopy to shelter native climax seedlings.

Plant Setting Out

3.5.17 A staggered planting grid was used in the Trial Nursery. However, the exotic plant species were grouped in pairs at a spacing of 1.5m, with every pair approximately 7m apart horizontally. Due to the orientation of the Trial Nursery, the native climax seedlings were planted on the windward side along the 7.5m spaces. This, compounded by the fact that (E1) *Acacia confusa* and (E4) *Acacia auriculiformis* (both relatively successful pioneers) were planted close together on the leeward side, and the poor performance of some other pioneer species, meant that the overall sheltering effect achieved in the Trial Nursery was poor and not available where most needed.

3.5.18 In future phases of restoration planting, the direction of the prevailing winter monsoon and orientation of the planting pattern should be simultaneously considered and **pioneer or nurse species planted on the windward side of native species**.

Pioneer-Climax Species Ratio

3.5.19 With seedling trees planted at 1.5m spacings in the Trial Nursery., exotic-pioneer species made up 20% of plants and native-climax species 80% (i.e. a 1:4 ratio) As the exotic species were paired-up, the resulting spacing between the pairs was approximately 4m in a staggered triangular-grid. At such spacing, the overall sheltering effect was observed to be inadequate at the time of planting the native-climax species a year later.

3.5.20 In future phases of restoration, it is recommended that the **planting pattern and pioneer-climax species ratios should be considered together**. One possible configuration is to allocate exotic species at 3m spacings, and hence each native climax species would be 1.5m from the nearest exotic species in order to achieve effective sheltering, and allow for early establishment of native tree seedlings. In a staggered triangular-pattern, this configuration would result in 25% of exotic-pioneer plants to 75% of native-climax plants, which is equivalent to a 1:3 ratio. For the greatest sheltering effect, ideally the orientation of setting out should be adjusted relative to the winter monsoon, and the choice of pioneer species should be carefully selected such that they are of species with a high survival rate and achieve the target height (approximately 1.5m before the native climax species are planted.

Microclimatic Growth Tubes (MGTs)

3.5.21 Shelter appeared to be a critical factor for the success of planting in the Trial Nursery. MGTs were expected to help protect the planted seedlings from adverse weather and increase the success rate of native climax seedlings. Two types of MGT were tested to protect native tree seedlings. One type of the MGTs was taller (60cm in height), with a narrower opening and a circular opening. The other type was a shorter triangular tube with a wider opening (45cm in height).

3.5.22 Given the same age of the seedlings and similar site conditions in the Trial Nursery, it was noted that the seedlings grown in the 60cm tubes were taller than those in the 45cm tubes. At the end of the 2nd year of the Trial (July 2022), some species were found to be growing above the height of the MGTs. Examples included:

- (N15) *Pongamia pinnata* and also some of the (N12) *Myrica rubra*, which were probably associated with nitrogen-fixing soil microbes;
- (N6) *Hibiscus tiliaceus* and (N18) *Rhus succedanea*, which were probably particularly drought-tolerant; and
- certain individuals of (N4) *Aquilaria sinensis*, (N7) *Ilex rotunda* var. *microcarpa*, (N16) *Pyrus calleryana*, (N20) *Sapium sebiferum* and (N23) *Syzygium hancei* etc., which were protected under the canopy of nearby pioneer species.

3.5.23 Growth of most other native climax seedlings appeared to be limited to the confines of the MGTs of either type within the one-year trial, possibly because of the more exposed conditions above the end of the MGT. Some species like (N11) *Macaranga tanarius*, (N21) *Camellia crapnelliana* and (N22) *Sterculia lanceolata* were delivered at >1m in height when planted initially. These seedlings tended to die back subsequently to remain within the MGT, resulting in relatively poor health. It was observed that many seedlings had their foliage clustered at the opening of the MGT.

3.5.24 As all native seedlings were planted within an MGT, it is not possible to determine whether MGTs have helped increase their survival rate in this Trial. The difference between survival rates of native tree seedlings grown in the two MGT was not obvious – 69% for the 60cm circular type vs. 71% for the 45cm triangular type. Given then that the choice of MGT might not directly affect the resulting survival rate, **the wider-opening type should generally be preferred** in future restoration phases in order to allow more space for seedlings to develop.

3.5.25 In future restoration planting, **the height of the MGT should be taller than the plant inside at the time of planting**. The shelter provided by MGTs might help in early seedling establishment to some extent, but the effect might be less critical compared to shelter provided by surrounding living vegetation. Therefore, it is possible to consider MGTs as a temporary aid at the very early stages of seedling establishment when the site is open and exposed. In fact, if the planting of native tree seedlings is to be carried out after establishment of a canopy layer by exotic tree seedlings and/or fast-growing shrubs, the use of MGTs might be not needed at all. On the other hand, as seen from the graphs above, winter stress was evident in the development of exotic tree seedlings and shrubs, meaning that MGTs might be better used to aid these plants when the site is still open and exposed.

4.5 PEST AND WEED SUPPRESSION

Undesirable Weed Species

3.5.26 *Leucaena leucocephala* is one of the most aggressive invasive weed species across the whole of SENT. To prevent the issue worsening, the spread of *Leucaena leucocephala was* kept under control in the Trial Nursery through regular manual clearance whenever weed seedlings were observed, inclusive of root removal, as the seedlings were young and could be pulled out by hand. Hence, there were only sporadic individuals within the Trial Nursery from time to time, and these were soon removed. Due to such frequent and meticulous weed clearance exercises targeted at *Leucaena leucocephala*, it seems almost certain that no fruits and seeds of the weed species were produced within the Trial Nursery. Nevertheless, seedlings of *Leucaena leucocephala* reappeared a few months following every weed removal. It is suspected that the seeds of *Leucaena leucocephala* may have been mixed into the soil at the beginning of the Trial. As only a portion of the seeds germinate in each growing season, it would take several years for all its viable seeds to germinate and subsequently to be observed during inspections and to then get removed by workers. This signifies that **one of the solutions to the issue of *Leucaena leucocephala* is to remove the young seedlings as soon as possible to prevent the spread of its fruits and seeds.**

3.5.27 Other weeds such as *Mimosa pudica* and *Desmodia tortuosum* were found to be fast-growing, and colonizing large areas of the Trial in thick patches, smothering some of the planted seedlings. The issue was more serious in the warm season. In winter, both of these weed species tended to defoliate and open up space for the planted seedlings. Nevertheless, most of the Trial species appeared to be out-competed by these weeds again in the warm season. For the sake of early establishment, it is recommended that **the spread of self-generating weeds of leguminous plant species such as *Mimosa pudica* and *Desmodia tortuosum* should be managed** in future phases of restoration planting.

3.5.28 In the long-term it is expected that pioneer species like those exotic tree species planted in the Trial are able to form a closed canopy to shade out shrubby weeds which are generally sunlight-demanding. By that time, the issue of these weed species should be under control. Therefore, it is both important to prevent weed colonisation in the first place, and ensure the establishment of a canopy layer of pioneer species. It is **also important to replace dead seedlings of pioneer species** in order to maintain the intactness of the canopy layer, so that no spaces are left open for weed colonisation.

Weed Mat

3.5.29 From observations in the Trial Nursery in April 2021 in the 1st year of the Trial, as ambient temperature started to rise and sunlight hours became longer in the growing season, some seedlings were unexpectedly found to be declining, which is abnormal in spring. One of the possible explanations for this unusual observation is that the weed mats might have been installed too tightly around the stems of the seedlings, so that they heated up as sunlight shone directly onto the weed mats. As a result, it is possible that the soil temperature around the roots of the seedlings exceeded their tolerable range, and the plants overheated. Following mitigation to cut open the weed mats to allow better ventilation, some of the seedlings were saved and gradually recovered.

3.5.30 It is therefore recommended that caution should be taken when applying weed mat around seedlings. **Weed mat should be made of material which allows ventilation** so that soil heat can be exchanged with the surrounding atmosphere through convection, in order to maintain stable thermal dynamics. The installation of weed mats and the planting approach for seedlings should be carefully specified in relation to this issue.

4.6 WATERING AND MAINTENANCE

Watering

3.5.31 In principle, frequent watering should only be carried out when plants are newly planted, and when roots have not fully established yet and are still within their own rootballs from the nursery. As plants grow, their root zone extends, ideally, both laterally (in search of oxygen supply and possibly interacting with soil microbes in exchange of nutrients) and vertically (in search of water) at certain depth that is less affected by fluctuation of both temperature and moisture level than at the surface, or otherwise the plants will experience unfavourable growth conditions). After root establishment, plants in their outdoor habitat usually need little artificial watering as they start to regulate their transpiration rates by opening and closing of stomata and become adapted to the site environment (except at times when there is prolonged drought spell and lack of ground water reserve for uptake).

3.5.32 Ways should be explored to maintain sufficient soil moisture levels suitable for the growth of both trees and the symbiotic soil microbes. Watering should be targeted at suitably modified local ground conditions which will allow retention of water, such as planting pits and furrows (a trial of furrows is being undertaken in the SENT Phase 17 restoration, to investigate possibilities of improving irrigation effectiveness with reduced manpower, and trial results are expected to be delivered in early 2027).

3.5.33 Given that the site is an engineered slope with compacted soil, it is believed that water (mainly from precipitation and irrigation) easily drained fast across the surface and that it infiltrates only slowly into the soil, such that the overall moisture level of the soil profile is relatively low, as necessitated by engineering requirements. Nevertheless, given sufficient time (as in the case of long-term plant establishment), through repeated precipitation and action of water potential difference within the soil horizons, the gaps between the particles of compacted soil at depth will inevitably and eventually be filled with moisture (there is generally high rainfall in Hong Kong, and hence a likely surplus of water from precipitation, compared to many other parts of the world), although the process could be slow due to the compacted nature of the soil. The soil moisture at depth serves as a water reserve (although lower for this site compared to others). This is important to the hydrostatic and thermodynamic balance of the plants and soil microbes – as water at depth is driven towards the surface and the majority of root systems through transpiration pull and capillary rise during a dry and sunny day. Water at the soil surface tends to evaporate or be transpired first, and must be replenished by water from soil depths through capillary rise. Therefore, there will likely be fluctuation of water and temperature near the soil surface, and the replenishment of water will help t stabilise the moisture levels and temperature of the ground and plants at the surface. Therefore, when watering is needed (possibly when there is prolonged drought), it should be carried out slowly, and deeply so that it can reach the soil deep below the surface. The purpose of this is to replenish the ground water reserve in the soil, and prevent loss of water through evaporation and runoff at the soil surface, as the issue is more severe if watering is done in a frequent but shallow fashion. It should also be noted that root systems of the plants tend to be shallow due to the effect of the compacted soils (a site constraint, as oxygen is lacking deeper in the soil). Root system development predominantly at shallow depths in the long-term might not be most desirable, and possibly place the plants under unfavourable conditions such as seasonal temperature extremes and droughts, and there is higher risk of windthrow. Ways should be explored to encourage a deeper root system, and establishing interactions between plants and soil mycorrhizal networks could make a difference (Al-Karaki, 2013; Grossnickle, 2005; Holl, 2016; Jones, 2014; Lambers, 2020; Larcher, 2003; Pallardy, 2008; Schulze, 2019; Spittlehouse,1990; Taiz, 2002).

Grass Coverage Maintenance

3.5.34 The planting of the Trial Nursery was preceded by establishing a layer of grass on the site, to stabilise the surface of the slopes. In the winter of the first year of the Trial, when grass cutting was just carried out, subsequent monitoring found that many plants were in decline. It is believed that a layer of grass cover helps stabilise daily temperature variation at ground level, maintaining the optimum micro-climate for the seedling plants, and keeping moisture in the topsoil. Cutting the grass appeared to have a detrimental effect in these terms.

3.5.35 The effect of grass coverage and the height of grass layer should be considered in future phases of restoration and when specifying the planting maintenance approach. Grass cutting should be carried out as required only (for example, in a situation where the grass layer is generally too thick (>1.5m) while the planted tree and shrub seedlings are still very short). **When it is necessary, grass cutting should be scheduled in the growing season (March to September), with a minimum height of 300mm of existing grass cover retained**, so that there is enough time for grass to regrow and form a better coverage to the ground and neighbouring planting.

5 RECOMMENDATIONS FOR LANDSCAPE MANAGEMENT APPROACHES

5.1 RECOLLECTION AND CONSOLIDATION OF KEY POINTS FROM ANALYSIS

5.1.1 The following is a recapitulation and summary of key points from this report.

1. Fast-growing exotic pioneer trees are critical to effective canopy formation, and canopy coverage is important to the successful establishment and growth of native climax species, as the latter naturally prefer a sheltered environment, such as the understorey of a natural woodland.
2. While most native tree species belong to climax species, which naturally require shelter from surrounding vegetation for their early development, some species, especially leguminous species, might be directly planted at open sites, as they possess characteristics and an adaptability similar to many exotic pioneer species.
3. Shrubs are fundamentally woody species similar to trees, barring their smaller size. Like trees, some shrubs act like pioneer trees and others have characteristics similar to climax species. Planting of pioneer shrubs in a phased planting approach should be explored further. Considering shrubs should not grow too large to dominate trees in the long-term, pioneer shrub species could be an excellent choice to create screen vegetation for native-climax species. Pioneer shrubs are also easier to manage when thinning is necessary in later stages.
4. It has been observed that soil microbes might form successful symbiotic partnership with plants at the root zone, and play an important role in improving plant performances and survival rates. Instead of relying on random occurrence, artificial inoculation of soil microbes to plant root zones should be explored in future phases of restoration to give a better chance of successful early establishment of planting.
5. Winter weather, primarily due to the northeasterly winter monsoon experienced in SENT, is a main threat to the growth of plants there. Measures should be explored to protect the planted seedlings from exposure to the winter weather, including the low temperatures and occasionally strong monsoon winds. To maintain stable air pockets between exotic pioneer plants, the plants should be spaced closely together.
6. The timing of planting should ideally be scheduled in spring to maximize their exposure to warm summer weather so the plants can establish and prepare for the subsequent winter.
7. Seedlings of native-climax species should be placed close to areas of shelter created by the exotic-pioneer plants.
8. Depending on the choice of pioneer species in creating the canopy, phased planting should be arranged such that there is sufficient time for the canopy to adequately establish. According to experience in the Trial Nursery, it appears that a 1-year gap between planting exotic-pioneers and native-climax species is not adequate. It is considered that native-climax species should be planted 2 or 3 years after the exotic-pioneers, so that the pioneer species grow to more than 2m in size and provide a better established canopy coverage.
9. Planting patterns should be strategically oriented to create areas of shelter formed by pioneer species against the winter monsoon wind, into which native-pioneer seedlings can be planted.
10. Pioneer-climax species provide the best opportunity of success in establishing early canopy coverage. One might however slightly increase the proportion of exotic tree seedlings from 20% to 25%, to enable 3m spacings between pioneer species. Another approach is to separate the doubled-up exotic tree seedlings in the planting pattern to a better use of space.

11. The choice of MGT type appears generally not to be a critical factor to the growth of the plant, except for plant height in the first two years. If phased planting is being executed such that the native climax species are planted 2 or 3 years after the pioneer species, the value of MGTs surrounding the native-climax species might be low as the neighbouring pioneer species should by then have achieved adequate size to provide shelter. Instead, MGTs might be better used to surround exotic pioneer trees or shrubs in the first year of planting, when the site is exposed.
12. Occurrence of weeds such as *Leucaena leucocephala* should be regularly checked and removed immediately. The frequency of weeding should be high enough so that fruits and seeds of the species are not allowed to set on-site.
13. When weed mats are specified, its installation should allow sufficient ventilation.
14. Artificial watering should be used only when plants are newly established, or when there is prolonged drought. When it is needed, the watering should be targeted at specifically decompacted soil areas.
15. Grass cutting should be scheduled in the growing season only (March to September), so that there is enough time for grass to regrow and form a better coverage.

5.2 SENTX TRIAL NURSERY RECOMMENDATION – RESTORATION LANDSCAPE DESIGN PROCESS

5.2.1 Based on the lessons learnt from the Trial Nursery, an updated process for the design of the landfill landscape restoration is proposed, as shown in Figure 5.1. Some amendments to existing practices are proposed to implement the suggested measures raised in Section 4 and improve the outcome of the landscape restoration. These include:

- changes to exotic/native percentage mix;
- changes to planting matrix;
- amendment of phased planting program; and
- amendment of growth tube application.

5.2.2 It is recommended to alter the exotic/native percentage mix; from 20% exotic to 25% exotic. The change to 25% exotic enables the utilisation of a planting matrix with a 3m spacing between exotic trees, instead of the 4m spacing in the matrix in the Trial Nursery.

5.2.3 Regardless of the circumstance of the changes to the exotic/native percentage mix, it is recommended to change the planting matrix to a shorter spacing between exotic trees. Section 5.3 below sets out the comparison of different possible planting matrix pattern.

5.2.4 It is also recommended to amend the phased planting program such that the native climax species in the second phase of the program are planted after the initial pioneer planting have undergone three years of growth on-site. The exact timing of the second-phase planting could be adjusted subject to the performance of the exotic pioneer species. (Paquette, 2013)

5.2.5 It is also recommended to amend the growth tube application strategy in the above mentioned amended phased planting program, as the initial pioneer planting is predicted to be well established by the end of the second or third year and providing shelter for the native climax species. It is therefore recommended to review the need for MGT application, as MGTs could be more wisely applied at where there is need (for example, at the periphery of a planting grid where some native tree seedlings would inevitably be more exposed), or as a trial to aid the growth of native pioneer shrub species.

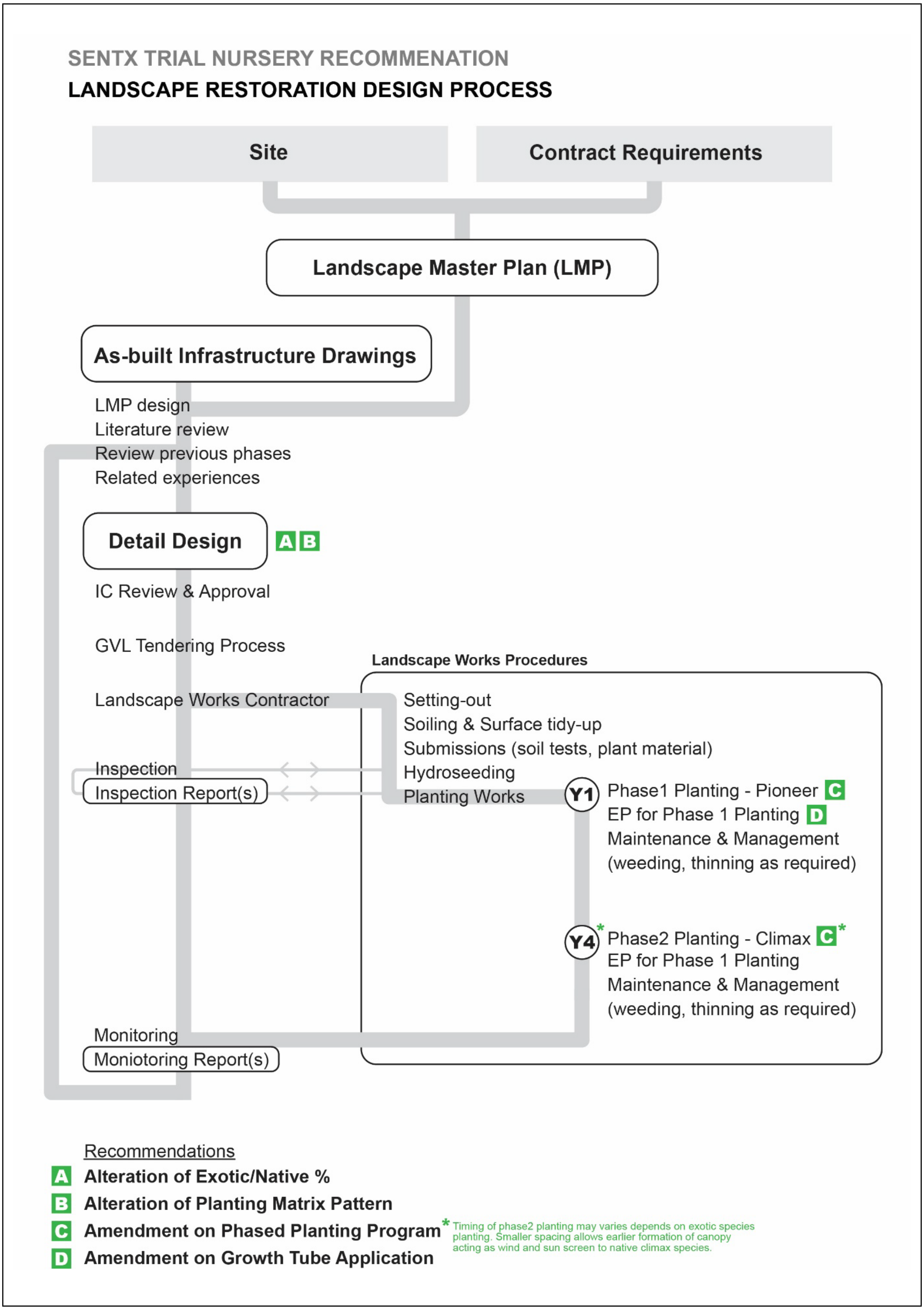

Figure: 5.1: Landscape Restoration Design Process

5.3 POSSIBLE AMENDMENTS TO PLANTING MATRIX AND EXOTIC/NATIVE PERCENTAGE MIX

5.3.1 The Contract requires the exotic/native percentage mix to be about 20%. This is equivalent to a ratio of 1 exotic : 4 natives.

5.3.2 The Trial Nursery used a planting matrix that satisfied the 20% exotic requirement (refer to Appendix A).

5.3.3 From the lessons learnt at the Trial Nursery monitoring, it was found that various factors including the predetermined exotic species percentage, planting matrix, orientation and performance of the Trial pioneer species are interlinked and that they affect one another.

5.3.4 In this section, various versions of the planting matrix are proposed for consideration in future phases of planting. The drawings in Appendix C provide a comparison between different versions of planting matrices for consideration in future planting design.

5.3.5 The table below provides a summary of key features of these different versions of the planting matrices.

Table 4.1: Summary Table of Various Versions of Proposed Planting Matrices

Planting Matrix Pattern	Typical SENT Matrix (Phase 17 reference)	Trial Nursery Matrix	Proposed Matrix Variation A	Proposed Matrix Variation B	Proposed Matrix Variation C
Exotic/Native Percentage Mix	40% exotic / 60% native	20% exotic / 80% native	20% exotic / 80% native	20% exotic / 80% native	20% exotic / 80% native
Typical Spacing between Pioneer Species	Varies, 1.5m to 3m	4m	3m (750mm for group of 7 shrubs)	4m	3.35m
Longest Distance between Pioneer Species	4m	6.87m	5.2m	6.87m	4.74m
Sheltered Sides for each Climax Species	2 sides	1 side	2 sides	1 side	1 side
Pros	Good shelter	Compliant with specification	Good shelter; Compliant with specification	Compliant with specification	Moderately good shelter; compliant with PS
Cons	Non-compliant with specification; overlapping canopy of pioneer species	Relatively poor shelter; overlapping canopy of pioneer species		Relatively poor shelter	

5.3.6 From the study at the Trial Nursery, it is noted that shrubs can also function as pioneer or nurse species, given the right choice of shrub species and sufficient time for establishment. Possible benefits of using shrubs as pioneer plants include:

- Shrubs can be packed together and form colonies. The example, in Appendix C illustrates a 750mm spacing for shrubs. Given that there can be more than one plant per group of shrubs, the success of each group is not restricted by the survival of every individual plant as in the case of pioneer tree seedlings. As plants tend to cluster and share beneficial soil microbes within colonies, there is a good chance for each shrub colony to develop into a sheltering plant for the climax species;
- Shrubs are relatively easier to maintain and more practically thinned out when necessary;
- Shrubs tend to be smaller than climax tree species eventually. It is unlikely for them to dominate the habitat in the long-term and will allow the climax tree species to grow and take on the dominant role.

5.3.7 Proposed Matrix Variation A is recommended as the planting matrix for future phases of planting, as it provides good shelter for each climax seedlings on 2 sides and good shelter generally. While

Variation A include a group of seven nos. of native shrubs as pioneer. Otherwise, it is recommended to use Proposed Matrix Variation C, as it also provides moderately good shelter due to its relatively compact pattern.

