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29. HORTICULTURE

29.1 GENERAL REQUIREMENTS

29.1.1 SCOPE

Work covered under this section consists of furnishing all labour, equipment and material necessary to perform all operations required for landscaping inclusive but not limited to finished grading, supplying and spreading of soil and manures, turfing, planting/seeding/grass for lawns including supply and installation of tree guards, decorative stones, maintenance period, landscape, warranty, appliances and services necessary for and incidental to completing all the turfing operations and the associated works in a workmanship like manner, according to the provisions of the Contract.

29.1.2 QUALITY ASSURANCE

The work must be undertaken by an experienced contractor specialising in turfing work and other specified activities. Work shall be performed and supervised at all times by qualified personnel.

All materials shall be shipped with certificates of inspection as required by the Engineer-in-Charge. Manufacturer's certified analysis for standard packaged products shall be provided.

29.1.3 SUBMITTALS

The Contractor shall submit catalogue data and literature of manufacturers and suppliers.

The Contractor shall submit manufacturer's certified analysis of all standard products, including soil, fertilisers, peat, seed, inorganic and organic mulches.

The Contractor shall submit a Performance Schedule for plantation of grass and carrying out other works within fourteen (14) days of the start of the Contract. This schedule shall identify the source of procurement of grass for plantation.

The Contractor shall submit a weekly work schedule for approval before work is started. The schedule shall identify tasks to be completed on a weekly basis and the anticipated schedule for completing the tasks. The Contractor will then modify and submit the schedule on a weekly basis identifying tasks completed, tasks to be completed, problems encountered and recommendations.

If ordered a soils report is to be submitted by the Contractor for all soils to be used for preparation of ground. The Contractor shall arrange for an approved independent analyst to prepare a physical and chemical analysis of the soil and irrigation water to be used. The analyst shall also provide recommendations on soil amendment, fertiliser application and the like. The report shall be submitted to the Engineer-in-Charge for approval before soil is placed. In the case of imported soil, the report shall be submitted at least 10 days prior to delivery. The report shall identify the source(s) from which imported soils are to be furnished. At a minimum, the soil shall be analysed for:

- a) Total salts (electro-conductivity of soil solution)
- b) Soil pH
- c) Exchangeable sodium, calcium, magnesium and potassium
- d) Available phosphates
- e) Organic matter as a percentage
- f) Available zinc, manganese, iron and boron
- g) Total sulphates

The soil analysis shall also include fertilisers and other amendment requirements and quantities which when incorporated with the soil will provide the required nutrient levels for vigorous plant growth. Additional soil samples shall be taken at the rate of one in every 20 loads or as directed

by the Engineer-in-Charge and analysed. The results will be compared with the original sample to ensure consistency and compatibility of supply.

If specified, an operation and maintenance manual is to be provided by the Contractor. Instructions shall be furnished for year round care of plantation to be followed by the Owner. As a minimum, the manual will include the following:

1. Irrigation details: including water application rates and maintenance procedures
2. Fertilisation: including fertiliser descriptions, application rates and application schedule
3. Salinity control: including leaching methods and leaching program monitoring.
4. Pesticide/fungicide/herbicide applications: including safety application rates, procedures, and schedules.
5. Turf grass management: including mowing procedures, a verification, topdressing, vertical mowing for thatch removal, rolling, over-seeding and springing.
6. General maintenance: including pruning, stakes and ties, replacement and clean-up, protective fencing and grading.
7. Equipment inventory: including maintenance procedures and manufacturer's maintenance manual.
8. Landscape maintenance personnel requirements and job descriptions.

29.1.4 JOB CONDITIONS

The Contractor shall proceed with and complete grass planting operations as rapidly as possible as portions of the Site become available.

No planting shall be carried out during periods of heavy rain, sandstorms, heavy winds, or during intense daytime heat.

When special conditions warrant a variance to the planting time and conditions, a proposed planting schedule shall be submitted to the Engineer-in-Charge for review and approval. In such cases, the planting will be installed at no additional cost and all conditions and obligations such as maintenance and warranty remain the same.

29.2 SOIL

Soil shall be sweet sand or washed marine sand free of admixtures of subsoil, foreign matter, toxic substances, weeds and any material or substance that may be harmful to plant growth. The Contractor shall furnish agricultural soil from approved sites.

Material shall be stored in piles less than 1 metre high. Piles shall be protected from undue compaction and maintained free of contamination and construction debris.

The soil shall comply with the following chemical criteria:

- a) pH value: not less than 6.5 nor more than 8.5
- b) Electro-conductivity: less than 4 mmhos/cm saturated extract at 25 °C
- c) Free carbonates: less than 0.5 % air dried.
- d) Chlorides: less than 200 ppm in saturated extract.
- e) Sulphates: less than 200 ppm in saturated extract.
- f) Exchangeable sodium: less than 15 % in neutral normal ammonium acetate.
- g) Boron: less than 1.5 ppm, hot water soluble.

The soil shall comply with the grading criteria in Table 29.4(a).