5.3.8 The above discussions about possible amendments to planting matrix layout and exotic/native percentage mix are based on the assumption that the climax tree seedlings are planted three years after the initial planting of pioneer seedlings. The estimated crown spreads (assuming they are more or less equal to height in early stage) of the pioneer tree/shrub seedlings after three years have been extrapolated from data collected. The estimated crown spreads of the pioneer trees and shrubs are therefore 2.25m and 1m respectively (see Figure 5.2 and Figure 5.3):

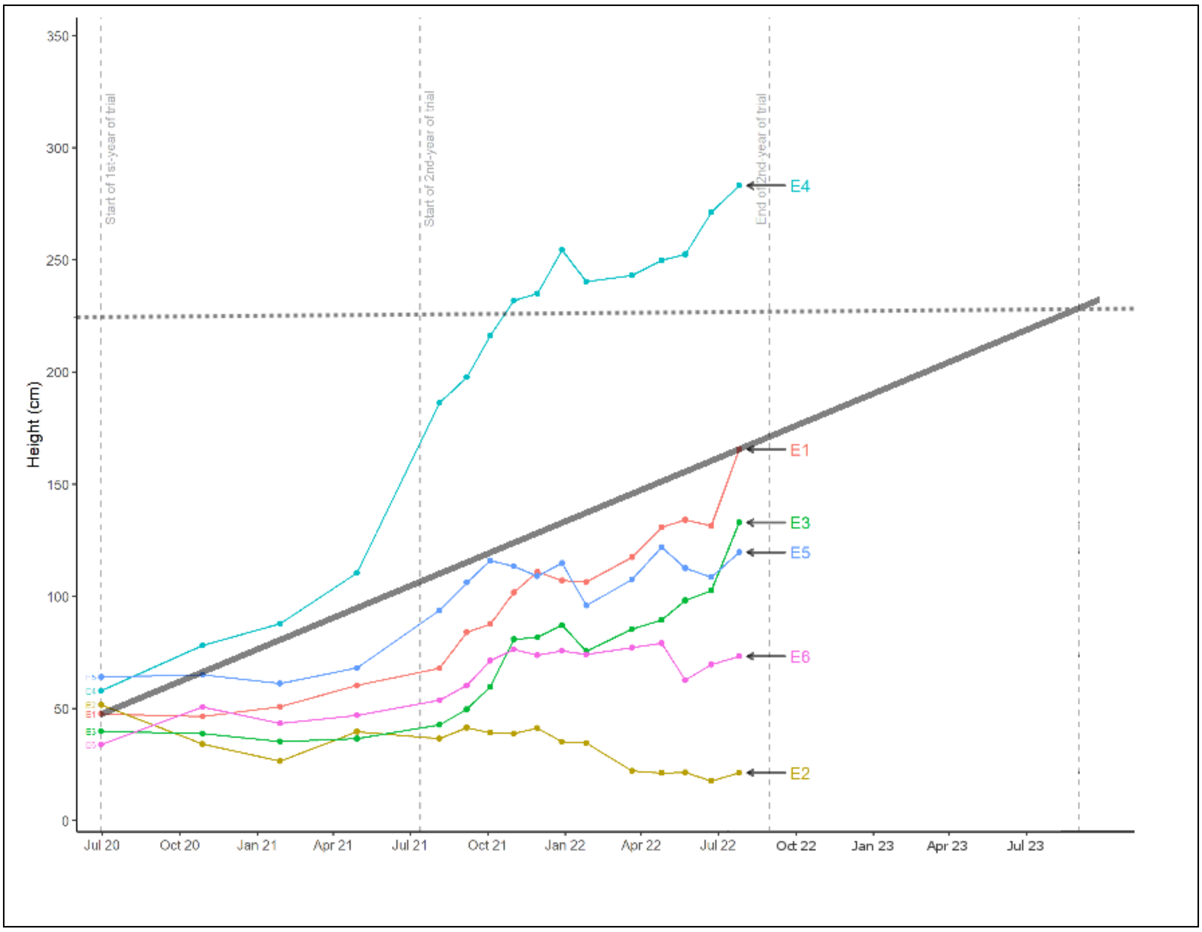

Figure 5.2: Estimated Crown Spread of Pioneer Tree Seedlings Extrapolated from the Trend of Average Height of Individual Exotic Tree Species

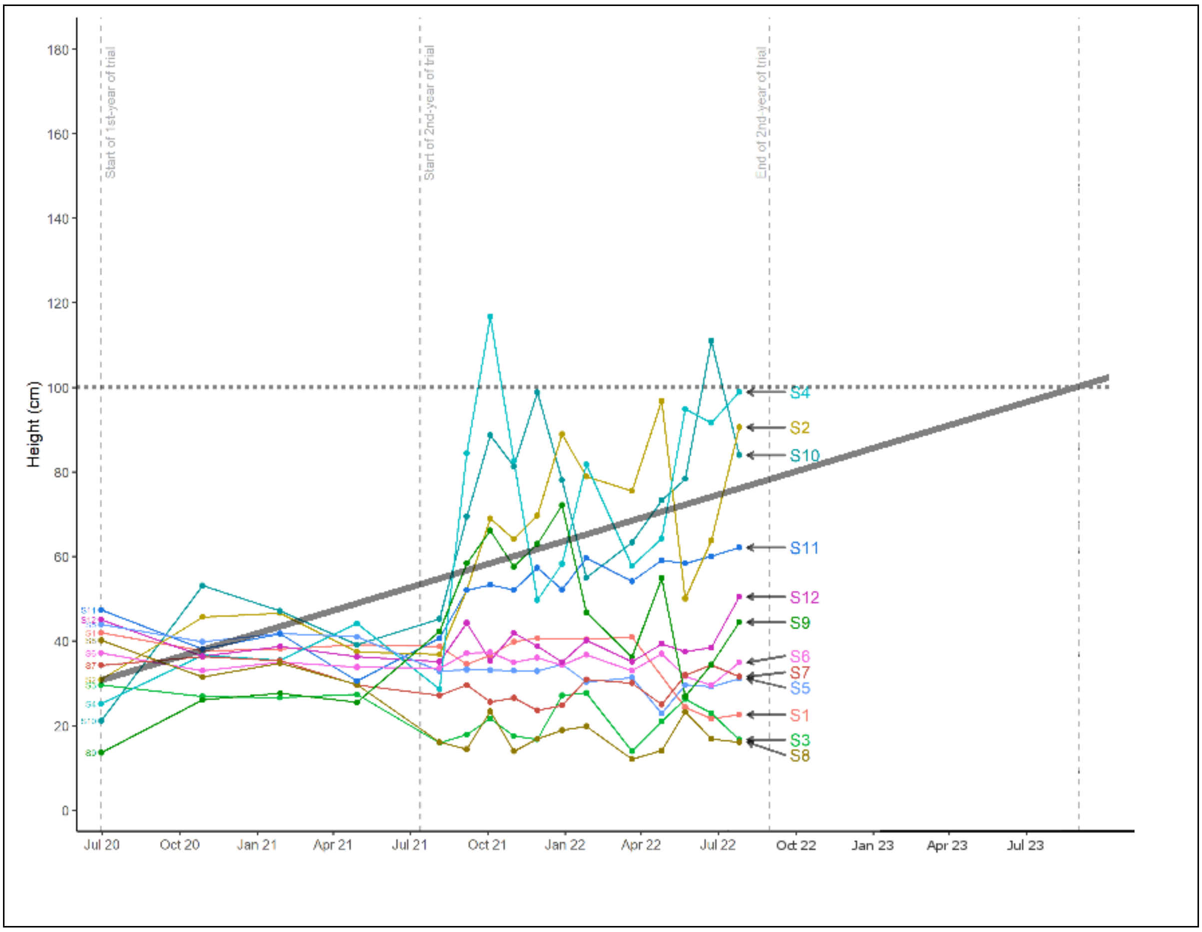

Figure 5.3: Estimated Crown Spread of Pioneer Shrub Seedlings Extrapolated from the Trend of Average Height of Individual Shrub Species

5.4 CONCLUSION

5.4.1 As can be seen from the preceding sections of this Report, the SENTX Trial Nursery has proven to be a fruitful source of data and insight into the performance and establishment of landscape restoration planting at the SENT landfill.

5.4.2 It is submitted that there are useful lessons, outlined in this section above, that can be learned and applied in future phases of landscape restoration and planting which have the potential to materially benefit the end-result of the landscape restoration itself. It is therefore suggested that that these recommendations be given serious consideration.

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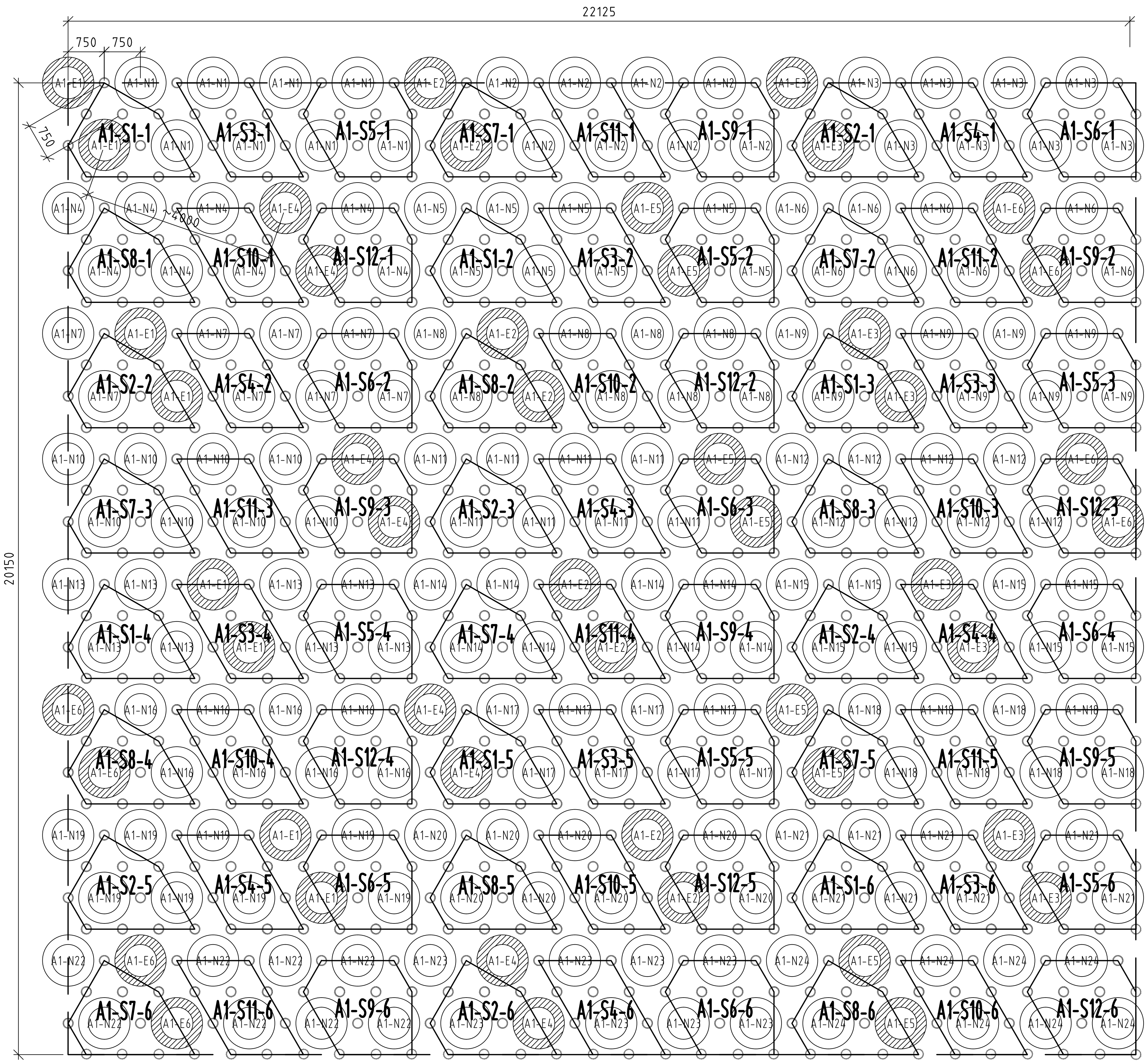
Appendix A

Updated Drawings for SENTX Trial Planting

- Drawing No. GVL16-TN_A1
- Drawing No. GVL16-TN_A2
- Drawing No. GVL16-TN_B1
- Drawing No. GVL16-TN_B2
- Drawing No. GVL16-TN-04
- Drawing No. GVL16-TN-05



NOTES:

EACH SUB-AREA CONSISTS OF 720 NO. OF SHRUBS. THE SHRUBS ARE ARRANGED RANDOMLY IN 6 GROUPS OF 10 PER SPECIES.

SHRUB CODING (E.G. A1-S1-1) INDICATES #1 BLOCK OF SHRUB SPECIES S1 IN SUB-AREA A1. THE SPECIES CODES ARE SHOWN ON DWG. GVL16-TN05.

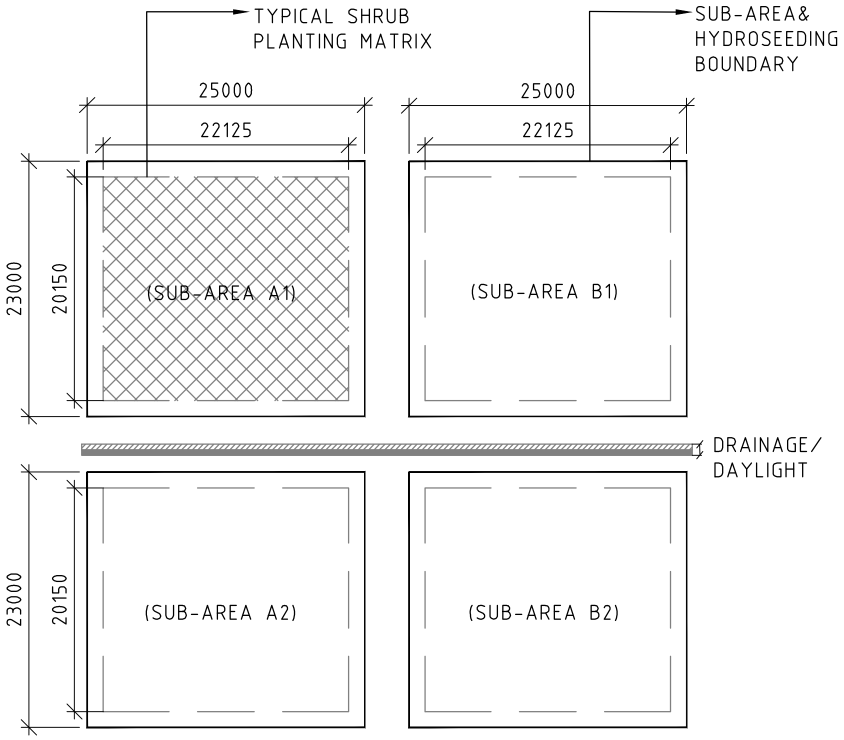
EXTENT OF SHRUB PLANTING

LOCATION SET OUT FOR EXOTIC NURSE SEEDLING TREE

LOCATION SET OUT FOR NATIVE SEEDLING TREE

SHRUB TO BE PLANTED (IN GROUPS OF 10 PER SPECIES)

A1-S1-1 CODE OF SHRUB (SEE DWG. GVL16-TN-05)



A KEYPLAN
SCALE N.T.S.

Amendment No.	Date	Description	Drawn by	Checked by	Approved by
B	AUG 2021	GENERAL REVISION	BW	KP	DM
A	OCT 2020	GENERAL REVISION	TW	KP	DM

Job Title
Contract No.EP/SP/10/91
SOUTH-EAST NEW TERRITORIES LANDFILL EXTENSION

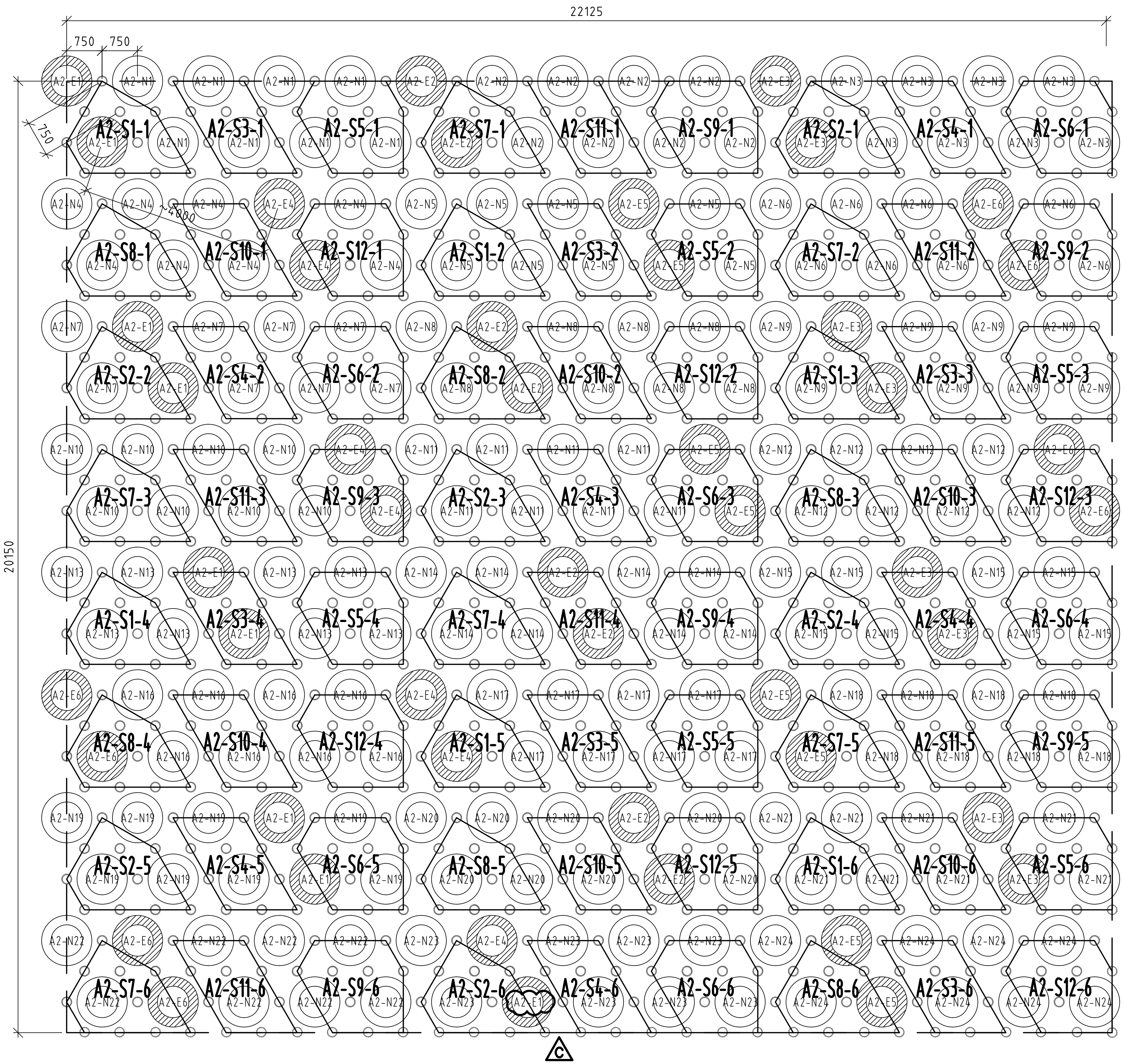
Drawing No.
GVL16-TN-A1

Drawing Title
TYPICAL SHRUB PLANTING MATRIX

Scale
N.T.S.

Drawn by	TW	Checked by	KP	Approved by	DM	Date	JUN 2020	Job. No.	GVL16

雅邦 Urbis Limited
Planning, Urban Design, Landscape, Golf & Environmental Consultants
Urbis Limited, 11/F Siu On Centre, 188 Lockhart Road, Wan Chai, Hong Kong. Tel : 2802 3333 Fax : 2802 8662



NOTES:

EACH SUB-AREA CONSISTS OF 720 NO. OF SHRUBS. THE SHRUBS ARE ARRANGED RANDOMLY IN 6 GROUPS OF 10 PER SPECIES.

SHRUB CODING (E.G. A2-S1-1) INDICATES #1 BLOCK OF SHRUB SPECIES S1 IN SUB-AREA A2. THE SPECIES CODES ARE SHOWN ON DWG. GVL16-TN05.

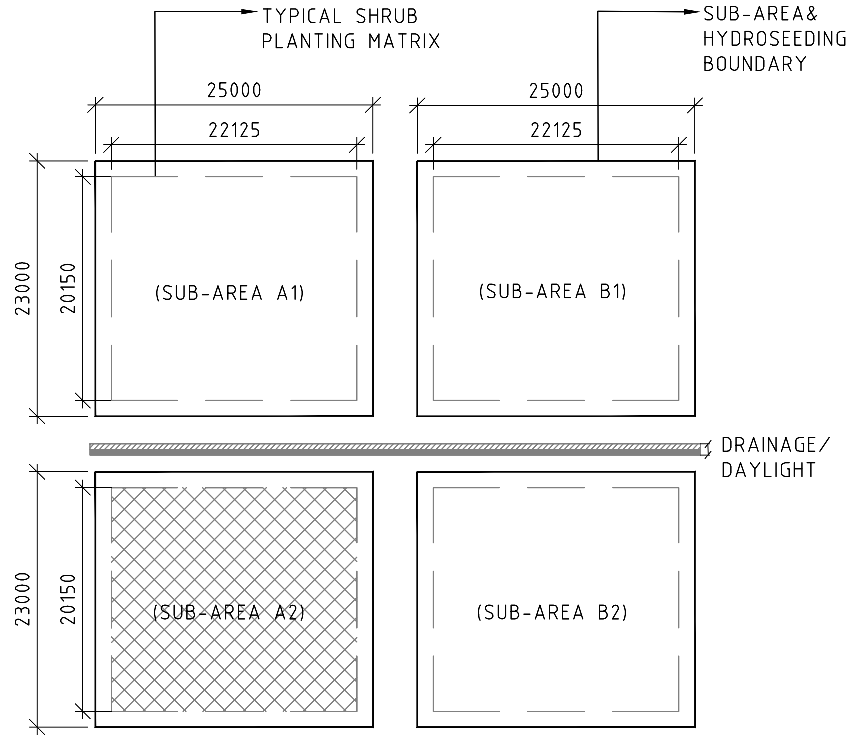
EXTENT OF SHRUB PLANTING

LOCATION SET OUT FOR EXOTIC NURSE SEEDLING TREE

LOCATION SET OUT FOR NATIVE SEEDLING TREE

SHRUB TO BE PLANTED (IN GROUPS OF 10 PER SPECIES)

A2-S1-1 — CODE OF SHRUB (SEE DWG. GVL16-TN-05)



A KEYPLAN
SCALE N.T.S.

Amendment No.	Date	Description	Drawn by	Checked by	Approved by
C	AUG 2022	GENERAL REVISION	WW	KP	DM
B	AUG 2021	GENERAL REVISION	BW	KP	DM
A	OCT 2020	GENERAL REVISION	TW	KP	DM

Job Title
Contract No.EP/SP/10/91
SOUTH-EAST NEW TERRITORIES LANDFILL EXTENSION

Drawing No. GVL16-TN-A2

Drawing Title
TYPICAL SHRUB PLANTING MATRIX

Scale N.T.S.

Drawn by	Checked by	Approved by	Date	Job. No.
TW	KP	DM	JUN 2020	GVL16

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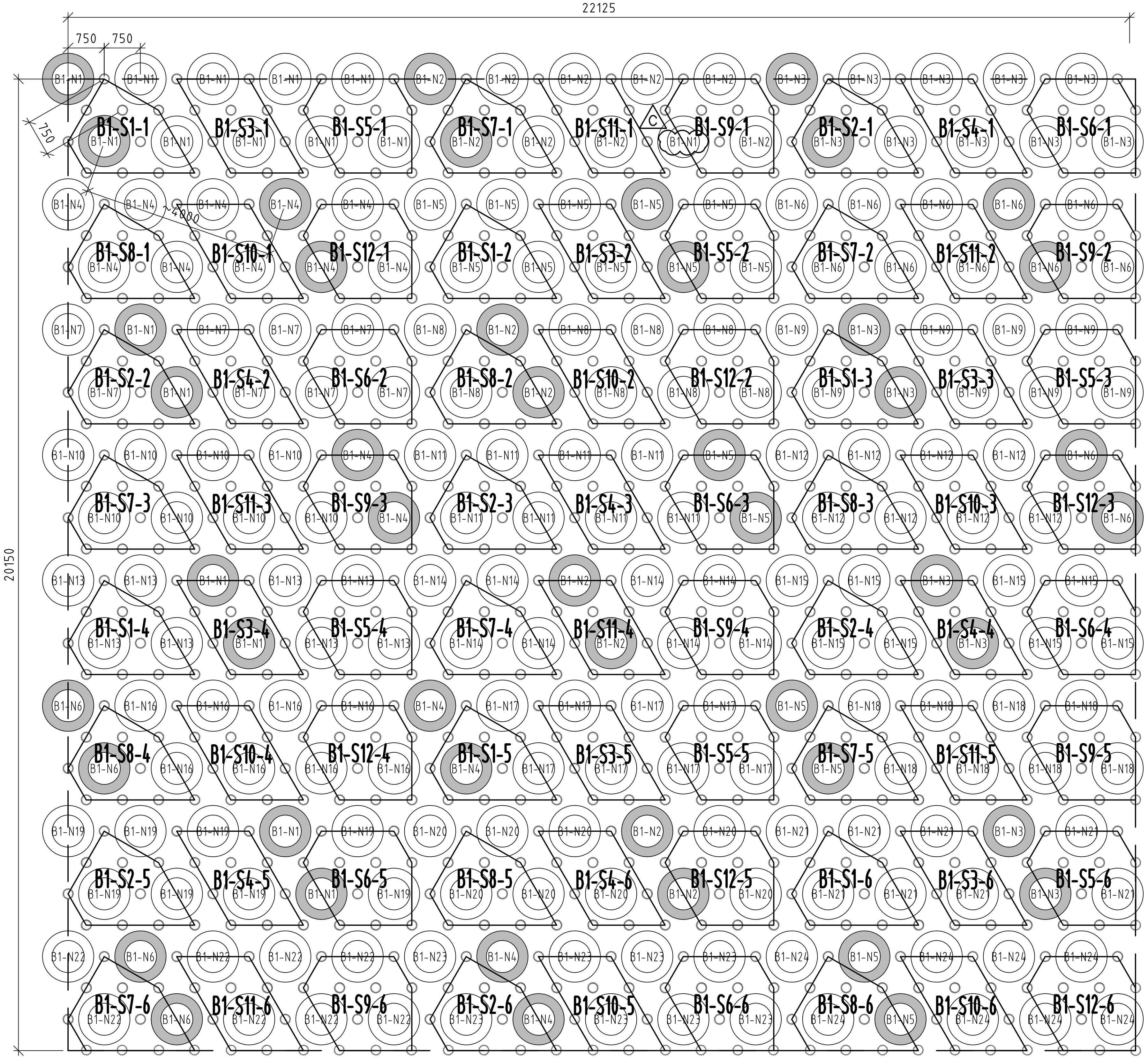
Urbis Limited, 11/F Siu On Centre, 188 Lockhart Road, Wan Chai, Hong Kong. Tel : 2802 3333 Fax : 2802 8662



NOTES:

EACH SUB-AREA CONSISTS OF 720 NO. OF SHRUBS. THE SHRUBS ARE ARRANGED RANDOMLY IN 6 GROUPS OF 10 PER SPECIES.

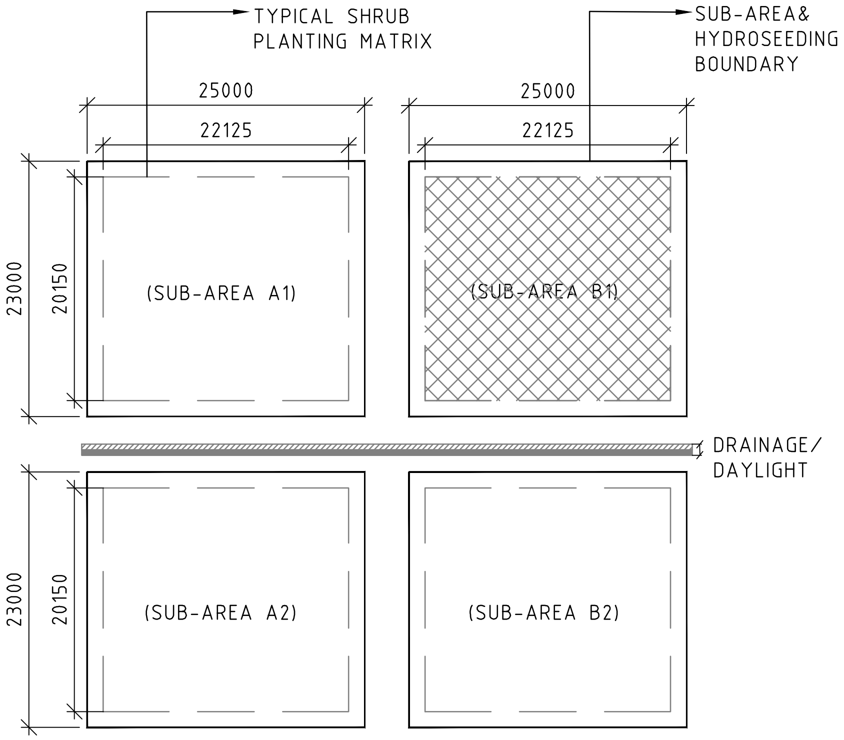
SHRUB CODING (E.G. B1-S1-1) INDICATES #1 BLOCK OF SHRUB SPECIES S1 IN SUB-AREA B1. THE SPECIES CODES ARE SHOWN ON DWG. GVL16-TN05.

EXTENT OF SHRUB PLANTING

LOCATION SET OUT FOR NATIVE SEEDLING TREE

SHRUB TO BE PLANTED (IN GROUPS OF 10 PER SPECIES)

B1-S1-1 CODE OF SHRUB (SEE DWG. GVL16-TN-05)



A KEYPLAN
SCALE N.T.S.

Amendment No.	Date	Description	Drawn by	Checked by	Approved by
C	AUG 2022	GENERAL REVISION	BW	KP	DM
B	AUG 2021	GENERAL REVISION	BW	KP	DM
A	OCT 2020	GENERAL REVISION	TW	KP	DM

Job Title
Contract No.EP/SP/10/91
SOUTH-EAST NEW TERRITORIES LANDFILL EXTENSION

Drawing No.
GVL16-TN-B1

Drawing Title
TYPICAL SHRUB PLANTING MATRIX

Scale
N.T.S.

Drawn by	TW	Checked by	KP	Approved by	DM	Date	JUN 2020	Job. No.	GVL16

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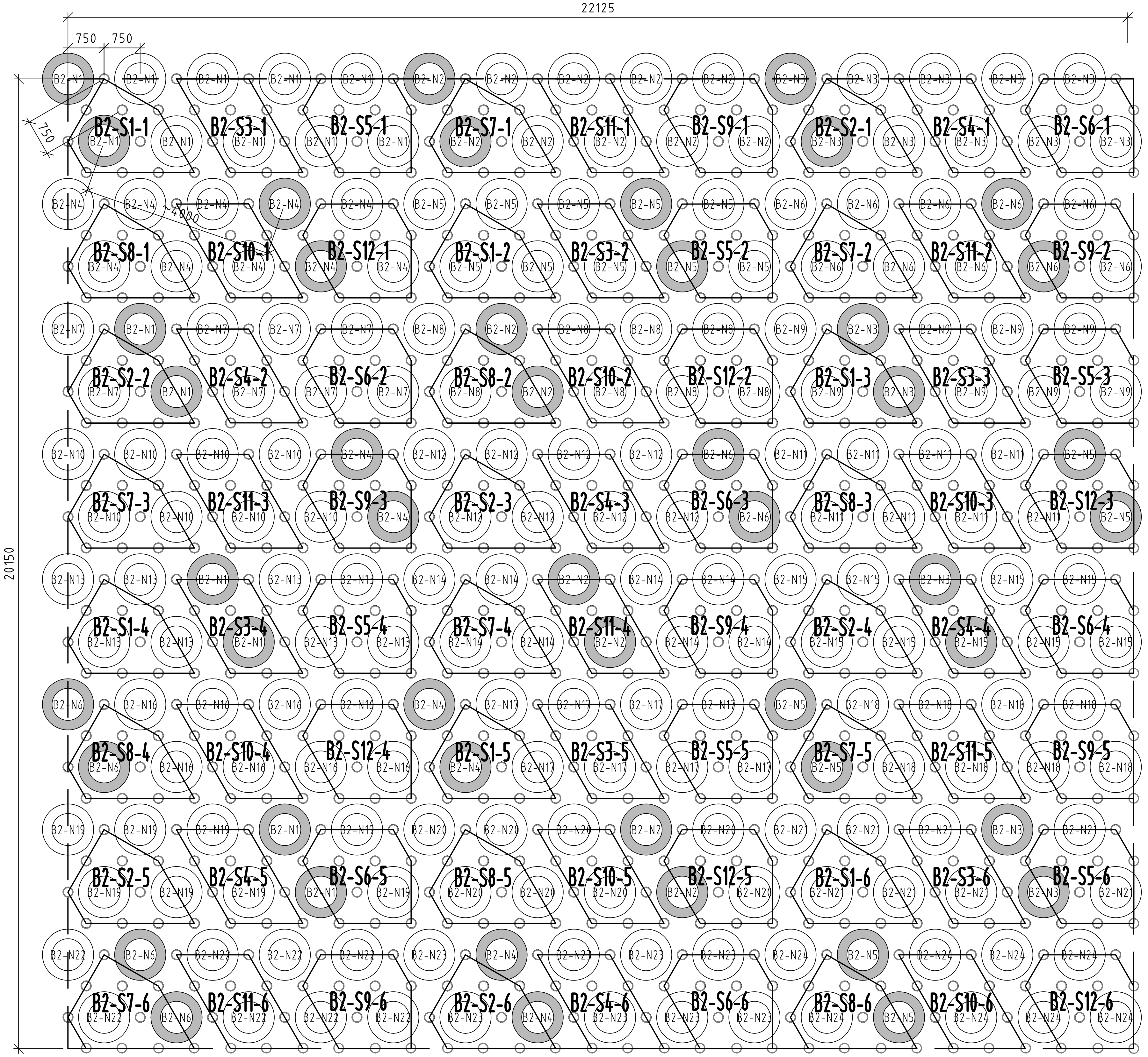


NOTES:

EACH SUB-AREA CONSISTS OF 720 NO. OF SHRUBS. THE SHRUBS ARE ARRANGED RANDOMLY IN 6 GROUPS OF 10 PER SPECIES.

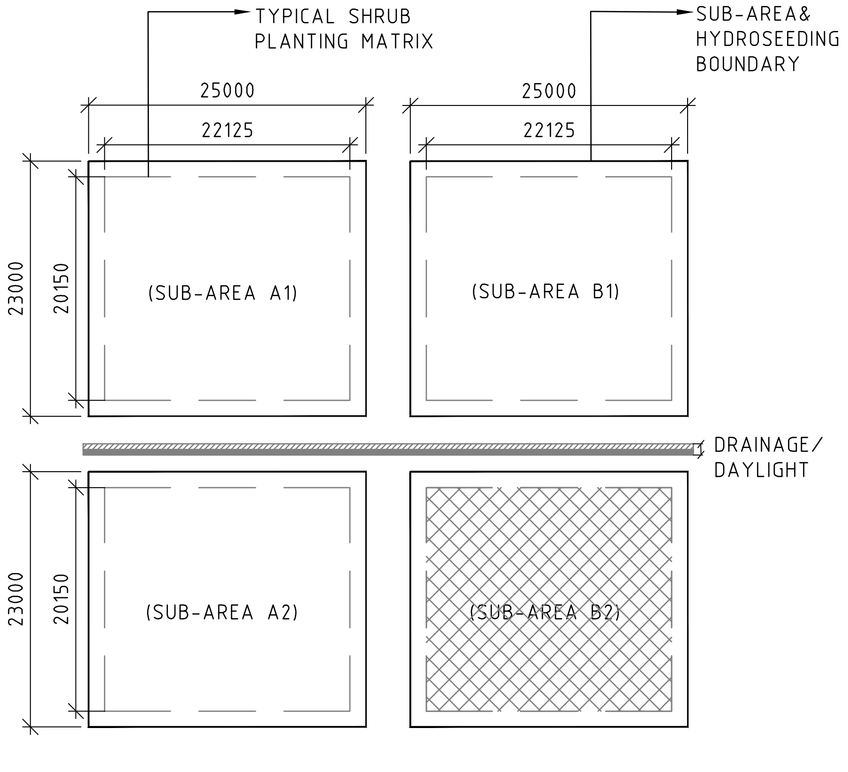
SHRUB CODING (E.G. B2-S1-1) INDICATES #1 BLOCK OF SHRUB SPECIES S1 IN SUB-AREA B2. THE SPECIES CODES ARE SHOWN ON DWG. GVL16-TN05.

EXTENT OF SHRUB PLANTING

LOCATION SET OUT FOR NATIVE SEEDLING TREE

SHRUB TO BE PLANTED (IN GROUPS OF 10 PER SPECIES)

B2-S1-1 — CODE OF SHRUB (SEE DWG. GVL16-TN-05)



A KEYPLAN
SCALE N.T.S.

Amendment No.	Date	Description	Drawn by	Checked by	Approved by
B	AUG 2021	GENERAL REVISION	BW	KP	DM
A	OCT 2020	GENERAL REVISION	TW	KP	DM

Job Title
Contract No.EP/SP/10/91
SOUTH-EAST NEW TERRITORIES LANDFILL EXTENSION

Drawing Title
TYPICAL SHRUB PLANTING MATRIX

Drawing No. GVL16-TN-B2

Scale N.T.S.

Drawn by	Checked by	Approved by	Date	Job. No.
TW	KP	DM	JUN 2020	GVL16

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EXOTIC TREES (TO BE PLANTED IN YEAR 1)

CODE	SCIENTIFIC NAME	CHINESE NAME	ORIGIN	SPECIFIED SIZE	SPACING (MM)	QUANTITY IN AREA		TOTAL
						A	B	
E1	Acacia confusa	台灣相思	Exotic	SEEDLING TREE	1500	17 △10	0	17 △10
E2	Cassia nodosa	節果決明	Exotic	SEEDLING TREE	1500	16	0	16
E3	Dalbergia odorifera	降香黃壇	Exotic	SEEDLING TREE	1500	16	0	16
E4	Acacia auriculiformis	耳果相思	Exotic	SEEDLING TREE	1500	15 △10	0	15 △10
E5	Melia azedarach	苦楝	Exotic	SEEDLING TREE	1500	16	0	16
E6	Senna siamea	鐵刀木	Exotic	SEEDLING TREE	1500	16	0	16
					TOTAL EXOTICS (E):	96	0	96

NOTES:

1. SEEDLING TREES COMPLY WITH SPECIFICATION CLAUSE 3.11S.
2. FOR AREAS A1 & A2, ALL EXOTIC TREES ARE TO BE PLANTED DURING PLANTING SEASON OF YEAR 1 IN ACCORDANCE WITH THE SCHEMATIC PLANTING MATRIX AS SHOWN ON DWG. GVL16-TN06. THE POSITIONS OF NATIVE TREES TO BE PLANTED IN YEAR 2 ARE ALSO TO BE SET OUT DURING PLANTING SEASON OF YEAR 1 TO FACILITATE SHRUB PLANTING AND FUTURE NATIVE TREE PLANTING.
3. FOR AREAS A1 & A2, ALL NATIVE TREES ARE TO BE PLANTED DURING PLANTING SEASON OF YEAR 2 IN ACCORDANCE WITH THE SCHEMATIC PLANTING MATRIX AS SHOWN ON DWG. GVL16-TN06. DAMAGES TO THE ALREADY PLANTED TREES AND SHRUBS ARE TO BE AVOIDED AS FAR AS POSSIBLE.
4. FOR AREAS B1 & B2, ALL EXOTIC TREE SPECIES (E1-E6) ARE REPLACED BY NATIVE TREE SPECIES (N1-N6).
5. FOR AREAS B1 & B2, ALL NATIVE TREES ARE TO BE PLANTED DURING PLANTING SEASON OF YEAR 2 IN ACCORDANCE WITH THE SCHEMATIC PLANTING MATRIX AS SHOWN ON DWG. GVL16-TN06.

NATIVE TREES (TO BE PLANTED IN YEAR 2)

CODE	SCIENTIFIC NAME	CHINESE NAME	ORIGIN	SPECIFIED SIZE	SPACING (MM)	QUANTITY IN AREA		TOTAL
						A	B	
N1	Bridelia tomentosa	土蜜樹	Native	SEEDLING TREE	1500	16	33	49
N2	Celtis sinensis	朴樹	Native	SEEDLING TREE	1500	16	31	47
N3	Cinnamomum camphora	樟	Native	SEEDLING TREE	1500	16	31	47
N4	Aquilaria sinensis	土沉香	Native	SEEDLING TREE	1500	16	32	48
N5	Ficus microcarpa	細葉榕	Native	SEEDLING TREE	1500	16	32	48
N6	Hibiscus tiliaceus	黃槿	Native	SEEDLING TREE	1500	16	32	48
N7	Ilex rotunda var. microcarpa	小果鐵冬青	Native	SEEDLING TREE	1500	16	16	32
N8	Liquidambar formosana	楓香	Native	SEEDLING TREE	1500	16	16	32
N9	Litsea glutinosa	潺槁樹	Native	SEEDLING TREE	1500	16	16	32
N10	Machilus chekiangensis	浙江潤楠	Native	SEEDLING TREE	1500	16	16	32
N11	Macaranga tanarius	血桐	Native	SEEDLING TREE	1500	16	16	32
N12	Myrica rubra	楊梅	Native	SEEDLING TREE	1500	16	16	32
N13	Rhodoleia championi	紅苞木	Native	SEEDLING TREE	1500	16	16	32
N14	Polyspora axillaris	大頭茶	Native	SEEDLING TREE	1500	16	16	32
N15	Pongamia pinnata	水黃皮	Native	SEEDLING TREE	1500	16	17	33
N16	Cinnamomum burmannii	陰香	Native	SEEDLING TREE	1500	16	16	32
N17	Reevesia thyrsoidea	梭羅樹	Native	SEEDLING TREE	1500	16	16	32
N18	Cinnamomum burmannii	野漆樹	Native	SEEDLING TREE	1500	16	16	32
N19	Sapium discolor	山烏臼	Native	SEEDLING TREE	1500	16	16	32
N20	Sapium sebiferum	烏臼	Native	SEEDLING TREE	1500	16	16	32
N21	Camellia crapnelliana	紅皮糙果茶	Native	SEEDLING TREE	1500	16	16	32
N22	Sterculia lanceolata	假蘋婆	Native	SEEDLING TREE	1500	16	16	32
N23	Syzygium hancei	韓氏蒲桃	Native	SEEDLING TREE	1500	16	16	32
N24	Viburnum odoratissimum	珊瑚樹	Native	SEEDLING TREE	1500	16	16	32
					TOTAL NATIVES (N):	384	480	864
					TOTAL (E)+(N):	480	480	960

Amendment No.	Date	Description	Drawn by	Checked by	Approved by
10	AUG 2022	GENERAL REVISION	WW	KP	DM
9	AUG 2022	GENERAL REVISION	BW	KP	DM
8	AUG 2021	GENERAL REVISION	BW	KP	DM
7	APR 2021	GENERAL REVISION	BW	KP	DM
6	APR 2021	GENERAL REVISION	BW	KP	DM
5	JUN 2020	GENERAL REVISION	TW	KP	DM

Job Title
Contract No. EP/SP/10/91
SOUTH-EAST NEW TERRITORIES LANDFILL EXTENSION

Drawing No. GVL16-TN-04

Drawing Title
PLANTING SCHEDULE (SHEET 1)

Scale N.T.S.

Drawn by TW | **Checked by** BL | **Approved by** - | **Date** JUL 2018 | **Job. No.** GVL16

雅邦 Urbis Limited
Planning, Urban Design, Landscape, Golf & Environmental Consultants
Urbis Limited, 11/F Siu On Centre, 188 Lockhart Road, Wan Chai, Hong Kong. Tel : 2802 3333 Fax : 2802 8662

SHRUBS (TO BE PLANTED IN YEAR 1)

CODE	SCIENTIFIC NAME	CHINESE NAME	ORIGIN	SPECIFIED SIZE	SPACING (MM)	QUANITITY IN AREA		TOTAL
						A	B	
S1	Buxus sinica	黃楊	Native	SMALL SHRUB	750	120	120	240
S2	Calliandra haematocephala	紅絨球	Exotic	SMALL SHRUB	750	120	120	240
S3	Hamelia patens	希美利	Exotic	SMALL SHRUB	750	120	120	240
S4	Ipomoea pes-caprae	海灘牽牛	Native	SMALL SHRUB	750	120	120	240
S5	Rhododendron simsii	紅杜鵑	Native	SMALL SHRUB	750	120	120	240
S6	Pittosporum tobira	海桐	Exotic	SMALL SHRUB	750	120	120	240
S7	Rhaphiolepis indica	石斑木	Native	SMALL SHRUB	750	120	120	240
S8	Rhodomyrtus tomentosa	桃金娘	Native	SMALL SHRUB	750	120	120	240
S9 B	Verbena rigida	顯脈馬鞭草	Exotic	SMALL SHRUB	750	120	120	240
S10	Lespedeza formosa	美麗胡枝子	Native	SMALL SHRUB	750	120	120	240
S11	Vitex negundo	黃荊	Native	SMALL SHRUB	750	120	120	240
S12	Vitex rotundifolia	單葉蔓荊	Native	SMALL SHRUB	750	120	120	240
					TOTAL:	1440	1440	2880

HYDROSEEDING SEED MIX FOR AREAS A & B

SCIENTIFIC NAME	CHINESE NAME	ORIGIN	GRAM / SQM
CYNODON DACTYLON	狗牙根	Native	15
PASPALUM NOTATUM	百喜草	Exotic	10
EREMOCHLOA OPHIUROIDES	假儉草	Native	5
LOLIUM PERENNE*	黑麥草*	Exotic	5*

*BETWEEN SEPTEMBER AND MARCH INCLUSIVE, ADD LOLIUM PERENNE SEEDS AT A RATE OF 5 GRAM / SQ.M TO ALL SEED MIXES.

NOTES:

1. SMALL SHRUBS COMPLY WITH SPECIFICATION CLAUSE 3.17S.
2. GRASS SEEDS COMPLY WITH GS CLAUSE 3.26 (1) AND (2).
3. DURING PLANTING SEASON OF YEAR 1, ALL SHRUBS ARE TO BE PLANTED IN ACCORDANCE WITH THE SCHEMATIC PLANTING MATRIX AS SHOWN ON DWG. GVL16-TN07.

Amendment No.	Date	Description	Drawn by	Checked by	Approved by
B	AUG 2021	GENERAL REVISION	BW	KP	DM
A	MAR 2020	GENERAL REVISION	TW	KP	DM

Job Title
Contract No. EP/SP/10/91
SOUTH-EAST NEW TERRITORIES LANDFILL EXTENSION

Drawing No. GVL16-TN-05

Drawing Title
PLANTING SCHEDULE (SHEET 2)

Scale N.T.S.

Drawn by TW | Checked by BL | Approved by - | Date JUL 2018 | Job. No. GVL16

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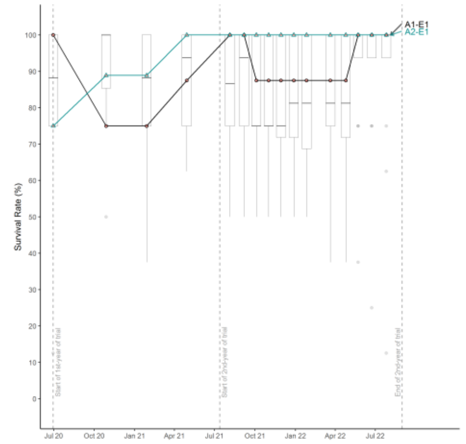
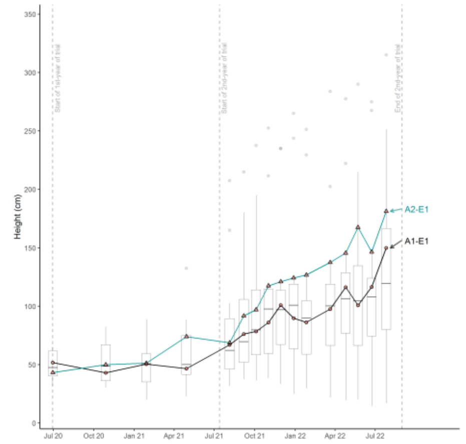
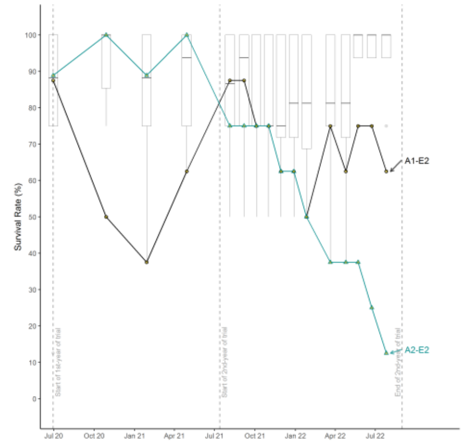
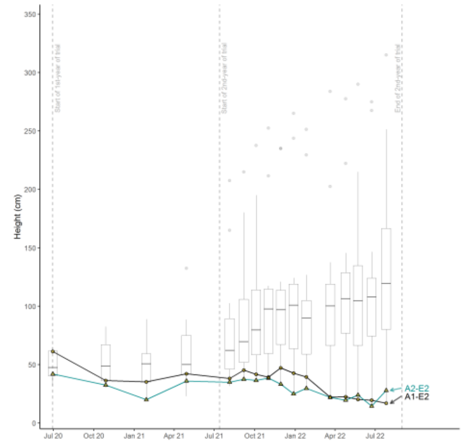
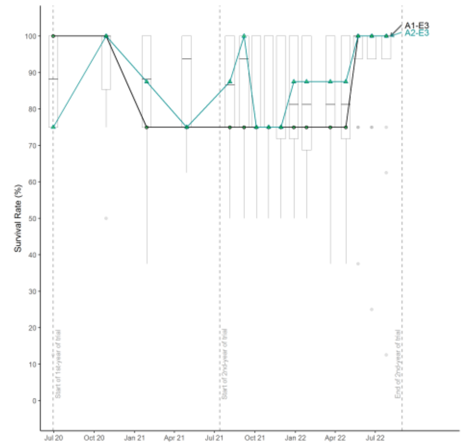
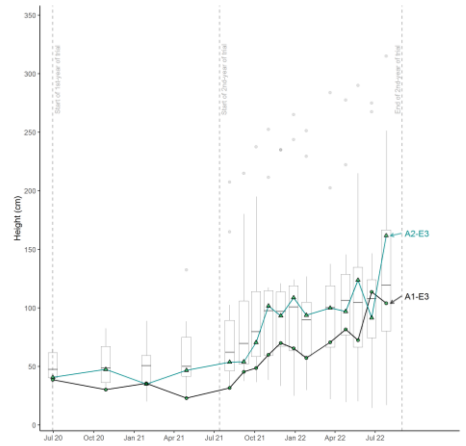
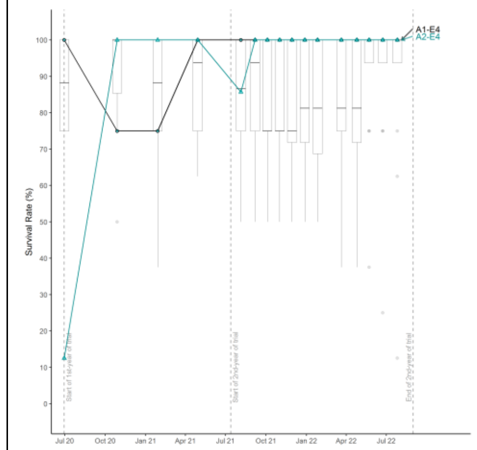
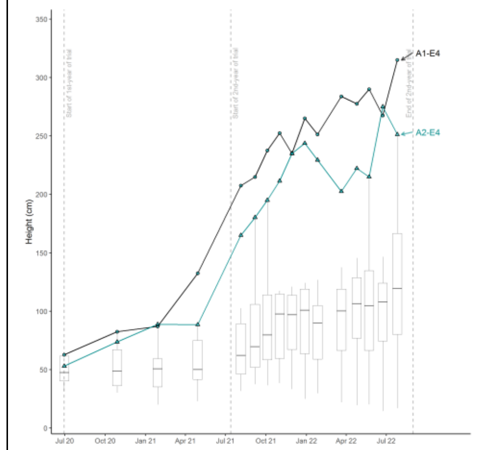
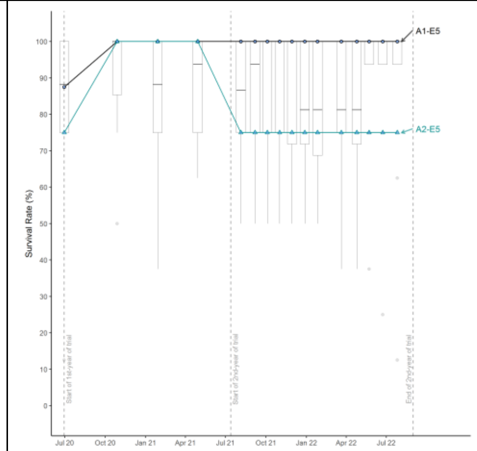
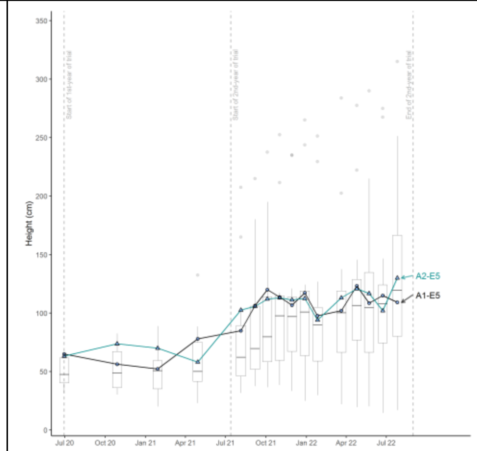
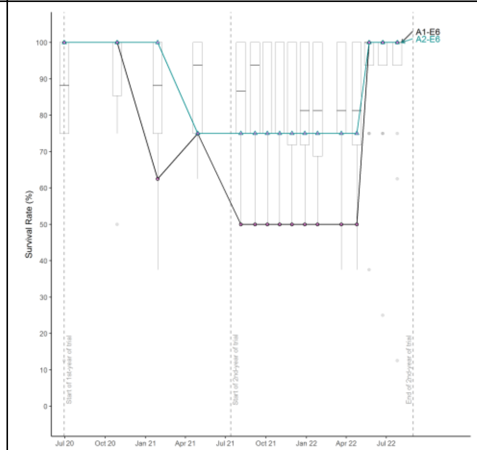
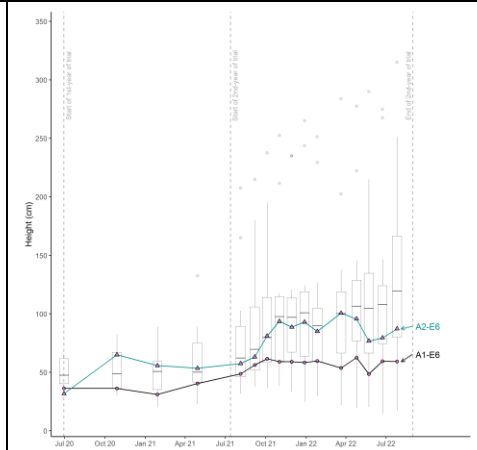
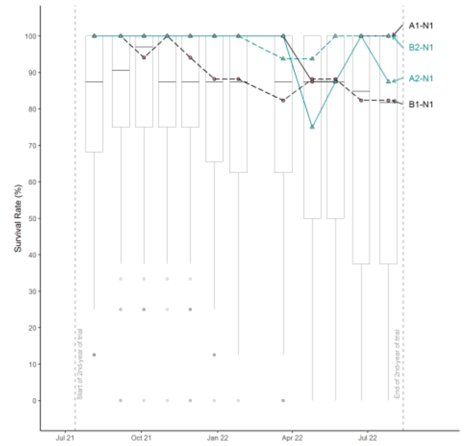
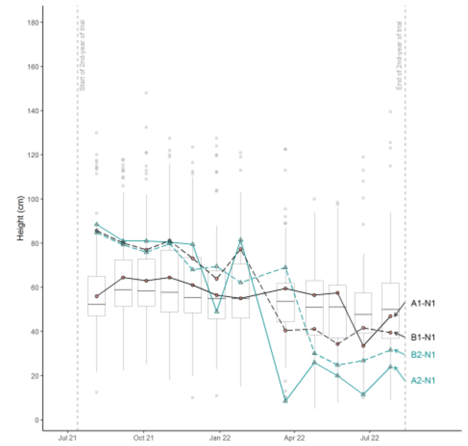
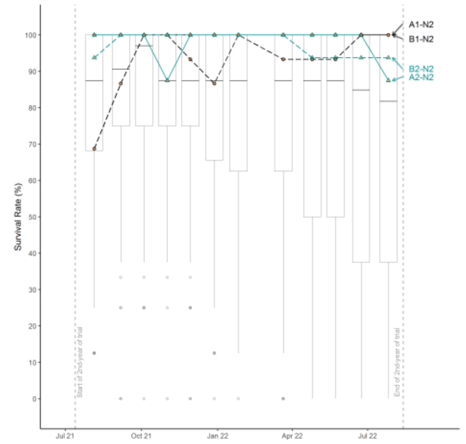
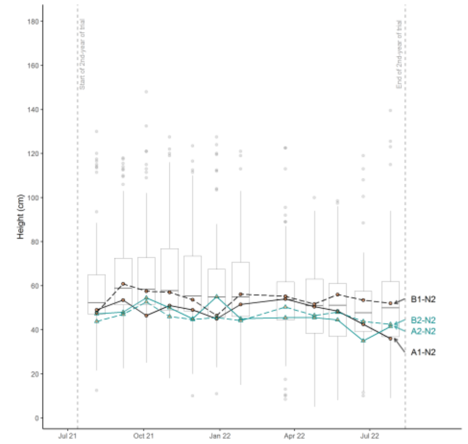
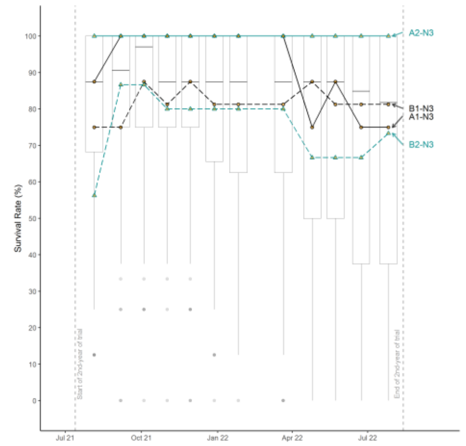
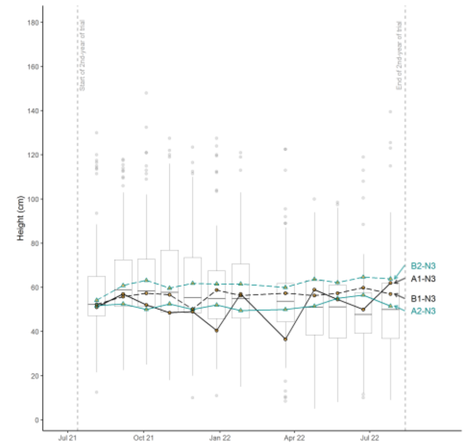
Appendix B