Table 29.4(a)

Sieve Size (mm)	% by Pass
5.000	100
2.380	65 to 100
1.180	45 to 100
0.600	35 to 80
0.300	5 to 48
0.150	0 to 15
0.075	0 to 3

29.2.1 SOIL CONDITIONERS & FERTILIZER

Peat shall be used where specified. Peat shall be a natural product of sphagnum moss peat/peat humus derived from a freshwater site. Peat shall be shredded and granulated to pass through a 12 mm mesh screen and conditioned in storage piles for at least 6 months after excavation. The peat shall be free from sticks, stones, roots, and other objectionable matter. It shall have a pH value of not less than 4 and nor more than 7.5. The minimum organic content shall be 85% on a dry weight basis. Peat shall be delivered in undamaged commercial bales in air dry condition.

Manure shall be the decomposed animal manure of fully fermented pre-dried cow or chicken manure with minimum nitrogen, phosphoric acid and potassium percentage of 2-2-2 and a pH value of 6.0 to 7.5. Sludge waste product may be used as a substitute subject to approval of the Engineer-in-Charge. Manure and sludge shall be free of stones, sticks and non-bio-degradable material.

Fertilizer shall consist of an approved compound containing not less than

- 10% Nitrogen
- 15% Phosphoric Acid
- 10% Potash
- or similar approved compound

29.2.2 PLANTING SOIL INGREDIENTS

The planting soil in gradients shall consist of approved soil, peat, manure and other soil conditioners as specified. The ingredients shall be placed in sequence as specified to meet the requirements of grass to be planted.

29.3 GRASS PLANTATION (LAWNS)

29.3.1 SITE PREPARATION FOR PLANTING AREAS

i. General Requirements

The Contractor shall examine areas to receive grass plantation with requirements and conditions affecting performance of work in this Section. The Contractor shall not proceed with plant operations until unsatisfactory conditions are discussed with the Engineer-in-Charge and corrected.

The Contractor shall determine the location of above grade and underground utilities and perform work in a manner which will avoid damage to them. Damage to underground utilities shall be repaired at the Contractor's expense.

When conditions detrimental to the growth of grass are encountered, such as rubble, adverse drainage or obstructions, the Contractor shall notify the Engineer-in-Charge prior to

planting. The area shall be cleared of stones, pebbles, stubbles, grass roots and other injurious matters and clods shall be broken.

The following pre-planting steps shall be required for building a lawn.

- a) Careful grading makes good drainage so that lawn won't puddle and develop spots that are water logged and soft, or hard and dry.
- b) Incorporating organic matter and other soil amendments which are needed for proper growth and easy maintenance.
- c) Blending of top soil with native soil is done to make a transitional layer between top soil and native soil as it avoids trapping roots in a shallow top soil basin in which they would be dependent on frequent feeding and very frequent watering.

The Engineer-in-Charge shall verify that sub-grades are as specified.

ii. Sub-Surface Grading

All perennial weeds shall be treated with an approved herbicide and the period of timerecommended by the manufacturer shall be allowed to elapse prior to commencing gradingoperations.

Grading operations shall occur when the sub-soil is reasonably dry and workable.

Areas to be graded shall be graded to smooth flowing contours with all minor hollows andridges removed. Rock projections and boulders shall be removed and disposed of at a location agreed with the Engineer-in-Charge.

Non-cohesive, light subsoil shall be loosened with a 3-tine ripper to a depth of 300 mm at 600mm centres. Stiff clay and other cohesive subsoil shall be loosened with a single tine ripper to a depth of 450 mm. at 1 m. centres.

A minimum of 150 mm of approved soil in accordance with 29.2 shall be spread uniformly over the loosened area andincorporated into the sub-grade soil to obtain a uniform and well pulverised soil mix. The area shall be compacted to a minimum of 90 % of maximum dry density as determinedin accordance with Test 13 of BS 1377.

iii. Finished Grading

Grades shall be brought to the finished ground levels agreed with the Engineer-in-Charge to a tolerance of ± 25 mm. Finished ground levels shall be 30mm below adjoining paving or kerbs after compaction and settlement. Grading shall becarried out in such a manner that even gradients are formed between the spot levels with a pleasant contour. No depressions shall remain which could collect standingwater.

Soil shall be placed in lifts not greater than 150 mm in thickness.

The filled area shall be compacted to a minimum of 90% of maximum density as determinedin accordance with Test 13 of BS 1377. The manure shall be spread uniformly for the specified thickness.

iv. Scalping Old Lawns

The old lawn contains noxious weed grasses as Bermuda grass and old sod shall be stripped off with flat back spade before building a new lawn. The existing sod shall not be dug into soil as clumps of buried sod.

v. Making the lawn bed smooth

A lawn bed shall be as smooth and flat as possible. However it should have slight pitch, even in flattened garden. Figure on fall of 6 to 12 inches in 100 feet so that water can run off once the root has reached its saturation point.

29.3.2 SEEDING A PREPARED LAWN BED

Divide the amount of seed necessary for the area into four equal portions, so that there are four approaches over the seed bed. Divide the seed bed half by running a string down the middle. Broadcast one quarter portion down each half, spreading it evenly and uniformly within each marked area. Then run the string across the middle of the lawn in the opposite directions and scatter the remaining two quarter portions on the two halves.