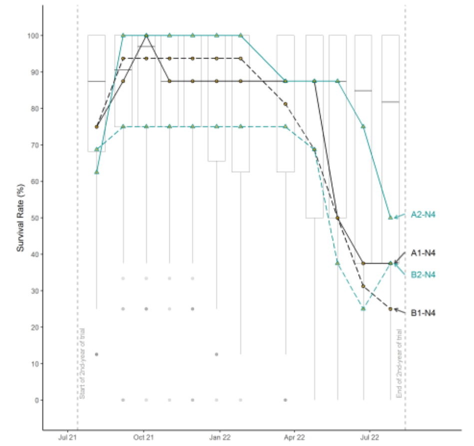
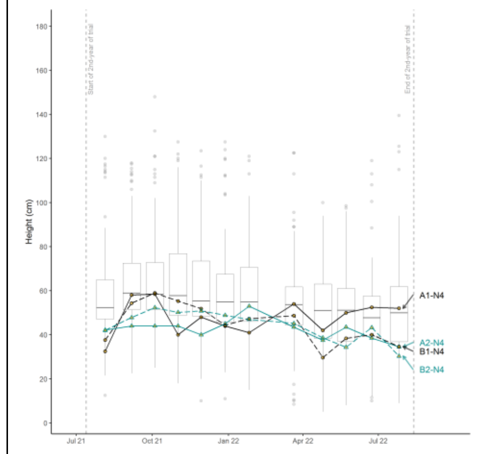
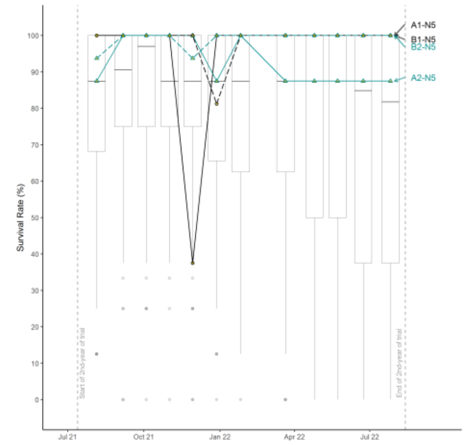
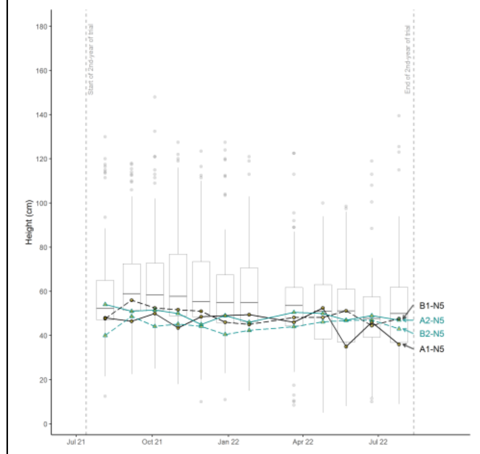
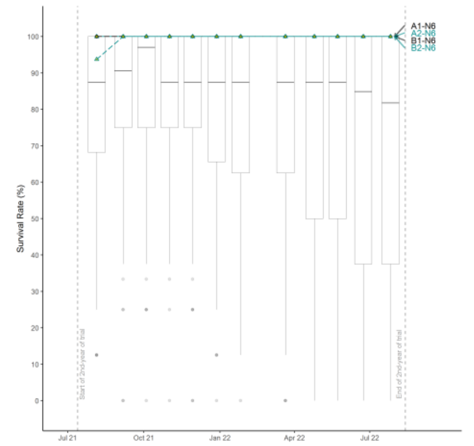
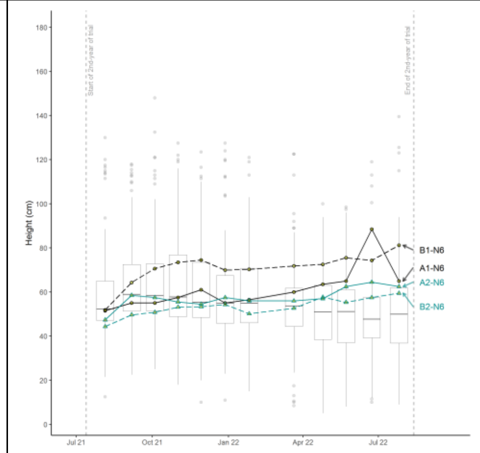
Evaluation of Individual Plant Species in Trial

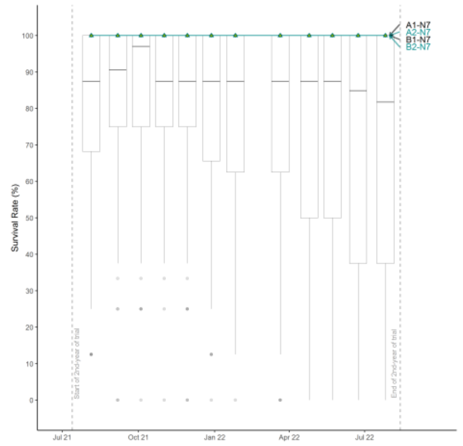
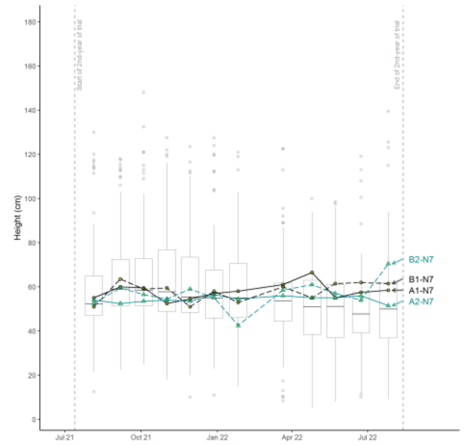
Plant Species Selection and Application

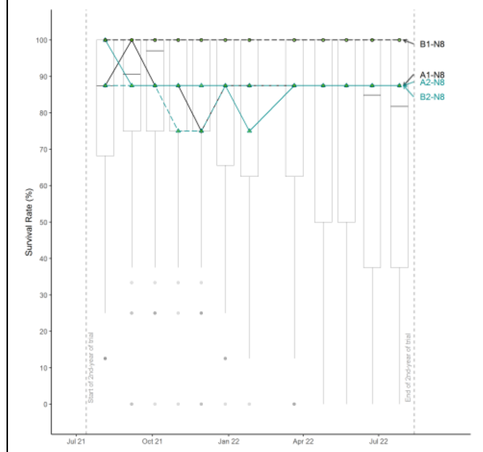
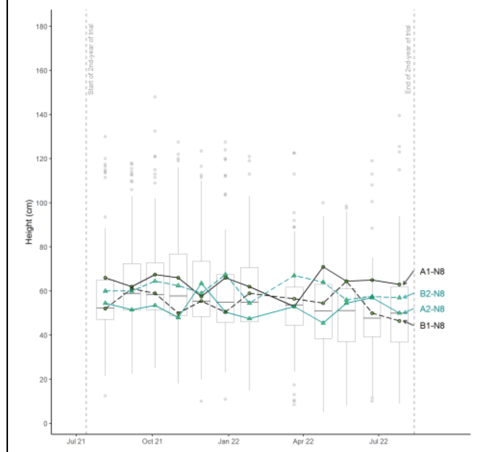
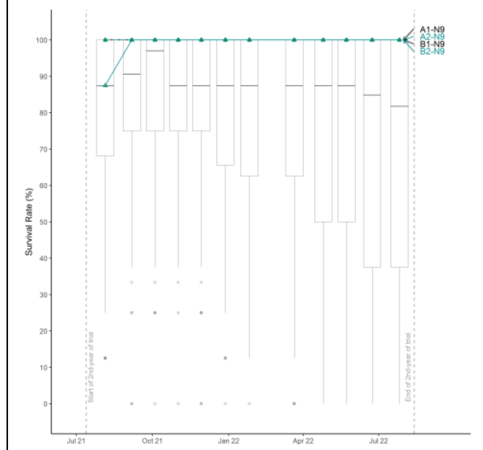
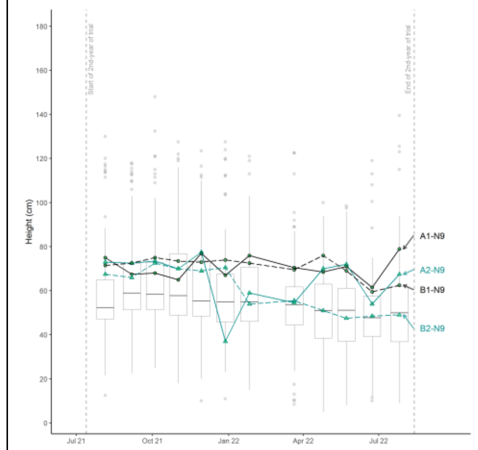
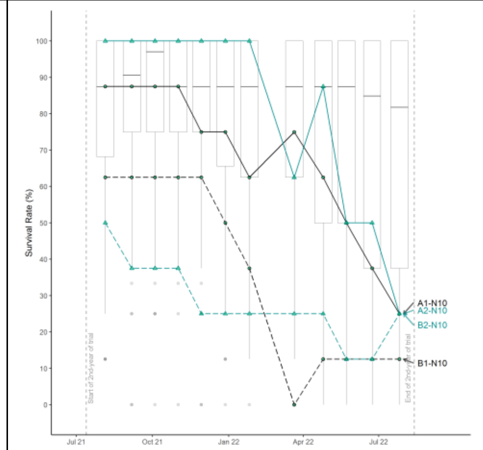
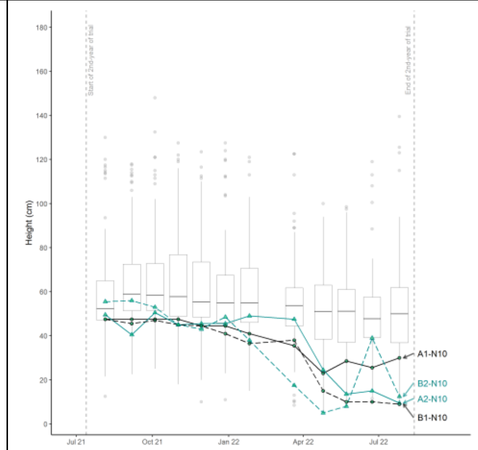
Species Name	Descriptions	Recommended Use	Typical Condition at End of Trial (Jul 22)	Trend of Average Survival Rate	Trend of Average Height
Exotic Trees (Pioneer nurse species)					
(E1) *Acacia confusa*	This species had a fairly high survival rate (approx. 80%) in the first-year of trial, and after replacement at the start of the 2nd year, the survival rate remained near 90%. The health of this species gradually improved from somewhat poor to good in two years, and in the period the average height increased from about 50cm to 150cm.	Evergreen pioneer species. This leguminous species forms symbiotic partnerships with nitrogen-fixing soil microbes. In the long-term the symbiotic partnership potentially supplies nitrogen nutrients in soils that might be utilised by other plant species.			
(E2) *Cassia nodosa*	This species declined from the first winter to the next summer. Despite replacements at the start of the second year, this species went into decline and the final survival rate was around 40%. The health of this species remained poor most of the time. Its average height was in steady decline from about 50cm to 25cm near the end of trial. This species demonstrated deciduous characteristics in winter.	Not recommended. This species was found to be unadaptable to the site conditions.			
(E3) *Dalbergia odorifera*	This species experienced slight decline in the first winter but survival rates still maintained around 80% throughout the trial period. Its health steadily improved from poor in the first winter (Jan 2021), to good at the end of trial in Jul 2022. The average height was stable at around 40cm in the first year, and in the second year rising to about 130cm. This species demonstrated deciduous characteristics in the first winter. The phenomenon was not as apparent in the 2nd winter, however. Flowering and fruiting have been observed.	Deciduous pioneer species. This leguminous species forms symbiotic partnerships with nitrogen-fixing soil microbes. In the long-term the symbiotic partnership potentially supplies nitrogen nutrients in soils that might be utilised by other plant species.			

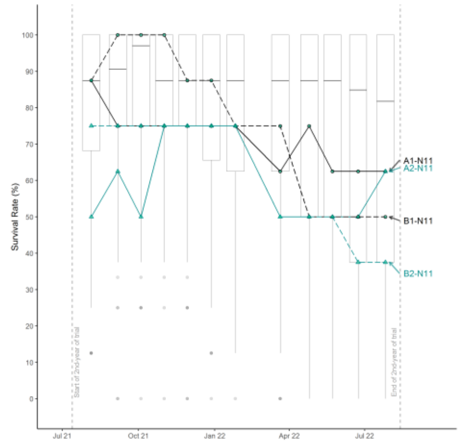
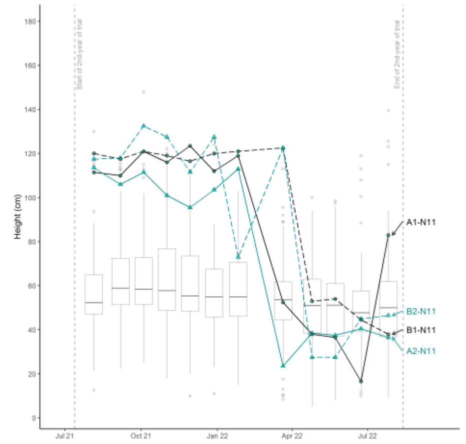
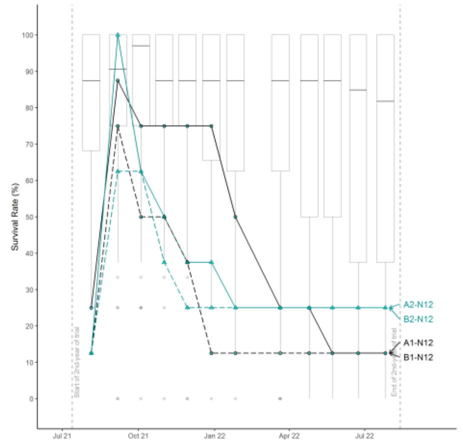
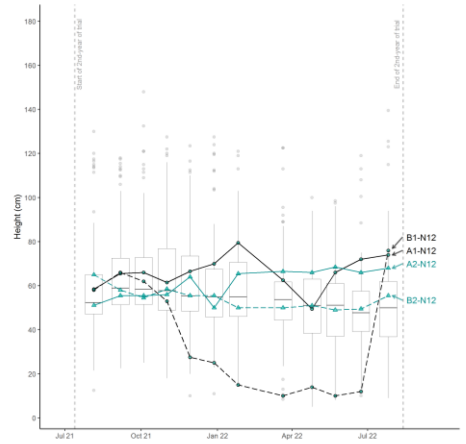
Species Name	**Descriptions**	**Recommended Use**	**Typical Condition at End of Trial (Jul 22)**	**Trend of Average Survival Rate**	**Trend of Average Height**
(E4) *Acacia auriculiformis*	This species had a fairly high survival rate (approx. 80%) in the first-year of the trial, and after replacement at the start of the 2nd year, the survival rate remained near 100%. The health of this species gradually improved from poor to good over two years, and in that period the average height increased from about 50cm to 280cm.	Evergreen pioneer species. This leguminous species forms symbiotic partnerships with nitrogen-fixing soil microbes. In the long-term the symbiotic partnership potentially supplies nitrogen nutrients in soils that might be utilised by other plant species.			
(E5) *Melia azedarach*	This species had a relatively high survival rate throughout the 2-year trial period (approx. 80%). Its health was generally fair throughout the trial, and the average height increased from about 60cm to 120cm at the end in Jul 2022. Known to be a deciduous species, it defoliated in winter as expected.	Not recommended. This species showed its adaptability on-site, but it also possibly took advantage of other native climax species in competition for space and resources.			
(E6) *Senna siamea*	This species was in decline from the first winter to the next summer, and then remained at about a 60% survival rate. Its health was fair most of the time, except during the decline in the first winter. The average height of this species remained at around 50cm in the first-year of the trial, and only slightly grew to about 70cm in the second year. This species demonstrated deciduous characteristics in the first winter. The phenomenon was not as apparent in the 2nd winter, however.	Not recommended. The performance of This species did not demonstrate it benefited from symbiotic partnership with nitrogen-fixing microbes in soil. The inclusion of this exotic species might only intensify competition among species for spaces and resources.			

Species Name	Descriptions	Recommended Use	Typical Condition at End of Trial (Jul 22)	Trend of Average Survival Rate	Trend of Average Height
Native Trees (Climax species) (Note: all native climax tree species were grown inside micro-climatic growth tubes (MGTs) in the trial.)					
(N1) *Bridelia tomentosa*	This species remained at a high survival rate at above 80% throughout the trial. Its health was found to decline to poor in the winter, and it only managed to recover partly in the following warm season. The average height of this species constantly reduced from more than 75cm to about 40cm throughout the trial period. This species was found to die back after the onset of the first winter. Necrotic leaf tip was common in this species.	Not recommended. This species did not appear to adapt well to the site conditions.			
(N2) *Celtis sinensis*	This species remained at a high survival rate (above 90%) throughout the trial period. This species was in fair health in general, except during in winter when it defoliated. Its average height remained at around 50cm throughout the whole trial period. This species is commonly known to be a deciduous species, and it defoliated in winter as expected.	Deciduous native climax species. This species appeared to be adaptable to the site conditions, although it did not demonstrate strong growth either.			
(N3) *Cinnamomum camphora*	This species remained relatively high in survival rate at around 75% throughout the trial period. Its health was always fair and its average height remained around 50-60cm in the trial period. This species demonstrated its stability and adaptability but little growth was observed. The phenomenon of chlorotic foliage was generally observed on this species (more severe in winter and less so in summer), which might indicate the lack of some critical nutrients in soils that impacted its growth.	Evergreen native climax species. This species appeared to be adaptable to the site conditions, although it did not demonstrate strong growth either.			

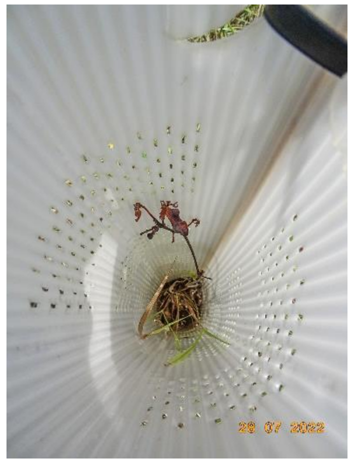
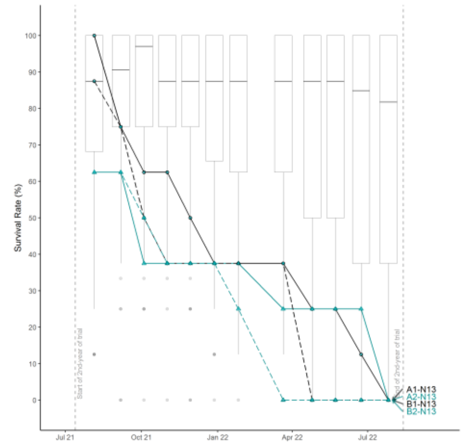
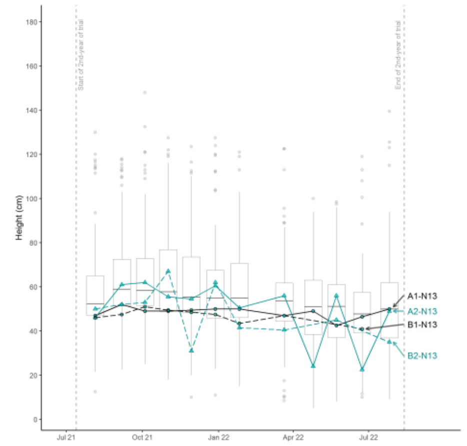
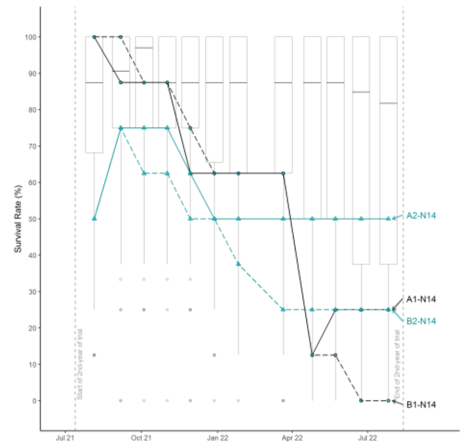
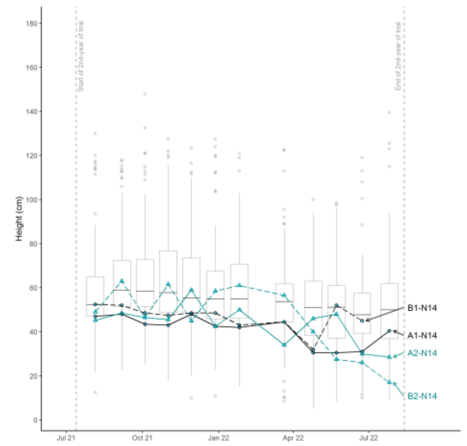
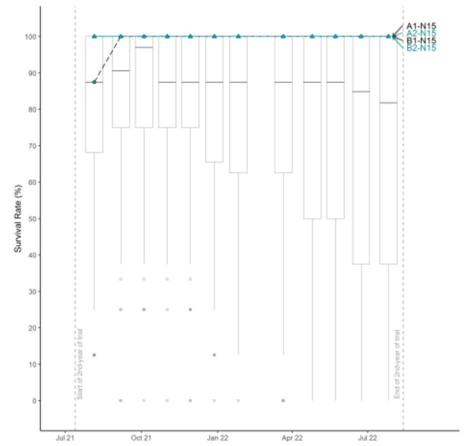
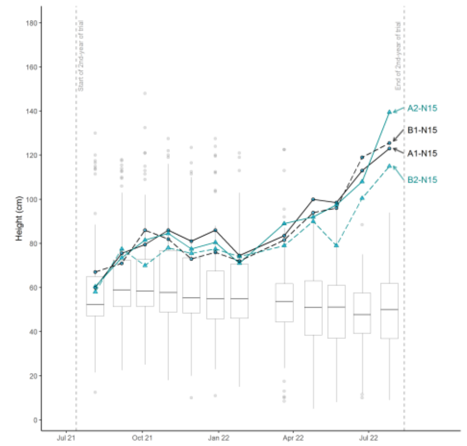
Species Name	**Descriptions**	**Recommended Use**	**Typical Condition at End of Trial (Jul 22)**	**Trend of Average Survival Rate**	**Trend of Average Height**
(N4) *Aquilaria sinensis* (*Protected species)	This species had a high survival rate (>80%) and was in fair health in the first few months. However, following the winter, this species went into decline with little sign of recovering in the subsequent warm season. Its final survival rate was <40% and its health turned poor. The average height of this species gradually reduced from 50cm to about 30cm.	Not recommended. This species appeared to be adaptable only when the site conditions were not extreme.			
(N5) *Ficus virens*	This species maintained a very high survival rate (near 100%) throughout the trial period. Its health was mostly fair, except in winter, and its average height remained around 50cm in the trial period. This species demonstrated its stability and adaptability but little growth was observed. The phenomenon of chlorotic foliage was generally observed on this species (more severe in winter and less so in summer), which might indicate the lack of some critical nutrients in soils that impacted its growth.	Deciduous native climax species. This species appeared to be adaptable to the site conditions, although it did not demonstrate strong growth either.			
(N6) *Hibiscus tiliaceus*	The survival rate of this species was almost always 100% throughout the trial period. Its health was generally fair and its height gradually increased from 50cm to about 70cm in one year. This species was arguably among the best two performing species in the trial nursery for its relatively good performance and growth. That said, the growth rate at approx. 20cm in a year was less than expected. It was also notable that in winter this species became slightly sparse in foliage.	Evergreen native climax species. This species appeared to be adaptable to the site conditions, and it demonstrated gradual growth on-site. Looking forward, more attention should be paid to microbial communities and nutrients in the soil in future use of this species.			

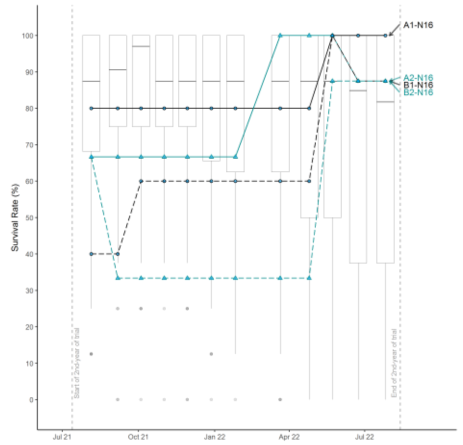
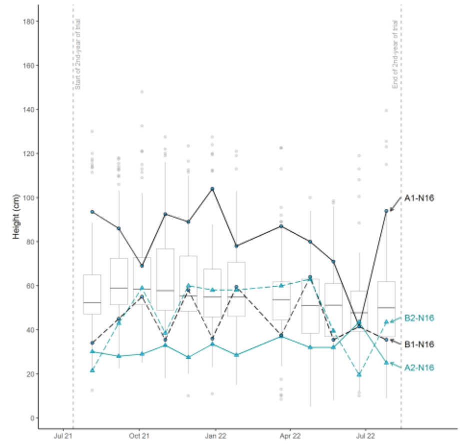
Species Name	**Descriptions**	**Recommended Use**	**Typical Condition at End of Trial (Jul 22)**	**Trend of Average Survival Rate**	**Trend of Average Height**
(N7) *Ilex rotunda* var. *microcarpa*	The survival rate of this species was almost always 100% throughout the trial period. Its health was found to be always fair, and its average height was generally about 50-60cm throughout the trial period. This species demonstrated superior stability and adaptability but little growth was observed. Occasionally, a few individuals of this species were found growing under the shade of nearby shrub species *Calliandra haematocephala* (S2), whose average height was around 90cm. In such conditions, the tree species was found to be able to grow further than the height of its MGT, and had greener- and healthier-looking foliage. In contrast, individuals at exposed locations were generally found to have chlorotic foliage and remained shorter than the MGT's height (<60cm). The phenomenon signified the importance of shelter for early establishment of this native climax species.  Individual under shelter appeared to grow well, contrast to the typical condition of its counterparts	Evergreen native climax species. This species appeared to be adaptable to the site conditions, although it did not demonstrate strong growth either.			

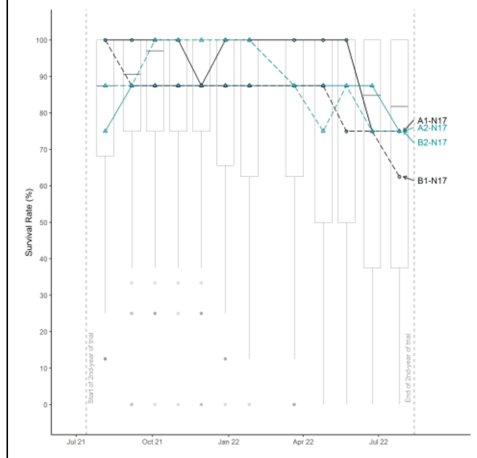
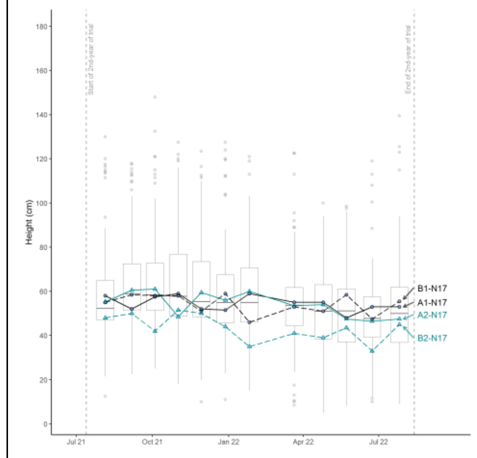
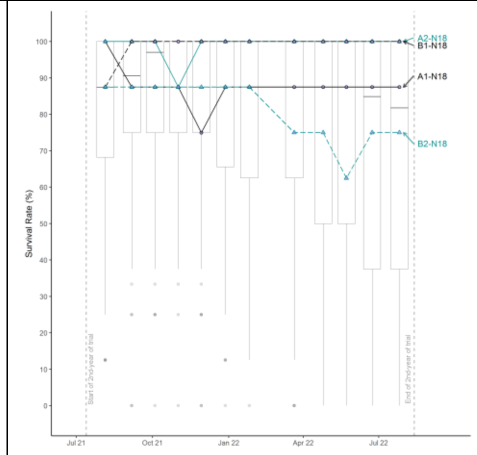
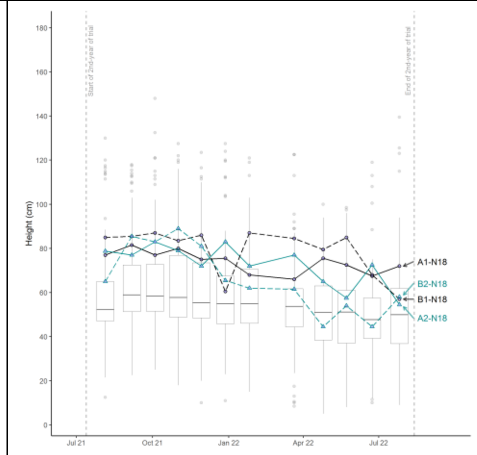
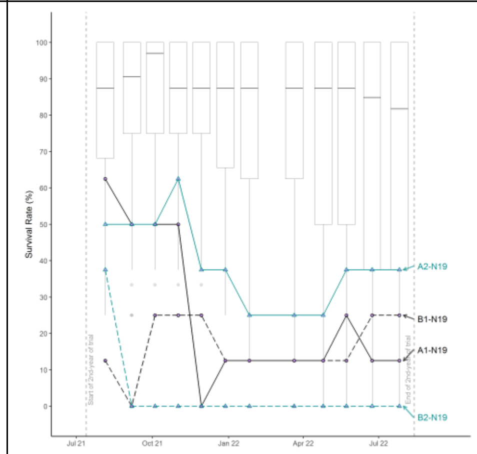
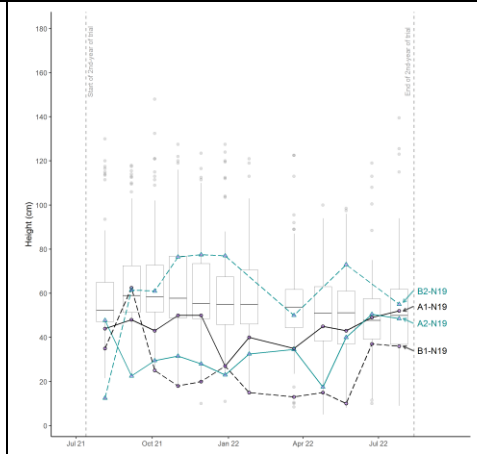
Species Name	**Descriptions**	**Recommended Use**	**Typical Condition at End of Trial (Jul 22)**	**Trend of Average Survival Rate**	**Trend of Average Height**
(N8) *Liquidambar formosana*	This species maintained a high survival rate (near 90%) throughout the trial period. This species was in fair health in general. Its average height remained around 50-60cm in the years of trial. This species is commonly known to be a deciduous species, and it defoliated in winter as expected.	Deciduous native climax species. This species appeared to be adaptable to the site conditions, although it did not demonstrate strong growth either.			
(N9) *Litsea glutinosa*	The survival rate of this species was almost always 100% throughout the trial period. Its health was generally fair and its height remained around 60cm during the trial. This species demonstrated its stability and adaptability but little growth was observed. Some individuals of this species defoliated and dieback in the winter, but most of them recovered in subsequent warm season.	Evergreen native climax species. This species appeared to be adaptable to the site conditions, although it did not demonstrate strong growth either.			
(N10) *Machilus chekiangensis*	This species declined ever since getting planted on-site. Its survival rate dropped from 75% to around 20% in a year. Its health declined from fair initially to poor at the end of trial. The average height of this species decreased throughout the trial period, from 50cm to around 20cm. This species suffered severe die back starting from the onset of winter. Necrotic leaf tip was common in this species.	Not recommended. This species was found to be unadaptable to the site conditions.			

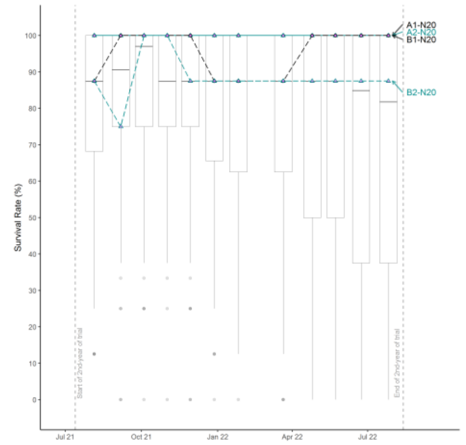
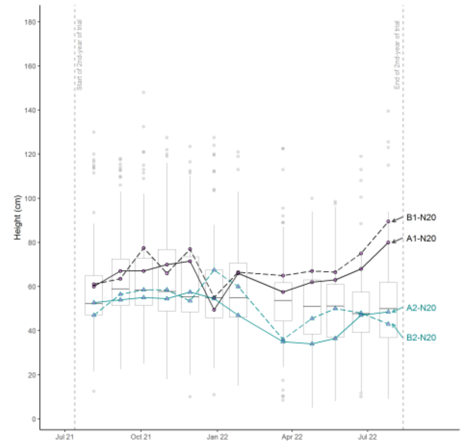
Species Name	**Descriptions**	**Recommended Use**	**Typical Condition at End of Trial (Jul 22)**	**Trend of Average Survival Rate**	**Trend of Average Height**
(N11) *Macaranga tanarius*	This species was in decline during winter. Its survival rate dropped from around 75% to 50% and then appeared to have stabilised in summer near the end of the trial. The health of this species was poor in general, though gradually improved to fair near the end of the trial. In the same period, its average height dropped from around 110cm to about 40cm. The dieback was especially quick in the winter. It was noted that this species was planted much taller than the MGT (about 110cm planting size vs. 45-60cm MGT size). The plants were not therefore in the shelter of the MGT as designed, and probably suffered severely from exposure to the winter monsoon as a result.	Not recommended. This species was found to be generally unadaptable to the site conditions, especially in cold weather.			
(N12) *Myrica rubra*	Overall, this species was found to decline quickly from the second month after planting, namely Sep 2021, to Apr 2021. The survival rate finally stabilised at around 20% thereafter. The survivors however demonstrated their adaptability to the site conditions, and remained in relatively fair health from spring to the end of the trial in summer. Its average height remained around 50cm for most of the trial period, and appeared to rise near the end of trial in summer. The overall performance of this species was far from perfect, but the heterogeneity within the species was arguably the most biologically interesting finding in the Trial Nursery. It is known that nitrogen-fixing bacteria in the *Frankia* genus could form mutualistic symbiosis with plant hosts in *Myrica* genus. Comparatively, bacteria in the *Rhizobia* genus could establish a similar relationship with many leguminous species, as in some examples in the trial nursery. In such cases, the plant hosts could take advantage of the nitrogen-fixing ability of the bacteria and obtain nitrogen nutrients from the atmosphere. It was hypothesized that those plants in this species which quickly declined in winter failed to establish such a relationship with *Frankia* spp. fast enough in the first autumn. Around 20% of	Native climax species, to be used if treatment with symbiotic nitrogen-fixing bacteria is available prior to planting. This species was found to be generally unadaptable to the site conditions when untreated with mutualistic microbes.			

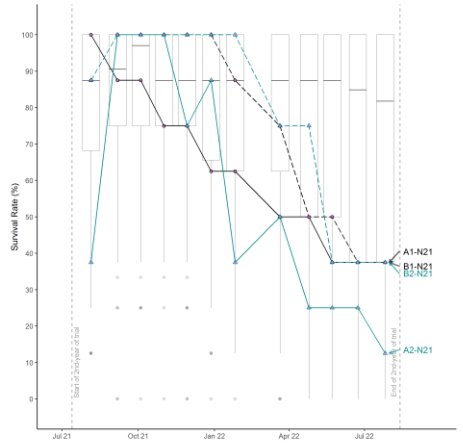
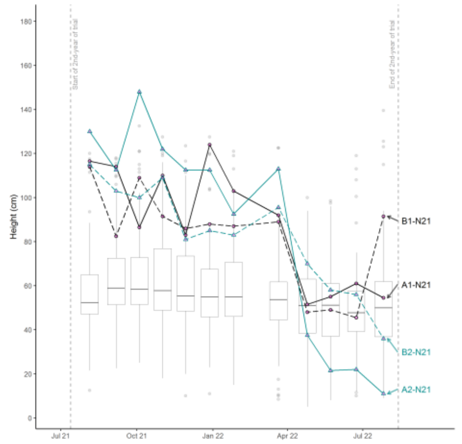
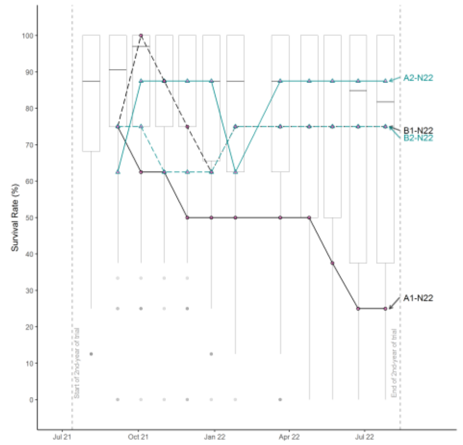
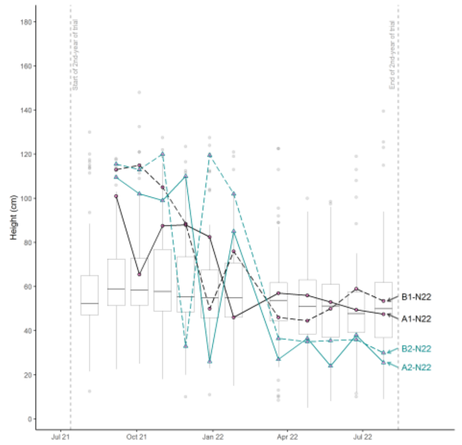
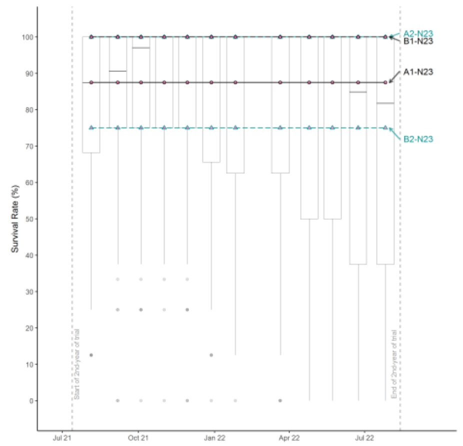
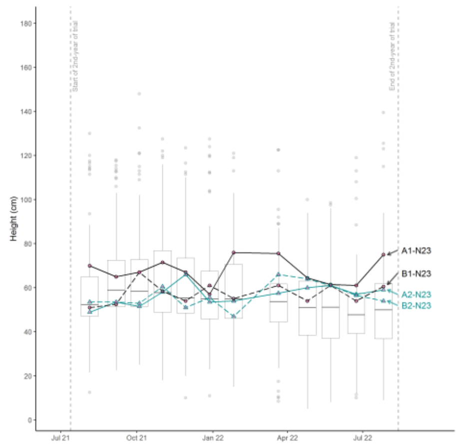
Species Name	**Descriptions**	**Recommended Use**	**Typical Condition at End of Trial (Jul 22)**	**Trend of Average Survival Rate**	**Trend of Average Height**
	the *Myrica* plants might have successfully established such a symbiotic relationship with the bacteria, and hence they were enhanced in plant health and resistance to the elements and survived through the adverse weather and generally harsh conditions on-site. The foliage colour of the few successful survivors of this plant species was among the deepest green among the native tree seedlings in the trial nursery, probably second only after *Pongamia pinnata* (N15), which is a nitrogen-fixing leguminous plant. The phenomenon appeared to be consistent with the hypothesis of a symbiosis with microbes.  Individual of N12 that appeared to grow well, contrast to typical condition of its counterparts, possibly a result of symbiosis between soil microbes and the host plant				

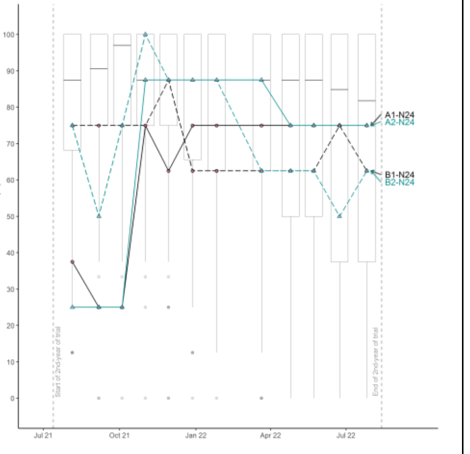
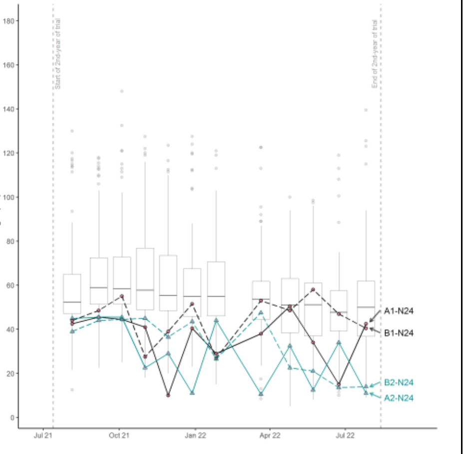
Species Name	**Descriptions**	**Recommended Use**	**Typical Condition at End of Trial (Jul 22)**	**Trend of Average Survival Rate**	**Trend of Average Height**
(N13) *Rhodoleia championi* (*Protected species)	This species was found to go into quick decline since the first month after planting. The survival rate dropped from around 75% to 0% at the end of the trial, in one year. The health of this species was mostly poor throughout the trial period. Its average height remained around 40-50cm. Dieback and necrotic leaf tip were common in this species.	Not recommended. This species was found to be unadaptable to the site conditions.			
(N14) *Polyspora axillaris*	This species was in decline following the adverse weather in winter. Its survival rate dropped from around 75% to 25% and then appeared to stabilise in the summer near end of the trial. Its general health remained poor throughout the trial period. The average height of this species was stable, decreasing from around 50cm to about 25cm within one year.	Not recommended. This species was found to be unadaptable to the site conditions.			
(N15) *Pongamia pinnata*	This species remained at a 100% survival rate for almost the whole trial period. Its evaluated health was generally good, except in winter when it exhibited some degree of defoliation, but the plants quickly recovered once the weather became warm in spring. This species demonstrated the strongest growth among the native tree seedlings in the Trial Nursery. The average height increased from about 60cm to around 120cm within one year. Similar growth rates were only found in the category of Exotic Tree Seedlings. The good performance of this species suggested it shares some similarities with the exotic pioneer species. Most probably these leguminous species take advantage of the partnership with symbiotic nitrogen-fixing bacteria and have access to nitrogen nutrients from the atmosphere.	Deciduous native climax or pioneer species. This species appeared to be adaptable to the site conditions. Moreover, this species demonstrated strong growth rates similar to some exotic pioneer species.			

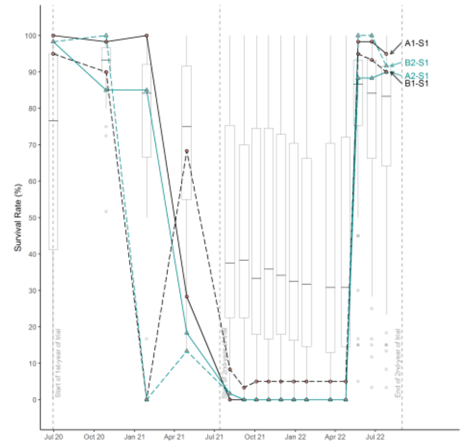
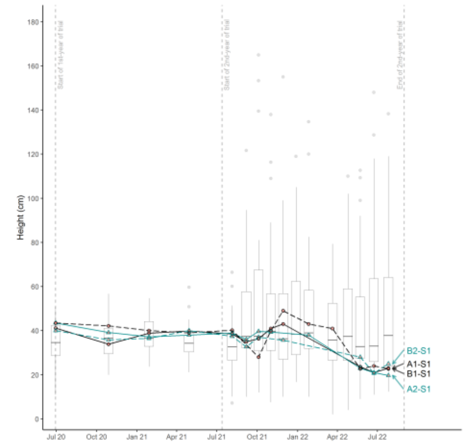
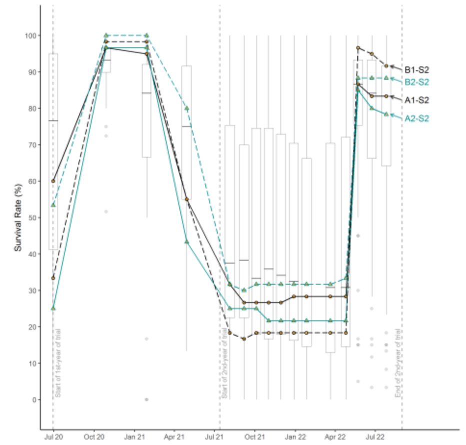
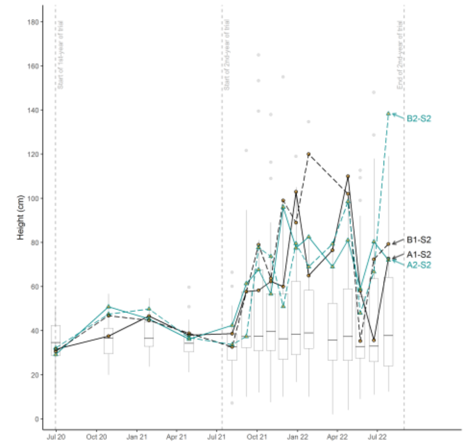
Species Name	**Descriptions**	**Recommended Use**	**Typical Condition at End of Trial (Jul 22)**	**Trend of Average Survival Rate**	**Trend of Average Height**
(N16) *Pyrus calleryana*	This species was in short supply when the trial nursery was set up. The sample size was small. The survival rate in such a small sample was relatively low at around 60% at the beginning of the trial but then appeared to be stable at that level for most of the trial period. When replacement planting took place in May 2022, the survival rate remained at around 90%. The health of this species remained fair throughout the trial period. Its average height was also stable at around 50cm. Individuals growing in shade were found to be healthier and taller than those exposed.  Individual under shelter appeared to grow well, contrast to the typical condition of its counterparts	Deciduous native climax species. This species appeared to be adaptable to the site conditions, although it did not demonstrate strong growth either.		 	

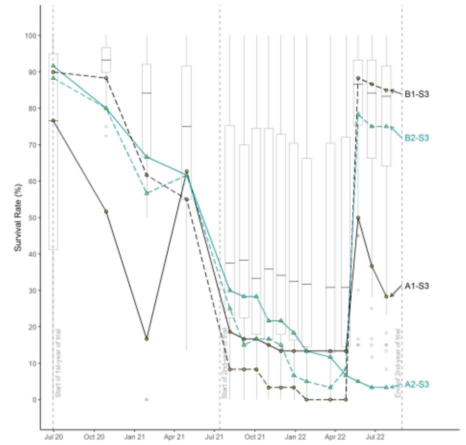
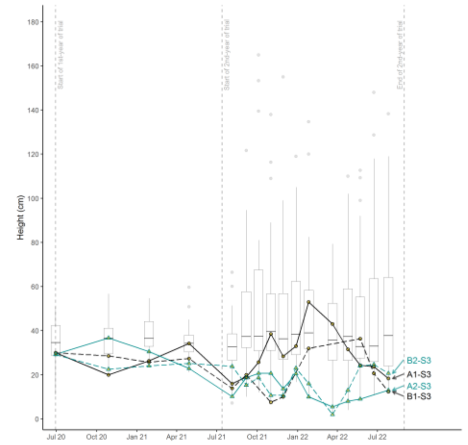
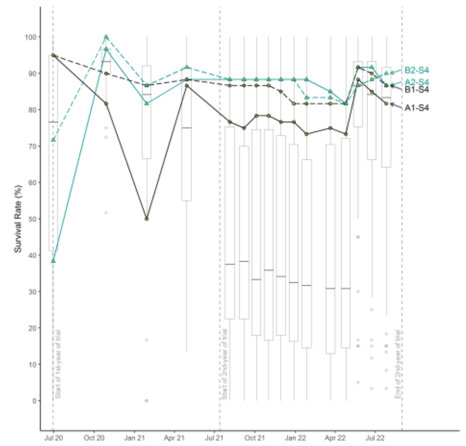
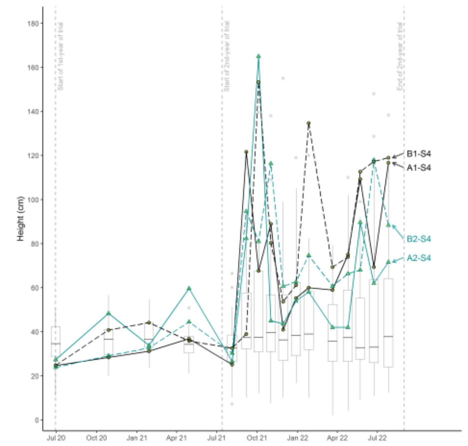
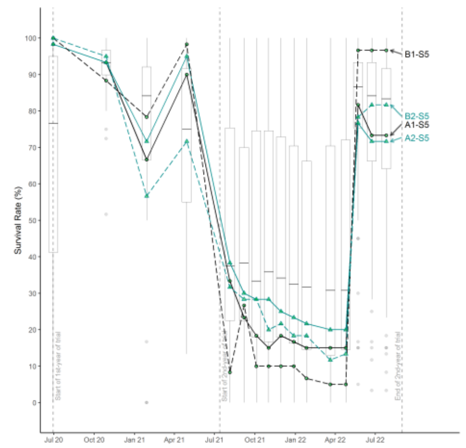
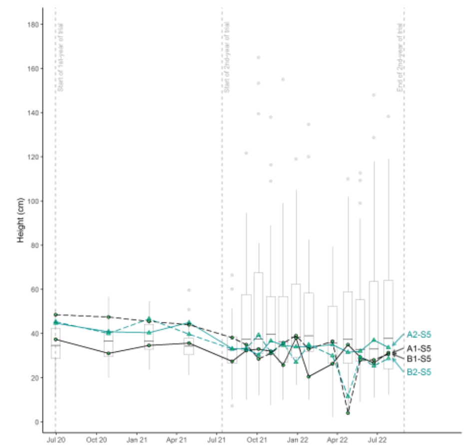
Species Name	Descriptions	Recommended Use	Typical Condition at End of Trial (Jul 22)	Trend of Average Survival Rate	Trend of Average Height
(N17) *Reevesia thyrsoidea*	This species had a survival rate of around 90% throughout most of the trial period, but near the end of trial it suddenly dropped to around 70% and continued to decline. The health of this species was fair initially but after the first winter, it started to fluctuate and became poor by the end of the trial. The average height remained at around 50cm throughout the trial period. Necrotic leaf tip was common in this species.	Not recommended. This species appeared to be unadaptable to the site conditions in long-term.			
(N18) *Rhus succedanea*	This species maintained a relatively high survival rate of nearly 90% throughout the trial. Its health was mostly fair except in the winter. The average height constantly dropped from around 80cm initially to around 60cm at the end of the trial. This species performed as a typical deciduous species.	Deciduous native climax species. This species appeared to be adaptable to the site conditions, although it did not demonstrate strong growth either.			
(N19) *Sapium discolor*	This species had a low survival rate (approx. 40%) after initial planting and later the rate dropped to about 10%. Its health remained poor for most of the trial period. The average height of this species was around 30-40cm. This species performed as a deciduous species as expected.	Not recommended. This species was found to be unadaptable to the site conditions.			

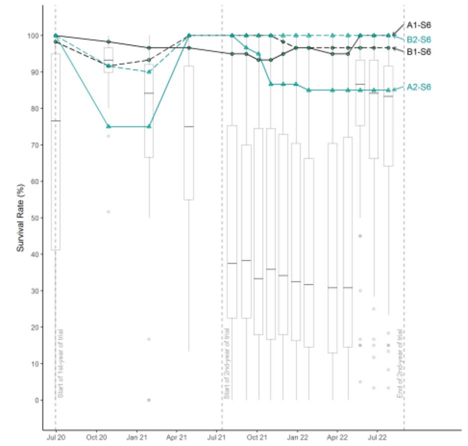
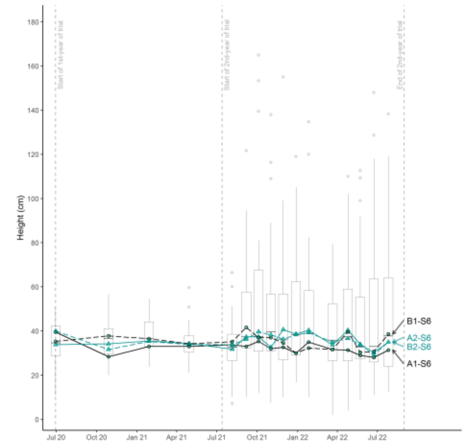
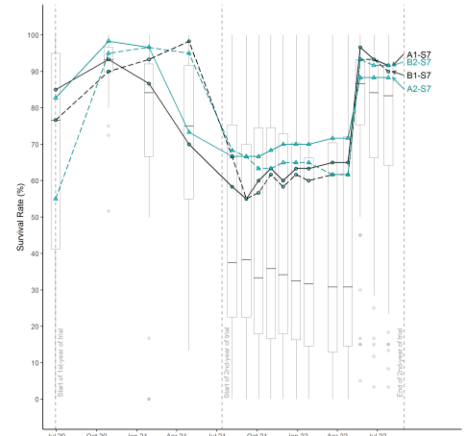
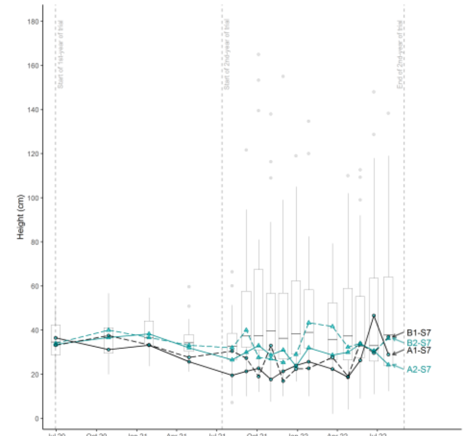
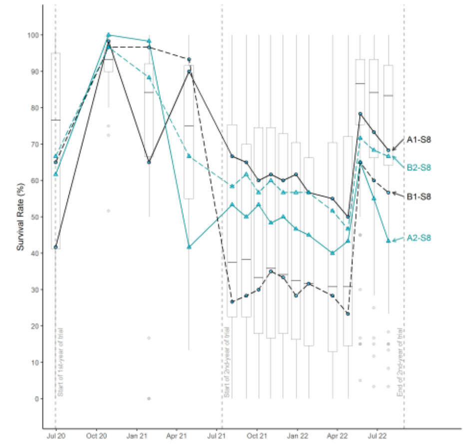
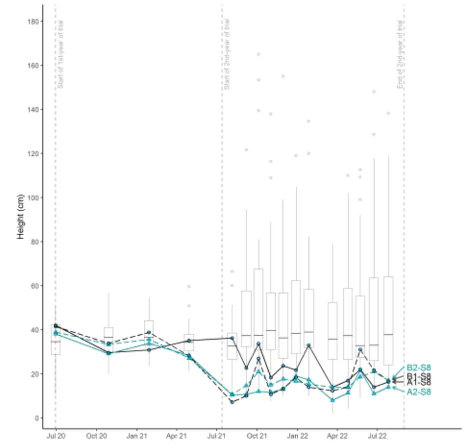
Species Name	**Descriptions**	**Recommended Use**	**Typical Condition at End of Trial (Jul 22)**	**Trend of Average Survival Rate**	**Trend of Average Height**
(N20) *Sapium sebiferum*	This species maintained an over 90% survival rate throughout the trial period. Its health was fair in general except in winter when it defoliated. The average height of this species was around 60cm, and near the end of trial in the summer, it demonstrated a stable trend in growth to around 70cm. Individuals growing in shade were found to be healthier and taller than those exposed.  Individual under shelter appeared to grow well, contrast to the typical condition of its counterparts	Deciduous native climax species. This species appeared to be adaptable to the site conditions, although it did not demonstrate strong growth either.			

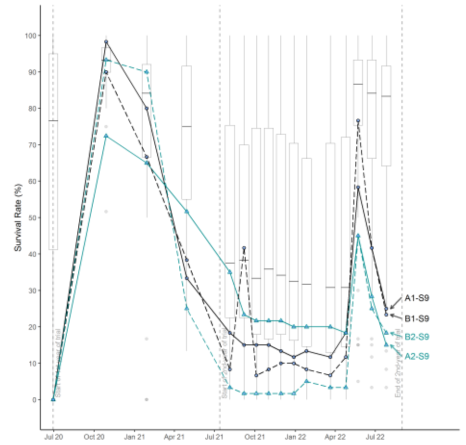
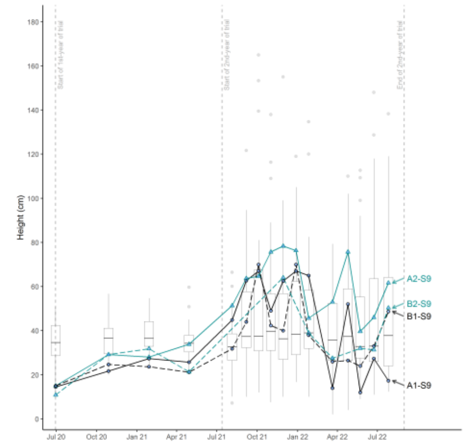
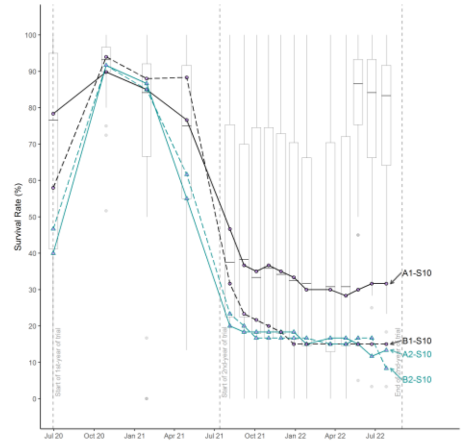
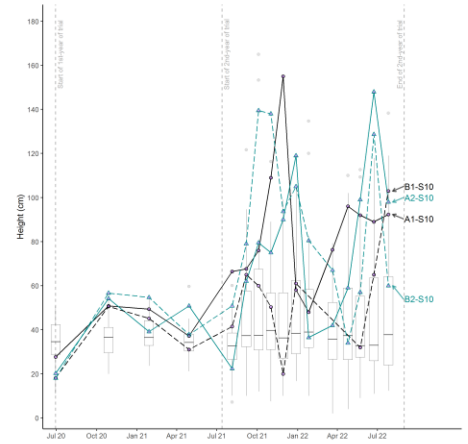
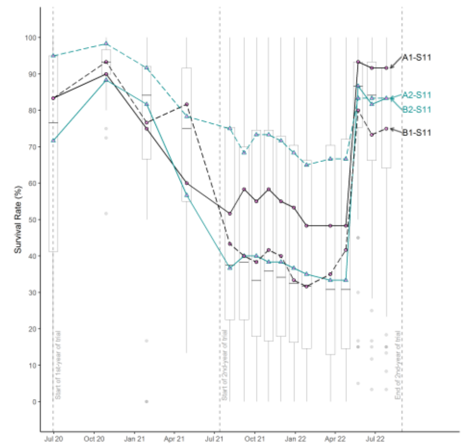
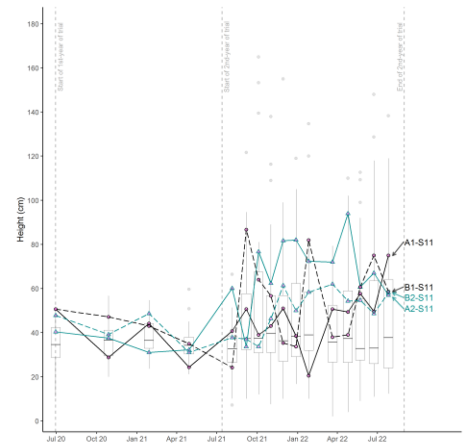
Species Name	Descriptions	Recommended Use	Typical Condition at End of Trial (Jul 22)	Trend of Average Survival Rate	Trend of Average Height
(N21) *Camellia crapnelliana*	This species was in decline from the first winter to the next summer of the trial, and in that period, the survival rate dropped from around 80% to 30%, and the trend did not appear to show any sign of slowing-down at the end of trial. The plants' health remained poor throughout the trial period. Its average height dropped from around 120cm to 50cm. Dieback and necrotic leaf tips were common in this species. It should be noted that when planted this species was very oversized and much taller than their MGTs.	Not recommended. This species was found to be unadaptable to the site conditions.			
(N22) *Sterculia lanceolata*	This species maintained a survival rate of around 60% throughout most of the trial period. Its health remained poor throughout most of the trial period until it improved to fair near the end. The average height dropped from around 110cm to around 40cm and then stabilised. Dieback and necrotic leaf tips were common in this species. It's noted this species were exceedingly oversized compared to the MGT.	Not recommended. This species demonstrated its stability in survival rate but neither growth rate and health were impressive.			
(N23) *Syzygium hancei*	The survival rate of this species maintained a constant level of around 90% throughout the whole trial period. Its health remained fair with only a slight dip in winter. Its average height was around 60cm throughout the trial period. This species demonstrated its stability in adapting to the site conditions. However, except for a few individuals grown in shade in nearby shrubs of *Calliandra haematocephala* (S2), most of the individuals in this species were found to be in chlorotic foliage. The phenomenon might hint there was shortage of some resources in general, and the accompanying pioneer species might provide some help.	Evergreen native climax species. This species appeared to be adaptable to the site conditions, although it did not demonstrate strong growth either.			

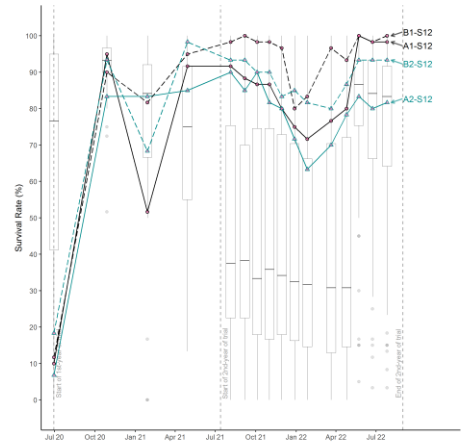
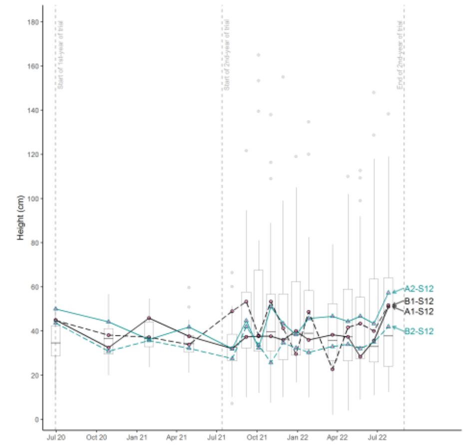
Species Name	**Descriptions**	**Recommended Use**	**Typical Condition at End of Trial (Jul 22)**	**Trend of Average Survival Rate**	**Trend of Average Height**
(N24) *Viburnum odoratissimum*	This species was in slight decline following the first winter to the next spring of the trial, and in that period, its survival rate dropped from 80% to about 70%. Its health remained poor throughout the majority of trial but once stabilised, improved to a fair condition. The average height of this species was around 30cm throughout the trial period.	Evergreen native climax species. This species appeared to be adaptable to the site conditions, although it did not demonstrate strong growth either.			

Species Name	**Descriptions**	**Recommended Use**	**Typical Condition at End of Trial (Jul 22)**	**Trend of Average Survival Rate**	**Trend of Average Height**
Shrubs					
(S1) *Buxus sinica*	This species declined quickly from the first winter to the next summer of the trial, and by then the survival rate was close to zero. No growth in height had been recorded and health condition was mostly very poor (except for one or two exceptional survivors which remained fair in health).	Not recommended. This species was found to be unadaptable to the site conditions.			
(S2) *Calliandra haematocephal a*	This species was found to decline quickly from the first winter to the next summer of the trial. The survival rate stabilised at around 25%. The surviving plants however demonstrated one of the strongest growth rates among shrubs in the Trial Nursery (reaching about 90cm), and their health condition gradually improved from poor at the start of 2nd year summer to good at the end of trial. This species is commonly known to be evergreen locally. However, in the first winter, it exhibited deciduous characteristics. This unusual phenomenon was not observed in the second winter. This species is recognized as potentially a nitrogen-fixing species, forming a symbiotic partnership with soil microbes (*Rhizobia* spp.). It is hypothesized that the disparate performances from individuals of the same species was associated with the success or not for them to form a symbiotic relationship with nitrogen-fixing bacteria and/or other soil microbes. Interestingly, this species tended to be hit or miss on-site – it either survived or died in groups but seldom was found growing singly. The phenomenon might suggest that the natural microbe community in symbiotic relationship with the plant species might be only sporadically distributed and affected only plants close-by.	Evergreen pioneer species. The leguminous species forms a symbiotic partnership with nitrogen-fixing soil microbes. In the long-term the symbiotic partnership potentially supplies nitrogen nutrients to the soil that might be utilised by other plant species.			

Species Name	**Descriptions**	**Recommended Use**	**Typical Condition at End of Trial (Jul 22)**	**Trend of Average Survival Rate**	**Trend of Average Height**
(S3) *Hamelia patens*	This species was found to go into quick decline from the first winter to the next summer of the trial and went on gradually declining from the second winter to the subsequent spring. The final survival rate was around 10%. The health condition remained poor most of the time and there was never recorded any growth in height throughout the trial period.	Not recommended. This species was found to be unadaptable to the site conditions.			
(S4) *Ipomoea pes-caprae*	This species was found generally robust on-site. The survival rate of this species was always around 80% and the plants remained fair in health throughout the trial period. This species grew to around 1m in "length" within two years. As this species was known to be a groundcover, its growth was generally limited to horizontal expansion with not much gain in height. In contrast to common understanding, this species performed as a deciduous groundcover on-site instead of evergreen. Flowering had been recorded.	Not recommended. This species appeared to be adaptable to the site conditions, and it tended to be fast-growing as a groundcover on exposed locations. The species appeared to cover and affect the growth of other planted seedlings.			
(S5) *Rhododendron simsii* (*Protected species)	This species was found to go into quick decline from the first winter to the next summer of the trial and went on gradually declining from the second winter to the subsequent spring. The final survival rate was around 10%. Their health condition remained poor most of the time and there was never any recorded growth in height throughout the trial period. Interestingly, after the end of first-year decline, in Apr 2021, this species, although mostly defoliated and damaged through the winter, expended lots of energy in flowering. This might demonstrate its last resort strategy in reaction to adverse growing conditions. However, there were recorded no seedlings which were generated in this way in Trial Nursery.	Not recommended. As a member of the family Ericaceae, this species probably needs to establish a mutualistic relationship with ericoid mycorrhiza to adapt to soils which are poor in nutrients. The poor performance of the plants in the Trial Nursery suggested that such a partnership associated with this species failed to materialise on-site at primary to secondary succession stages, when conditions more favoured other pioneers.			

Species Name	**Descriptions**	**Recommended Use**	**Typical Condition at End of Trial (Jul 22)**	**Trend of Average Survival Rate**	**Trend of Average Height**
(S6) *Pittosporum tobira*	This species had a high survival rate (exceeding 90%). Its health condition remained fair in general and its height around 40cm throughout the trial period. Despite the high survival rate, this species apparently lacked nutrients required for healthy growth (presumably nitrogen, as chlorosis and stunted growth were generally observed).	Not recommended. This species is exotic and its growth rate was not impressive. The inclusion of this species might only intensify competition with native climax species for spaces and resources.			
(S7) *Rhaphiolepis indica*	This species was found to be in relatively mild decline from the first winter to the next summer of the trial. Its survival rate then stabilised at around 60%. The health condition was mostly fair and its height remained at around 30cm throughout the trial period. This species generally had sparse foliage. Flowering has been recorded.	Evergreen native climax species. This species appeared to be adaptable to the site conditions, although it did not demonstrate strong growth either.			
(S8) *Rhodomyrtus tomentosa*	This species was found to be in decline from the first winter of the trial to the next summer. Its survival rate was around 40%. Its health condition was mostly poor and its height remained below 20cm throughout the trial period. This species was stunted and easily died back in adverse weather.	Evergreen native climax species. This species is a common local plant and is known to be a dominant shrub in the nearby country park. The inclusion of this plant could help to simulate local countryside conditions in future planting.			

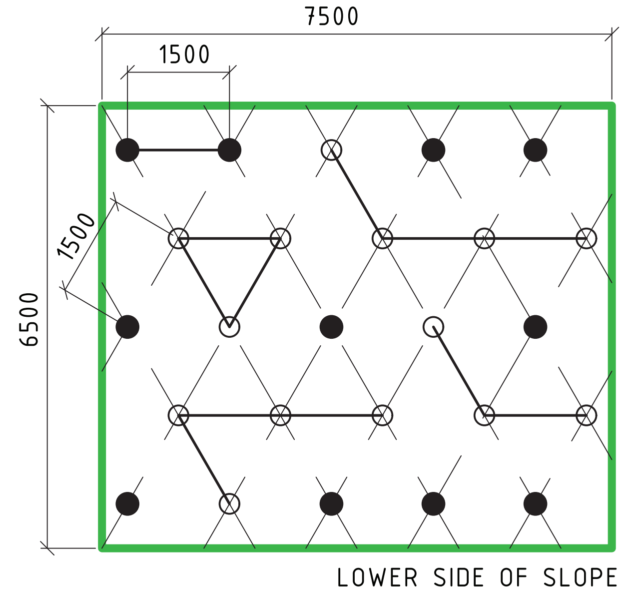
Species Name	Descriptions	Recommended Use	Typical Condition at End of Trial (Jul 22)	Trend of Average Survival Rate	Trend of Average Height
(S9) *Verbena rigida*	This species demonstrated fairly strong seasonality in health and height throughout the trial period. Flowering has been recorded. As a herbaceous plant that could be a tender perennial or annual, and this species probably needed to generate seeds to sustain itself through several seasons. However, there were no fruits nor new seedlings found in the trial period. The survival rate dropped quickly from the first winter of the trial to the next summer o around 10%. Heights fluctuated at around 50cm depending on the season. Its health condition was generally fair for the few surviving plants	Not recommended. This species was found to be unadaptable to the site conditions.			
(S10) *Lespedeza formosa*	This species was found to decline quickly from the first winter of the trial to the next summer. Its survival rate stabilised at around 20%. Surviving plants however demonstrated one of the strongest growth rates among shrubs in the Trial Nursery (reaching about 80cm), and their health condition was generally fair. The deciduous species demonstrated fairly strong seasonality. Flowering has been recorded. This species is recognized as potentially a nitrogen-fixing species, by forming symbiotic partnerships with soil microbes (*Rhizobia* spp.). It is hypothesized that the disparate performances between individuals of the same species was associated with the success or not for them forming a symbiotic relationship with nitrogen-fixing bacteria and/or other soil microbes.	Deciduous native climax species, if treatment with a symbiotic nitrogen-fixing bacteria is available prior to planting. This species was found to be generally unadaptable to the site conditions when untreated with mutualistic microbes. The good performance from the surviving plants of this leguminous species highlights the importance of a symbiotic partnership with mutualistic microbes.			
(S11) *Vitex negundo*	The survival rate of this species was stable (at around 50%) after declining from the first winter of the trial to next summer. After stable conditions were established, this species was found to grow slowly in height and maintained a fair health condition. This species performed as a typical a deciduous shrub on-site. Flowering has been recorded.	Deciduous native climax species. This species appeared to be adaptable to the site conditions, although it did not demonstrate strong growth either.			

Species Name	Descriptions	Recommended Use	Typical Condition at End of Trial (Jul 22)	Trend of Average Survival Rate	Trend of Average Height
(S12) *Vitex rotundifolia*	This species remained at a high survival rate (approx. 90%), more or less the same height (approx. 40cm), and a fair health condition throughout the trial period. This species was found unusually defoliated during winter on-site. Flowering has been recorded.	Evergreen native climax species. This species appeared to be adaptable to the site conditions, although it did not demonstrate strong growth either.			

Appendix C

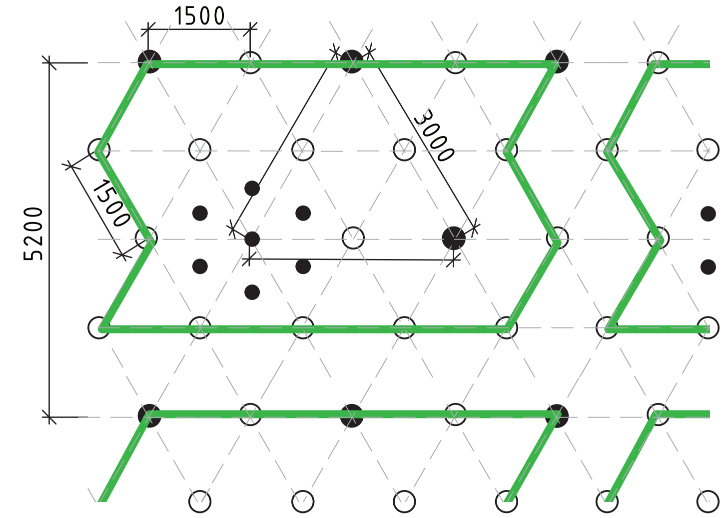
Various Versions of Proposed Planting Matrix Patterns

Typical SENT Matrix (Phase 17 reference)



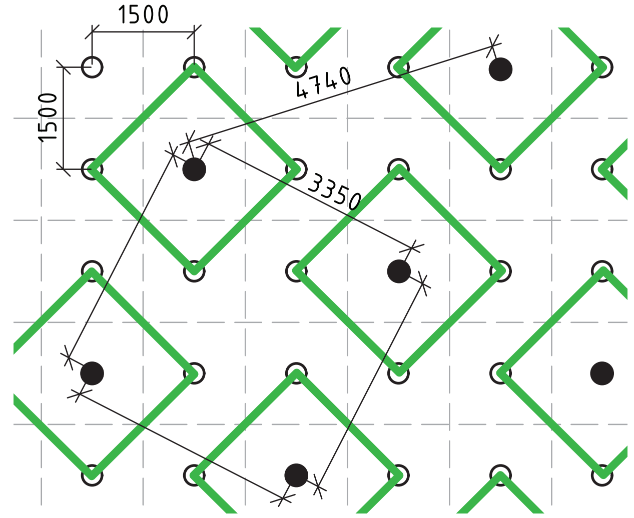
40% ● Pioneer Species (exotics)
60% ○ Climax Species (natives)

Proposed Matrix Variation A (25% exotic)



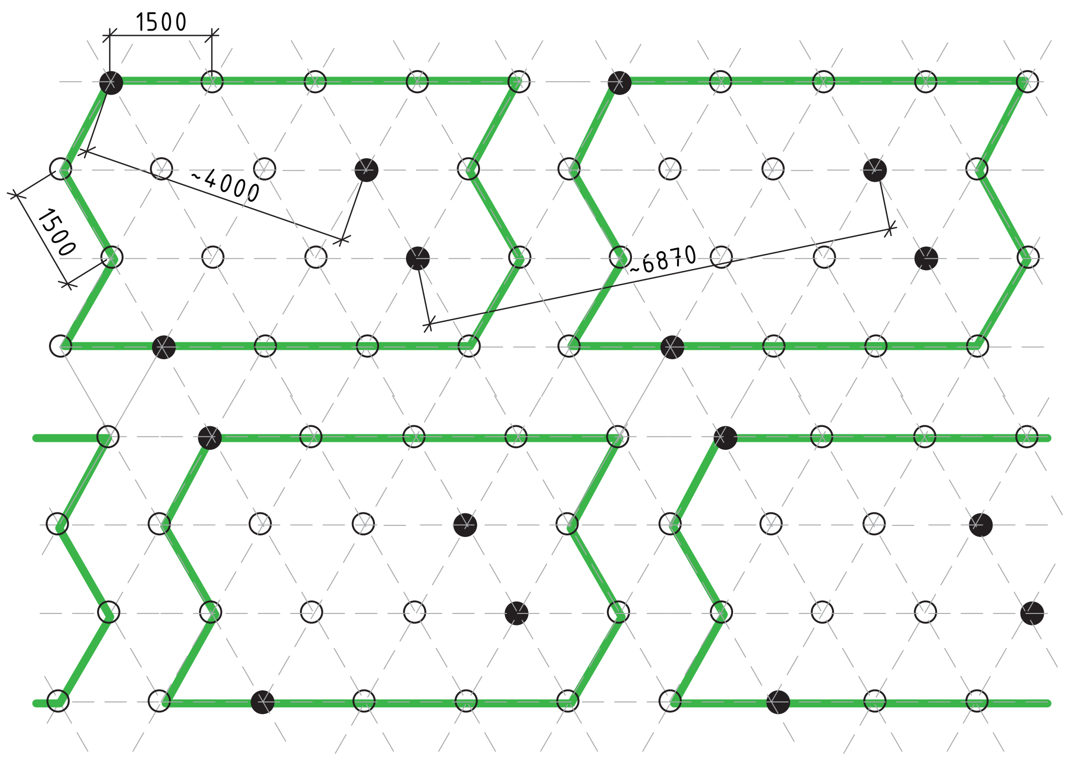
● Pioneer Species
20% (exotic trees,
5% native shrubs)
75% ○ Climax Species (natives)

Proposed Matrix Variation C (20% exotic)



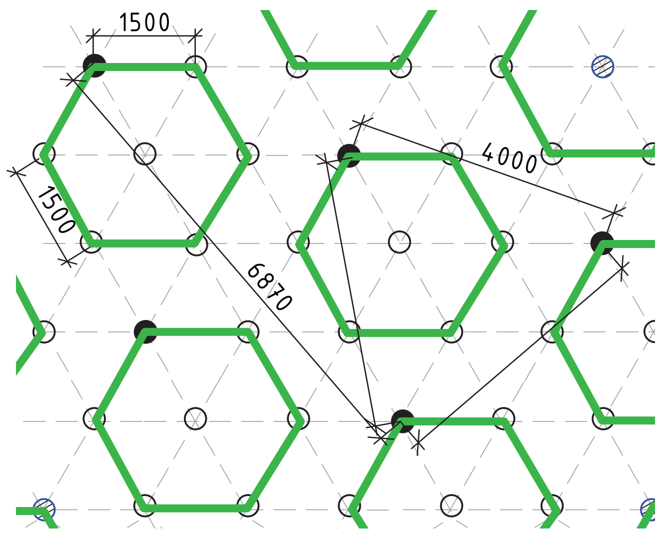
20% ● Pioneer Species (exotics)
80% ○ Climax Species (natives)

Trial Nursery Matrix - SENTX required 20% exotic



20% ● Pioneer Species (exotics)
80% ○ Climax Species (natives)

Proposed Matrix Variation B (14+6% exotic)



14% ● Pioneer Species (exotics)
6% ◎ Pioneer Species at Random Locations (exotics)
80% ○ Climax Species (natives)

Amendment No.	Date	Description	Drawn by	Checked by	Approved by

Job Title
CONTRACT: EP/SP/10/91 SUPPLEMENTAL AGREEMENT NO.2
SOUTH EAST NEW TERRITORIES LANDFILL EXTENSION (SENTX)

Drawing No.
GVL16-TN-SK01

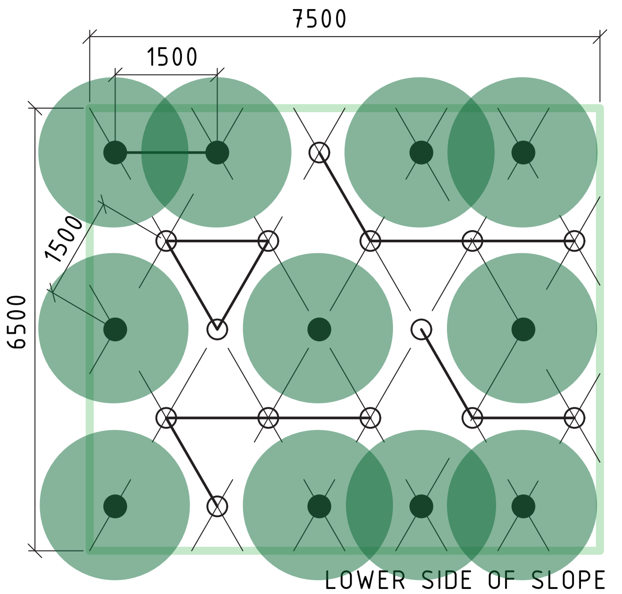
Drawing Title
PROPOSED PLANTING MATRIX PATTERNS (1 OF 2)

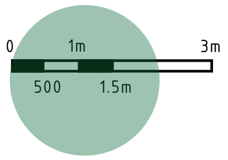
Scale
N.T.S.

Drawn by TW | Checked by BL | Approved by - | Date AUG 2023 | Job. No. GVL16

雅邦 Urbis Limited
Planning, Urban Design, Landscape, Golf & Environmental Consultants
Urbis Limited, 11/F Siu On Centre, 188 Lockhart Road, Wan Chai, Hong Kong. Tel : 2802 3333 Fax : 2802 8662

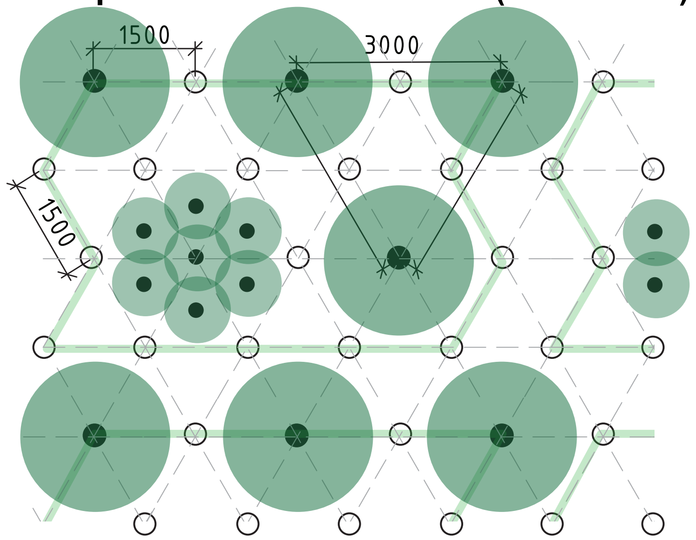
Typical SENT Matrix (Phase 17 reference)





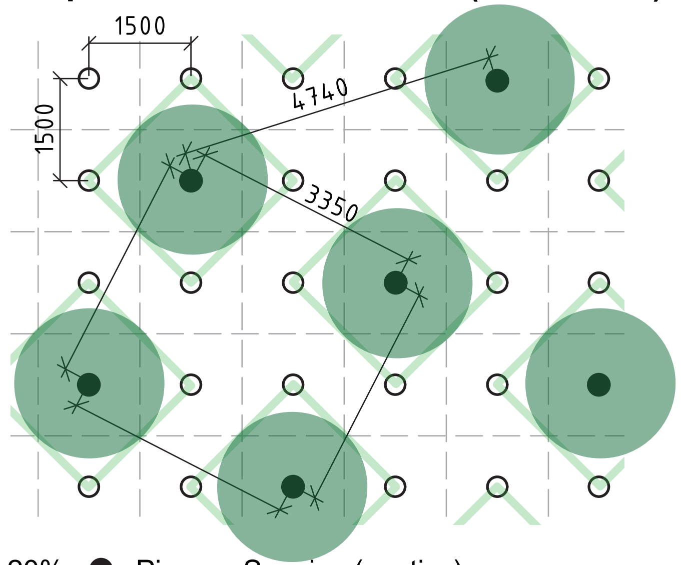
40% ● Pioneer Species (exotics)
60% ○ Climax Species (natives)

Proposed Matrix Variation A (25% exotic)



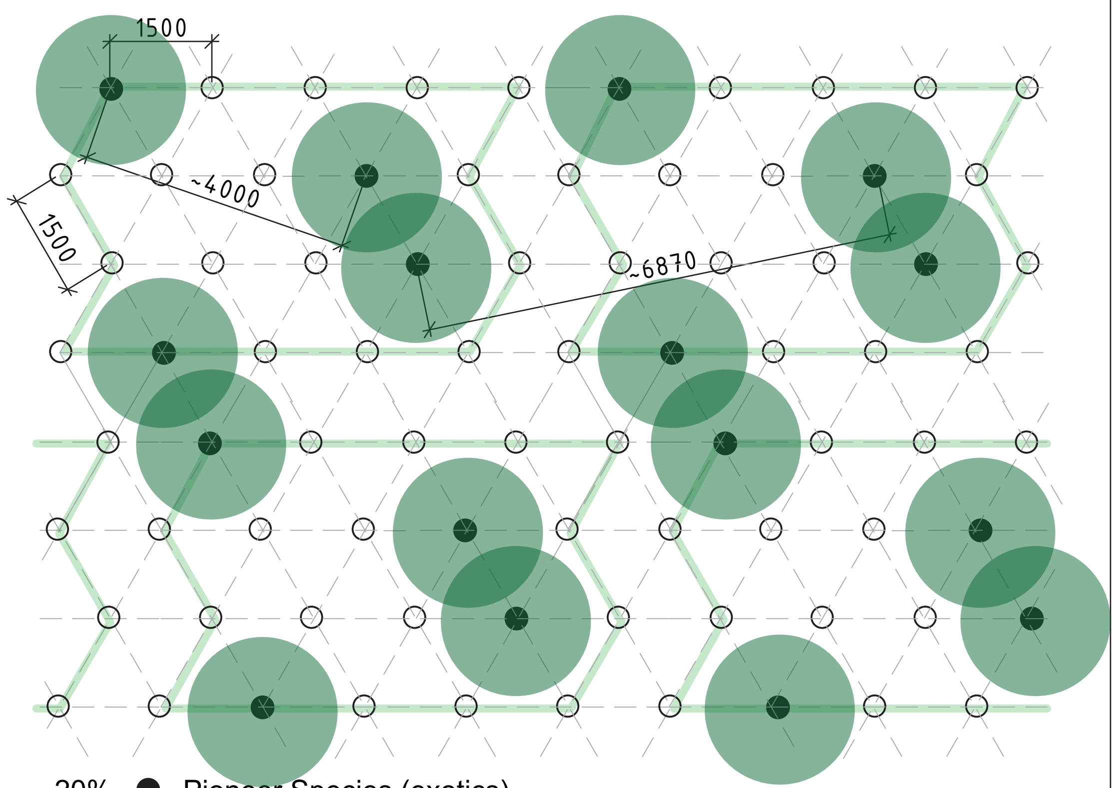
● Pioneer Species
20% (exotic trees,
5% native shrubs)
75% ○ Climax Species (natives)

Proposed Matrix Variation C (20% exotic)



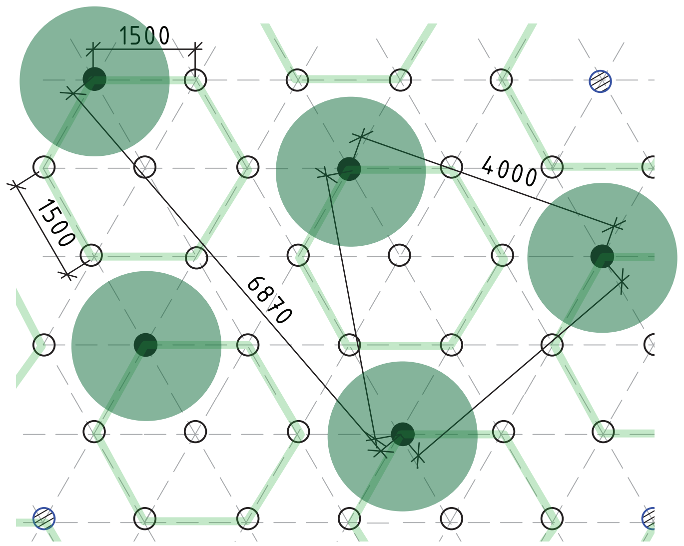
20% ● Pioneer Species (exotics)
80% ○ Climax Species (natives)

Trial Nursery Matrix - SENTX required 20% exotic



20% ● Pioneer Species (exotics)
80% ○ Climax Species (natives)

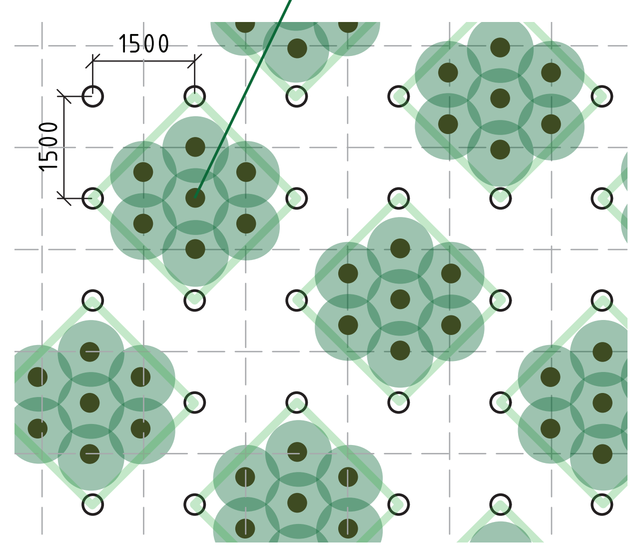
Proposed Matrix Variation B (14+6% exotic)



14% ● Pioneer Species (exotics)
6% Pioneer Species at Random Locations (exotics)
80% ○ Climax Species (natives)

Other Variations

Replacing 1 nos. of pioneer tree seedling with 7 nos. of shrubs



Amendment No.	Date	Description	Drawn by	Checked by	Approved by

Job Title
CONTRACT: EP/SP/10/91 SUPPLEMENTAL AGREEMENT NO.2
SOUTH EAST NEW TERRITORIES LANDFILL EXTENSION (SENTX)

Drawing No.
GVL16-TN-SK02

Drawing Title
PROPOSED PLANTING MATRIX PATTERNS (2 OF 2)

Scale
N.T.S.

Drawn by	Checked by	Approved by	Date	Job. No.
TW	BL	-	AUG 2023	GVL16

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Appendix D

Extracted pages from SENTX Contract

- Page 392 to 395 of Appendix C Part A – General Requirements
- Appendix 36.3.3 in Appendix C Part A & Part B

36.3.4.5 The material and construction of the footpaths and access tracks shall be compatible with the rural character of the landfill setting.

36.3.4.6 The master landscape plan shall indicate the size and location of lookout pavilions, sitting out areas and other recreational facilities. The location of fencing and sign posting facilities shall also be shown. Ornamental planting shall be included in conjunction with the lookout pavilions and sitting out areas.

36.3.4.7 The Contractor's Design shall consider whether an irrigation system is needed for the more formal areas of planting.

36.3.5 Trial Planting For Native Species

General

36.3.5.1 Pursuant to Condition 2.6 (Submission of Restoration and Ecological Enhancement Plan) of the EP, woodland planting for the Restoration works of SENTX shall consist of about 20% non-native tree species. Pursuant to Condition 2.7 (Setting up of Trial Nursery) of the EP, a trial nursery shall be set up for native plant species in advance during construction phase to fine tune the planting matrix and management intensity of the recommended indigenous tree species.

36.3.5.2 Further to Clauses 1.1.5.8 and 1.7.13 of this Specification, the Contractor shall, during the construction of the Initial Works for SENTX, set up a trial nursery, carry out trial planting according to the Drawings, and subsequently carry out establishment works to the plantings throughout the period of the Contract.

36.3.5.3 The planting matrix and management intensity of the SENTX Restoration phase woodland planting are subject to the outcome of this trial planting.

Location and layout

36.3.5.4 The trial nursery shall provide collectively no less than 1936 square meter (sq.m) of area available for planting. The planting area shall consist of two (2) quadrants of equal area, of which each quadrant shall not be less than 968 sq.m in area.

36.3.5.5 The Contractor shall propose a location within the Site for the trial nursery that could, as far as possible, represent the typical environment and planting condition at the Restoration phase of SENTX.

36.3.5.6 The Contractor shall submit a written proposal to the Independent Consultants for the location, detailed setting up and programme of works of the trial nursery for approval before implementation. A conceptual layout of the trial nursery is shown on Part A of Appendix 36.3.3 to this Specification which is indicative only.

36.3.5.7 To facilitate monitoring, the boundary of the trial nursery as well as the boundary of each quadrant shall be clearly demarcated and labelled with long-lasting materials in an approved design.

36.3.5.8 The trial nursery shall be backfilled with 1.2m deep soil mix that complies with GS clause 3.30 and this Specification to the designed finished level and contour of the location. The soil mix shall be ready and evenly mixed before delivery onto the Site. Spreading of soil conditioner onto existing topsoil and/or filling material for mixing in will not be accepted.

36.3.5.9 All soiling, grading and construction works shall be finished to the satisfaction of the Independent Consultants before commencement of hydroseeding and planting.

Planting

36.3.5.10 The trial nursery shall be hydroseeded in accordance with GS clause 3.69 to 3.72 with seed mixes as indicated on the Drawings. After hydroseeding, fix one layer of biodegradable erosion control mat that complies with GS clause 7.98 to the soil surface before covering with protective material that complies with GS clause 3.73.

36.3.5.11 The trial nursery shall be planted in accordance with relevant clauses of the GS and this Specification with trees and shrubs as indicated on the Drawings. Planting of trees and shrubs shall not take place until the grassing has attained 90% coverage in accordance with GS clause 3.94 to 3.96 or otherwise agreed with the Employer's Representative.

36.3.5.12 The Contractor shall agree with the Independent Consultants on whether grass cutting is necessary before planting of trees and shrubs, which may be determined according to:

- the growth condition of the hydroseeded plants;
- whether the hydroseeded plants would greatly hinder the pit planting operation; and
- whether grass cutting would result in excessive bare ground.

36.3.5.13 The Contractor should note that the native trees in this trial planting are specified to be planted one (1) year after the planting of exotic trees and all shrubs, which are aimed to act as nursing species for the native trees. Refer to the Drawings for details.

36.3.5.14 Refer to Clause 3.68B of SENTX Specification Part B on details regarding planting on erosion control mat.

Establishment Works

36.3.5.15 The Contractor shall carry out establishment works to the plantings throughout the period of the Contract in accordance with relevant sections of the GS and this Specification.

36.3.5.16 The Contractor shall provide intensive care to the trial planting and ensure all planted materials are growing healthily and vigorously.

36.3.5.17 If the Independent Consultants deems that the exotic tree plantings are casting excessive shade on other plantings, the Contractor shall carry out crown thinning to the exotic tree plantings. Each session of crown thinning should remove no more than 25% live foliage of each tree, with at least 3-month interval in-between each session.

36.3.5.18 The Contractor shall, at the instruction of the Independent Consultants, replace dead and/or otherwise unsatisfactory tree and/or shrub throughout the period of the Contract at the Contractor's own cost. The replacement tree and/or shrub may or may not necessarily be the same species of their predecessor, and shall be subject to the direction of the Independent Consultants.

Monitoring

36.3.5.19 The Contractor shall be responsible for carrying out periodic monitoring inspections of the trial plantings throughout the period of the Contract, and to submit periodic trial planting monitoring reports within 5 working days after each monitoring inspections to the Independent Consultants.

36.3.5.20 Monitoring inspections shall be carried out at monthly intervals, unless otherwise directed by the Independent Consultants.

36.3.5.21 Notwithstanding the above stated monitoring frequency, the Contractor shall carry out his own inspections as frequent as necessary, so as to identify the required establishment works from time to time and carry out the works in a timely manner.

36.3.5.22 The Contractor shall submit details of the personnel responsible to carry out the monitoring and sought approval from the Employer. Unless otherwise agreed, the personnel responsible to carry out the monitoring shall have the following minimum requirements:

- Have a bachelor's degree or higher in horticulture, or a related field such as botany, biology, forestry, arboriculture, landscape studies, landscape architecture, landscape management, landscape science, from a Hong Kong university, or equivalent; and
- Have a minimum of two years of proven full-time practical experience in soft landscaping, or a related field such as horticulture, arboriculture.

36.3.5.23 The Contractor shall keep detailed and accurate records of all establishment works and any other works related to the trial planting, so as to facilitate the studying of the management intensity required for proper establishment of the trial planting. Such record could be in the form of a logbook or other agreed means, be legible, and shall be easily retrieved upon request by the Independent Consultants. The record shall contain the date, type and manpower involved for each day that establishment works and/or other related works are being carried out. If watering is being carried out, the approximate amount in litres irrigated should also be recorded. Any other details deemed required by the Independent Consultants shall also be included.

36.3.5.24 Monitoring shall be carried out in a consistent and scientific manner. Information to be recorded for each monitoring session shall include, but not limited to, the items as listed in the sample worksheets as included in Part B of Appendix 36.3.3 of this Specification.

36.3.5.25 The monitoring reports shall be in a format approved by the Independent Consultants, and shall include the following:

- The abovementioned worksheets,
- Representative photographs showing the general condition of the trial nursery;

- Representative photographs of every planted species of trees and shrubs;
- Representative photographs of the hydroseeding and ground condition;
- Any presence of naturally regenerated vegetation and/or weeds;
- Any other special features recorded; and
- Any other information deemed necessary by the Independent Consultants.

All photographs shall be date-imprinted and properly annotated. An arrow should be added to the photograph to indicate the tree or feature in concern if that tree or feature is not apparent in the photograph.

Appendix 36.3.3

Part A - Trial Nursery conceptual Layout, Trial Planting Schedule, and Trial Planting Matrix

(Clause 36.3.3A.2 of SENTX Specification Part A refers)

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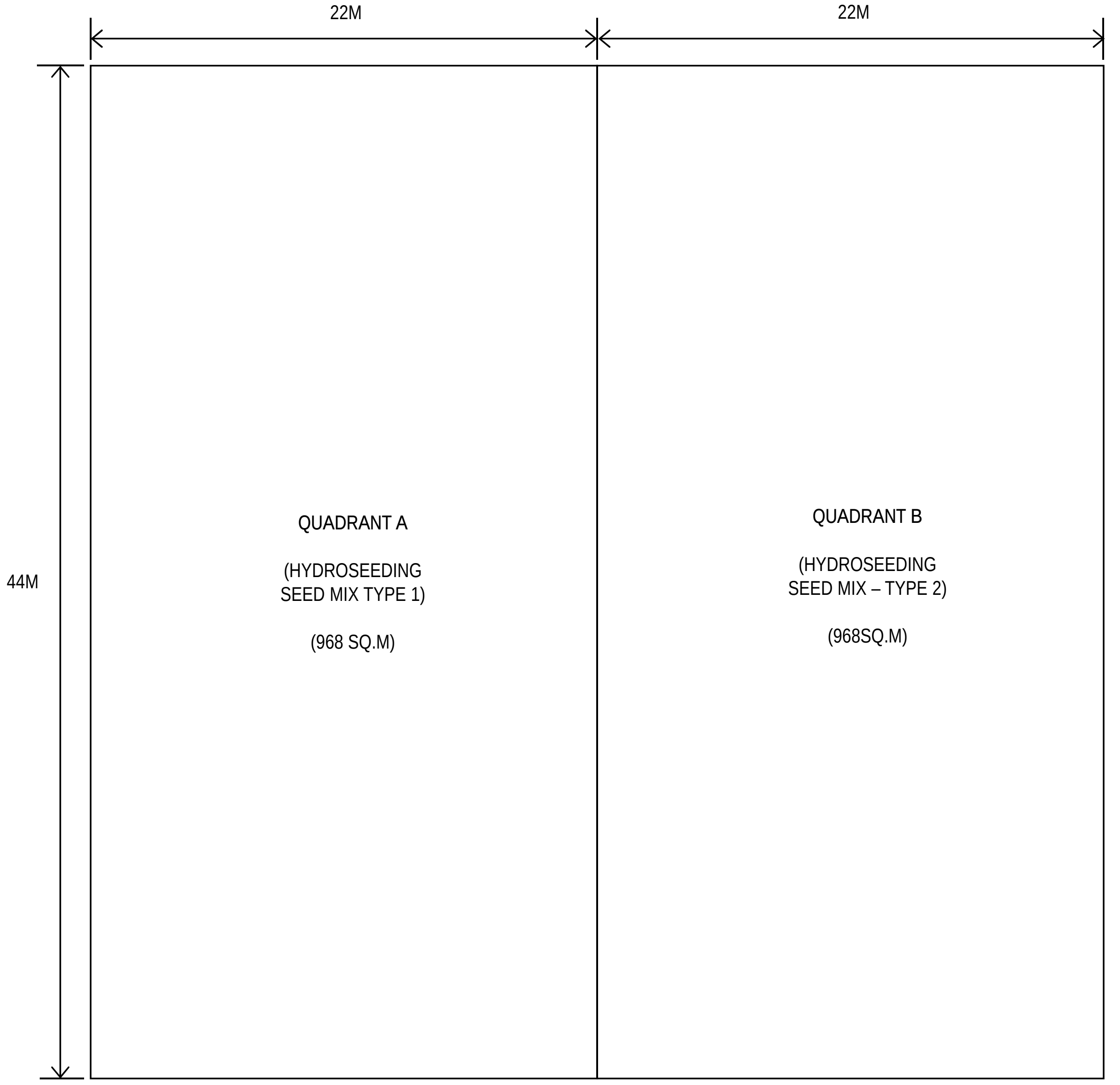


TRIAL NURSERY CONCEPTUAL LAYOUT
N.T.S.

NOTES:

1. THE CONCEPTUAL LAYOUT OF TRIAL NURSERY AS SHOWN ON PLAN IS INDICATIVE ONLY. THE CONTRACTOR SHALL PROPOSE THE EXACT LOCATION AND SUBMIT DETAILED LAYOUT TO THE ENGINEER FOR APPROVAL. DETAILED SETTING OUT SHALL BE CARRIED OUT ON SITE AND AGREED WITH THE ENGINEER PRIOR TO WORKS.

2. THE TRIAL NURSERY SHALL BE PROPOSED ON A LOCATION THAT COULD REPRESENT THE TYPICAL PLANTING CONDITION AT THE RESTORATION PHASE OF SENTX AS FAR AS POSSIBLE.

3. THE TRIAL NURSERY SHALL BE BACKFILLED WITH 1.2M DEEP SOIL MIX IN ACCORDANCE WITH GS CLAUSE 3.30 TO THE DESIGNED FINISHED LEVEL OF THE LOCATION. THE SOIL MIX SHALL BE READY AND EVENLY MIXED BEFORE DELIVERY ONTO THE SITE. SPREADING OF SOIL CONDITIONER ONTO SOIL / CDG SURFACE FOR MIXING IN WILL NOT BE ACCEPTED.

4. ALL SOILING AND CONSTRUCTION WORKS SHALL BE FINISHED TO THE SATISFACTION OF THE ENGINEER BEFORE COMMENCEMENT OF HYDROSEEDING AND PLANTING.

5. THE TRIAL NURSERY SHALL BE HYDROSEEDED IN ACCORDANCE WITH GS CLAUSE 3.69 TO 3.72 WITH SEED MIXES AS INDICATED ON PLAN. AFTER HYDROSEEDING, FIX ONE LAYER OF BIODEGRADABLE EROSION CONTROL MAT AS PER GS CLAUSE 7.98 TO THE SOIL SURFACE BEFORE COVERING WITH PROTECTIVE MATERIAL AS PER GS CLAUSE 3.73.

6. PLANTING OF TREES AND SHRUBS SHALL NOT TAKE PLACE UNTIL THE GRASSING HAS ATTAINED 90% COVERAGE IN ACCORDANCE WITH GS CLAUSE 3.94 TO 3.96, UNLESS AGREED WITH THE ENGINEER.

7. TO PLANT TREES AND SHRUBS, CUT A “T” SHAPED OPENING THROUGH THE EROSION CONTROL MAT AND CARRY OUT PIT PLANTING IN ACCORDANCE WITH RELEVANT CLAUSES OF GS & PS. THE EROSION CONTROL MAT SHALL THEN BE FOLDED BACK TO COVER THE ROOTBALL, AND SHALL NOT BE BURIED INTO THE PLANTING PIT.

APPENDIX 36.3.3, DRAWING 1: TRIAL NURSERY CONCEPTUAL LAYOUT

ARUP

EXOTIC TREES (TO BE PLANTED IN YEAR 1)

CODE	SCIENTIFIC NAME	CHINESE NAME	ORIGIN	SPECIFIED SIZE	SPACING (MM)	QUANTITY IN QUADRANT		TOTAL
						A	B	
E1	ACACIA CONFUSA	台灣相思	EXOTIC	SEEDLING TREE	1500	16	16	32
E2	GLIRICIDIA SEPIUM	格力豆	EXOTIC	SEEDLING TREE	1500	16	16	32
E3	FALCATARIA MOLUCCANA	南洋楹	EXOTIC	SEEDLING TREE	1500	16	16	32
E4	ACACIA AURICULIFORMIS	耳果相思	EXOTIC	SEEDLING TREE	1500	16	16	32
E5	MELIA AZEDARACH	苦楝	EXOTIC	SEEDLING TREE	1500	16	16	32
E6	SENNA SIAMEA	鐵刀木	EXOTIC	SEEDLING TREE	1500	16	16	32
					TOTAL:	96	96	192

NATIVE TREES (TO BE PLANTED IN YEAR 2)

CODE	SCIENTIFIC NAME	CHINESE NAME	ORIGIN	SPECIFIED SIZE	SPACING (MM)	QUANTITY IN QUADRANT		TOTAL
						A	B	
N1	BRIDELIA TOMENTOSA	土蜜樹	NATIVE	SEEDLING TREE	1500	16	16	32
N2	CELTIS SINENSIS	朴樹	NATIVE	SEEDLING TREE	1500	16	16	32
N3	CINNAMOMUM CAMPHORA	樟	NATIVE	SEEDLING TREE	1500	16	16	32
N4	FICUS MICROCARPA	榕樹	NATIVE	SEEDLING TREE	1500	16	16	32
N5	FICUS VIRENS	黃葛樹	NATIVE	SEEDLING TREE	1500	16	16	32
N6	HIBISCUS TILIACEUS	黃槿	NATIVE	SEEDLING TREE	1500	16	16	32
N7	ILEX ROTUNDA VAR. MICROCARPA	小果鐵冬青	NATIVE	SEEDLING TREE	1500	16	16	32
N8	LIQUIDAMBAR FORMOSANA	楓香	NATIVE	SEEDLING TREE	1500	16	16	32
N9	LITSEA GLUTINOSA	潺槁樹	NATIVE	SEEDLING TREE	1500	16	16	32
N10	LITSEA MONOPETALA	假柿木薑子	NATIVE	SEEDLING TREE	1500	16	16	32
N11	MACARANGA TANARIUS	血桐	NATIVE	SEEDLING TREE	1500	16	16	32
N12	MYRICA RUBRA	楊梅	NATIVE	SEEDLING TREE	1500	16	16	32
N13	PHYLLANTHUS EMBLICA	餘甘子	NATIVE	SEEDLING TREE	1500	16	16	32
N14	POLYSPORA AXILLARIS	大頭茶	NATIVE	SEEDLING TREE	1500	16	16	32
N15	PONGAMIA PINNATA	水黃皮	NATIVE	SEEDLING TREE	1500	16	16	32
N16	PYRUS CALLERYANA	豆梨	NATIVE	SEEDLING TREE	1500	16	16	32
N17	REEVESIA THYRSOIDEA	梭羅樹	NATIVE	SEEDLING TREE	1500	16	16	32
N18	RHUS SUCCEDANEA	野漆樹	NATIVE	SEEDLING TREE	1500	16	16	32
N19	SAPIUM DISCOLOR	山烏桕	NATIVE	SEEDLING TREE	1500	16	16	32
N20	SAPIUM SEBIFERUM	烏桕	NATIVE	SEEDLING TREE	1500	16	16	32
N21	SCHIMA SUPERBA	木荷	NATIVE	SEEDLING TREE	1500	16	16	32
N22	STERCULIA LANCEOLATA	假蘋婆	NATIVE	SEEDLING TREE	1500	16	16	32
N23	SYZYGIUM HANCEI	韓氏蒲桃	NATIVE	SEEDLING TREE	1500	16	16	32
N24	VIBURNUM ODORATISSIMUM	珊瑚樹	NATIVE	SEEDLING TREE	1500	16	16	32
					TOTAL:	384	384	768

NOTES:

1. SEEDLING TREES SHALL COMPLY WITH SPECIFICATION CLAUSE 3.11S.
2. DURING PLANTING SEASON OF YEAR 1, PLANT ALL EXOTIC TREES IN ACCORDANCE WITH THE SCHEMATIC PLANTING MATRIX AS SHOWN ON DRAWING 4. THE POSITIONS OF NATIVE TREES TO BE PLANTED IN YEAR 2 SHOULD ALSO BE SET OUT TO FACILITATE SHRUBS PLANTING AND FUTURE NATIVE TREE PLANTING.
3. DURING PLANTING SEASON OF YEAR 2, PLANT ALL NATIVE TREES IN ACCORDANCE WITH THE SCHEMATIC PLANTING MATRIX AS SHOWN ON DRAWING 5. AVOID DAMAGING THE ALREADY PLANTED TREES AND SHRUBS AS FAR AS POSSIBLE.

APPENDIX 36.3.3, DRAWING 2: TRIAL PLANTING SEEDLING TREE SCHEDULE

ARUP

SHRUBS (TO BE PLANTED IN YEAR 1)

SCIENTIFIC NAME	CHINESE NAME	ORIGIN	SPECIFIED SIZE	SPACING (MM)	QUANTITY IN QUADRANT		TOTAL
					A	B	
BUXUS SINICA	黃楊	NATIVE	SMALL SHRUB	750	120	120	240
CALLIANDRA HAEMATOCEPHALA	紅絨球	EXOTIC	SMALL SHRUB	750	120	120	240
HAMELIA PATENS	希美利	EXOTIC	SMALL SHRUB	750	120	120	240
IPOMOEA PES-CAPRAE	海灘牽牛	NATIVE	SMALL SHRUB	750	120	120	240
LIGUSTRUM SINENSE	山指甲	NATIVE	SMALL SHRUB	750	120	120	240
PITTOSPORUM TOBIRA	海桐	EXOTIC	SMALL SHRUB	750	120	120	240
RHAPHIOLEPIS INDICA	石斑木	NATIVE	SMALL SHRUB	750	120	120	240
RHODOMYRTUS TOMENTOSA	桃金娘	NATIVE	SMALL SHRUB	750	120	120	240
STACHYTARPHETA JAMAICENSIS	假馬鞭	EXOTIC	SMALL SHRUB	750	120	120	240
SYZYGIUM BUXIFOLIUM	赤楠	NATIVE	SMALL SHRUB	750	120	120	240
VITEX NEGUNDO	黃荊	NATIVE	SMALL SHRUB	750	120	120	240
VITEX ROTUNDIFOLIA	單葉蔓荊	NATIVE	SMALL SHRUB	750	120	120	240
				TOTAL:	1440	1440	2880

HYDROSEEDING SEED MIX - TYPE 1

SCIENTIFIC NAME	CHINESE NAME	ORIGIN	GRAM / SQ.M
CYNODON DACTYLON	狗牙根	NATIVE	15
PASPALUM NOTATUM	百喜草	EXOTIC	10
EREMOCHLOA OPHIUROIDES	假儉草	NATIVE	5
LOLIUM PERENNE *	黑麥草 *	EXOTIC	5*

HYDROSEEDING SEED MIX - TYPE 2

SCIENTIFIC NAME	CHINESE NAME	ORIGIN	GRAM / SQ.M
CYNODON DACTYLON	狗牙根	NATIVE	15
PASPALUM NOTATUM	百喜草	EXOTIC	10
EREMOCHLOA OPHIUROIDES	假儉草	NATIVE	5
CHAMAECRISTA ROTUNDIFOLIA	圓葉決明	EXOTIC	5
CROTALARIA RETUSA	吊裙草	NATIVE	5
DESMODIUM HETEROCARPON	假地豆	NATIVE	5
INDIGOFERA TINCTORIA	木藍	NATIVE	5
TRIFOLIUM REPENS	白車軸草	EXOTIC	5
LOLIUM PERENNE *	黑麥草 *	EXOTIC	5*

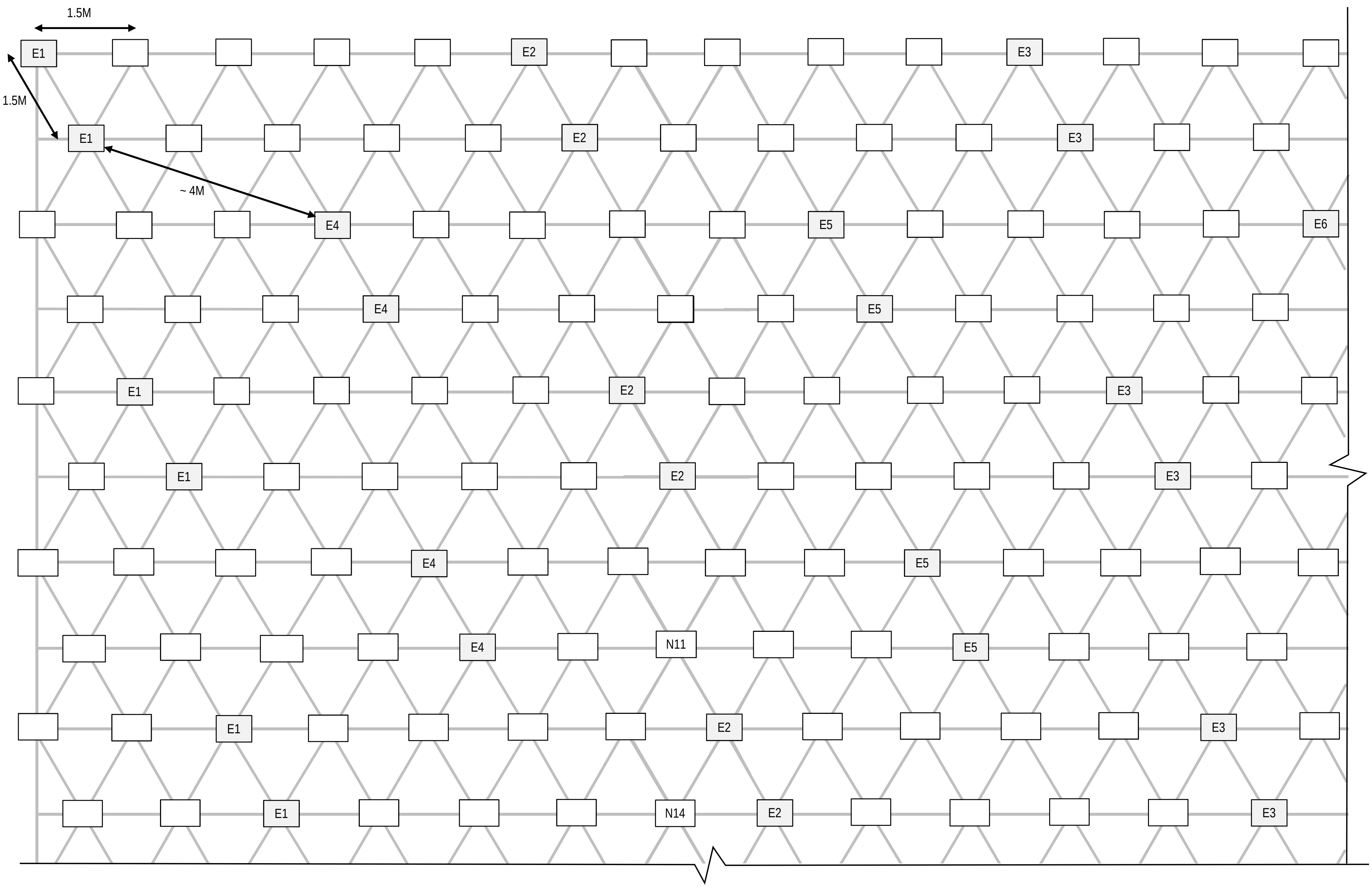
* BETWEEN SEPTEMBER AND MARCH INCLUSIVE, ADD LOLIUM PERENNE SEEDS AT A RATE OF 5 GRAM / SQ.M TO ALL SEED MIXES.

NOTES:

1. SMALL SHRUBS SHALL COMPLY WITH SPECIFICATION CLAUSE 3.17S.
2. GRASS SEEDS SHALL COMPLY WITH GS CLAUSE 3.26 (1) AND (2).
3. DURING PLANTING SEASON OF YEAR 1, PLANT ALL SHRUBS IN ACCORDANCE WITH THE SCHEMATIC PLANTING MATRIX AS SHOWN ON DRAWING 6.

APPENDIX 36.3.3, DRAWING 3: TRIAL PLANTING SHURB AND HYDROSEEDING SEED MIX SCHEDULE

ARUP



LEGEND:

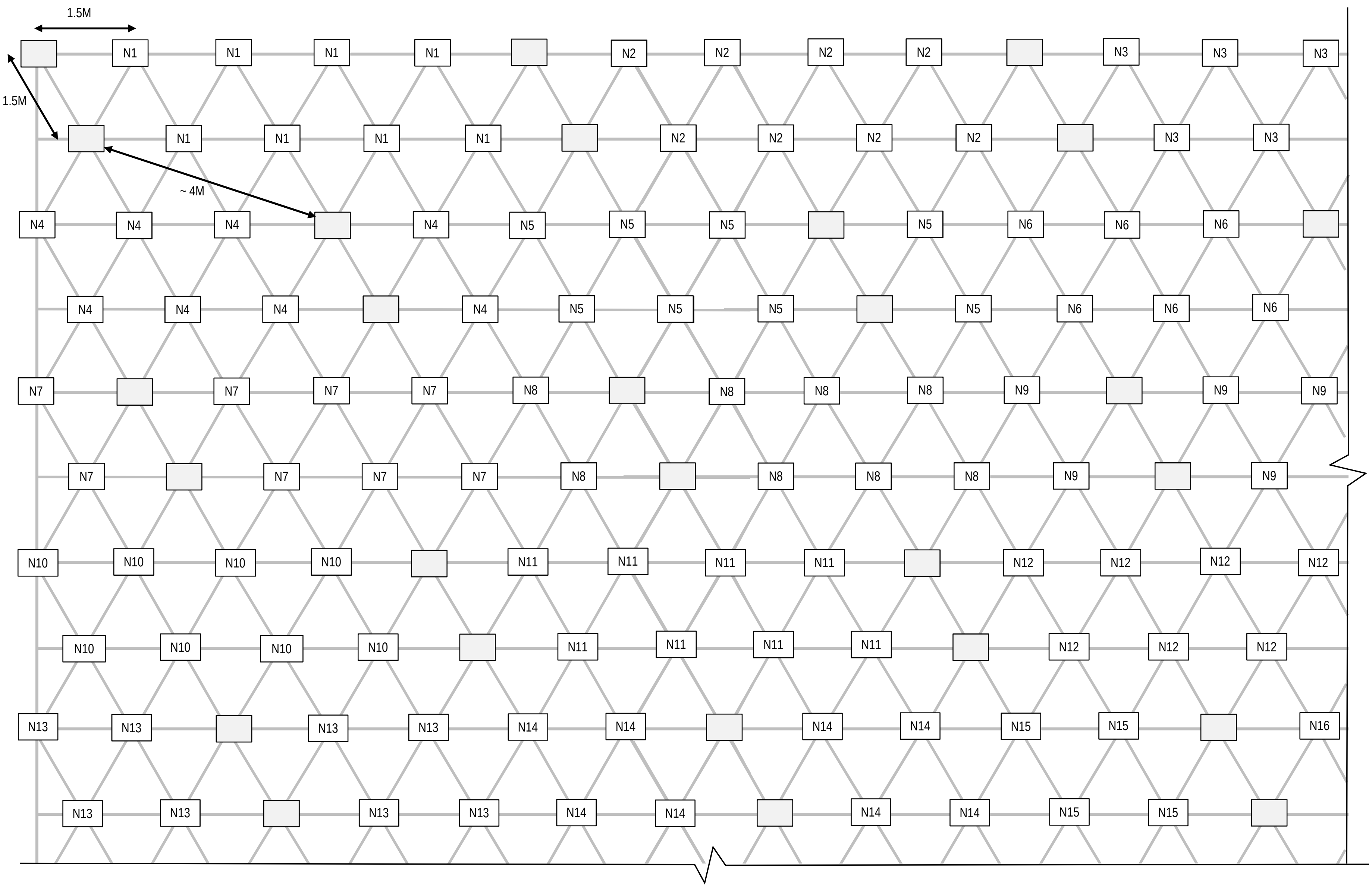
E1	EXOTIC SEEDLING TREE TO BE PLANTED IN YEAR 1
(blank box)	FUTURE LOCATION OF NATIVE SEEDLING TREE

NOTES:
1. PLANT EXOTIC SEEDLING TREES AND ALL SHRUBS IN YEAR 1.
2. THE LOCATION OF NATIVE TREES SHALL ALSO BE MARKED DURING SETTING OUT.

SEEDLING TREES SCHEHATIC PLANTING MATRIX (YEAR 1)
N.T.S.

APPENDIX 36.3.3, DRAWING 4: TRIAL PLANTING SEEDLING TREES PLANTING MATRIX (YEAR 1)

ARUP



NOTES:

1. PLANT NATIVE SEEDLING TREES IN YEAR 2, IN THE LOCATION ALREADY SET OUT IN YEAR 1.

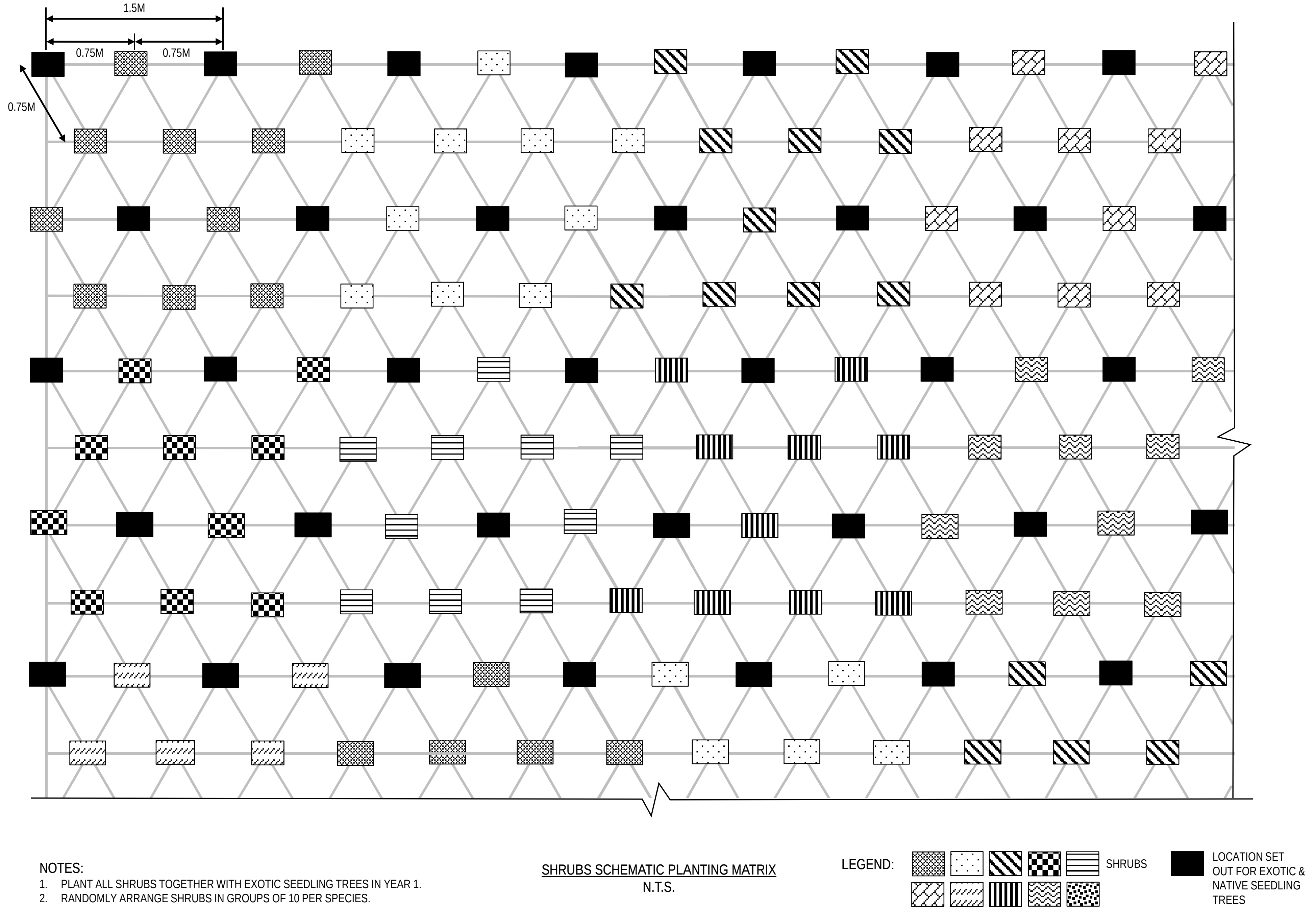
SEEDLING TREES SCHEHATIC PLANTING MATRIX (YEAR 2)
N.T.S.

LEGEND:

(grey box)	EXOTIC SEEDLING TREE ALREADY PLANTED IN YEAR 1
N1	NATIVE SEEDLING TREE TO BE PLANTED IN YEAR 2

APPENDIX 36.3.3, DRAWING 5: TRIAL PLANTING SEEDLING TREES PLANTING MATRIX (YEAR 2)

ARUP



NOTES:
1. PLANT ALL SHRUBS TOGETHER WITH EXOTIC SEEDLING TREES IN YEAR 1.
2. RANDOMLY ARRANGE SHRUBS IN GROUPS OF 10 PER SPECIES.

SHRUBS SCHEMATIC PLANTING MATRIX
N.T.S.

APPENDIX 36.3.3, DRAWING 6: TRIAL PLANTING SHRUBS PLANTING MATRIX

ARUP

Appendix 36.3.3

Part B - Trial Planting Sample Worksheet

(Clause 36.3.3A.5 of SENTX Specification Part A refers)

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SENTX Trial Planting Monitoring Worksheet

Date of Monitoring Inspection: ________________

General Description of the Condition of the Trial Planting & Trial Nursery:

SENTX Trial Planting Monitoring Worksheet

Date of Monitoring Inspection: _________________

Summary of Establishment Works Carried Out During Last Monitoring Session:

SENTX Trial Planting Monitoring Worksheet

Date of Monitoring Inspection: ________________

Exotic Trees

Code	Scientific Name	Chinese Name	Original Planted Qty	Survived Qty	Mean Height At Planting (cm)	^ Mean Height At Monitoring (cm)	^ General Health (*-V.Poor; *****-V.Good)	Additional Description / Remarks
E1	Acacia confusa	台灣相思						
E2	Gliricidia sepium	格力豆						
E3	Falcataria moluccana	南洋楹						
E4	Acacia auriculiformis	耳果相思						
E5	Melia azedarach	苦楝						
E6	Senna siamea	鐵刀木						

Notes: ^: For survived plants only.

Native Trees

Code	Scientific Name	Chinese Name	Original Planted Qty	Survived Qty	Mean Height At Planting (cm)	^ Mean Height At Monitoring (cm)	^ General Health (*-V.Poor; *****-V.Good)	Additional Description / Remarks
N1	Bridelia tomentosa	土蜜樹						
N2	Celtis sinensis	朴樹						
N3	Cinnamomum camphora	樟						
N4	Ficus microcarpa	榕樹						
N5	Ficus virens	黃葛樹						
N6	Hibiscus tiliaceus	黃槿						
N7	Ilex rotunda var. microcarpa	小果鐵冬青						
N8	Liquidambar formosana	楓香						
N9	Litsea glutinosa	潺槁樹						
N10	Litsea monopetala	假柿木薑子						
N11	Macaranga tanarius	血桐						
N12	Myrica rubra	楊梅						
N13	Phyllanthus emblica	餘甘子						
N14	Polyspora axillaris	大頭茶						
N15	Pongamia pinnata	水黃皮						
N16	Pyrus calleryana	豆梨						
N17	Reevesia thyrsoidea	梭羅樹						
N18	Rhus succedanea	野漆樹						
N19	Sapium discolor	山烏桕						
N20	Sapium sebiferum	烏桕						
N21	Schima superba	木荷						
N22	Sterculia lanceolata	假蘋婆						
N23	Syzygium hancei	韓氏蒲桃						
N24	Viburnum odoratissimum	珊瑚樹						

Notes: ^: For survived plants only.

SENTX Trial Planting Monitoring Worksheet

Date of Monitoring Inspection: ________________

Shrubs

Code	Scientific Name	Chinese Name	Origin	Approx. Survival %	Average Height At Monitoring (cm)	^ General Health (*-V.Poor; *****-V.Good)	Additional Description / Remarks
S1	Buxus sinica	黃楊	Native				
S2	Calliandra haematocephala	紅絨球	Exotic				
S3	Hamelia patens	希美利	Exotic				
S4	Ipomoea pes-caprae	海灘牽牛	Native				
S5	Ligustrum sinense	山指甲	Native				
S6	Pittosporum tobira	海桐	Exotic				
S7	Rhaphiolepis indica	石斑木	Native				
S8	Rhodomyrtus tomentosa	桃金娘	Native				
S9	Stachytarpheta jamaicensis	假馬鞭	Exotic				
S10	Syzygium buxifolium	赤楠	Native				
S11	Vitex negundo	黃荊	Native				
S12	Vitex rotundifolia	單葉蔓荊	Native				

Notes: ^: For survived plants only.

Hydroseeding

Grass Cover %:
Species Present & Their Condition:

Others

Naturally Regenerated Vegetation:
Noxious Weeds Present & Their Condition:
Additional Description / Remarks:

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