Broadcast the seed on the prepared lawn bed while the air is quite. It shall be done with hand or mechanical seeder.

After the seed is broadcast, rake it in lightly to ensure a thorough contact of seed with seed-bed soil. Very lightly brush up the seeded surface with a wire rake using light circular motion so that the seed is dispersed evenly. In case there are concentrated patches, swirl them out lightly into the surrounding area to make an even covering. At this stage, do the cross raking and mulching in flat soled shoes, tennis shoes, or barefooted.

In case of hot dry weather or drying winds, in the 30 days after sowing, apply a thin, moisture holding mulch, over the seed. After seeding and cross raking, put on a 1/8 to 1/16 inch layer of peat moss of screened sawdust that has been aged at last one year. Don't toss it upward so that it falls in piles.

Whatever the covering, roll it smooth with a light roller (empty) after you have applied it. If a peat moss covering is lumpy, chop up the lumps with the back side of a wire rake before rolling.

For initial watering, use adequate length of hose to get all the way around the lawn without dragging across it and a hand sprinkler that throws out a through but gentle spray. An hour a day for 20 to 30 days of watering shall be needed when days are warm and windy, waters 2 to 3 times a day to keep the surface continuously wet and keep the top dark with moisture until all the grasses are up.

If seeds and mulch happens to wash off on to an adjoining paved area, don't attempt to blast them back into place with the spray as it may washout more seeds along the sides of the seedbed.

After the first week, the little seeding will have gained enough stature to take a bending. It is possible at that time, to pull the weeds that come up with the seeds, lay a plank out across the seedbed and walk along it to pull the weeds.

Mow the lawn first time, when the grass is about 2 inches high or when the blades of grass take on a noticeable curvature. Bent grasses that are to be cut at 1 inch height should never be allowed to grow much higher than 1 inch. It is important that the mower be sharp at all times.

29.3.3 SEEDING ON A SLOPE

Lawns can be planted successfully on the ground that slopes upto 15%. If the slope is steeper, a ground cover or a system of terraces would be more satisfactory.

Prepare the seedbed as described in specifications 29.2.2.with following special care;

When racking the seed bed, rake across the slope, when rolling the seed bed, roll it up and down. Burlap or specially manufactured anti-erosion net spread over a newly seeded slope will keep moisture in the ground and prevent seed from washing away. If burlap is of a tight weave, remove it as soon as the grass begun to come up. Anti-erosion net or loose weave burlap can be left in place to vet. Sprinkler system can be used if the slope can be covered with burlap and holes are cut for the sprinklers head. Otherwise water the seedbed by hand, standing at the bottom of the top. Don't use sprinklers for at least two weeks and then run them slowly to avoid puddling or washout.

If erosion is likely to be a problem, install a drain scraper across the top of the slope to carry water off to one side.

Sodding with desired permanent grasses is a good solution where an immediate erosion hazard exists.

29.3.4 SODDING A PREPARED LAWN BED

i. Shipping and Delivery

Prior to shipping the grass to be planted shall be inspected, dug, and made ready for shipping in accordance with standard practices and procedures. The Engineer-in-Charge shall be notified of the delivery schedule in advance so the grass may be inspected upon arrival at the Site.

All unacceptable grass shall be removed from the Site immediately. The Engineer-in-Charge may request inspection at the source prior to delivery of grass to the Site. The Engineer-in-Charge reserves the right to reject any delivery that does not meet the quality requirements.

ii. Storage

Grass shall be installed as soon as possible after delivery to the Site. Grass shall be protected from exposure to wind and direct sunlight prior to installation. Grass not installed on the day of arrival shall be stored in shaded areas, protected from the wind and maintained and watered to good horticultural standards until planted. Care shall be taken to ensure that the grass does not dry out.

Seed and fertilisers shall be kept in dry storage away from contaminants in areas as designated or approved by the Engineer-in-Charge.

Soil, compost, fertilisers and other amendments shall be delivered to the Site and stored separately in approved locations and in a manner to avoid contamination and wetting until soil mixing operations commence.

iii. Procedure

Unroll the sod on prepared soil, lay the strips parallel with the strips staggered as in the brick layer running bond patterns. Press each successively laid strip snugly up against the one next to it.

After the sod strips are all laid in this fashion, roll the sod with roller half filled with water to smooth out rough spots and bond the sod with soil.

Now water a little more carefully than usual for a few days till the grass is set.

29.3.5 SPRINGING OR PLANTING GRASS ROOTS

i. Grass Materials

Grass sprigs shall be provided as healthy living stems stolons or rhizomes with attached roots including two to three nodes. They shall be 5 to 15 mm long without adhering soil. The limitation of time between harvesting and planting of sprigs shall be 24 hours. Sprigs shall be obtained from heavy and dense turf, free from weeds. Sprigs that have been exposed to heat and excessive drying will be rejected. Sprigs shall be planted at 150 mm apart in both directions.

Grass seed shall be the latest season's crop and shall be delivered in original sealed packages bearing the producer's guaranteed analysis for percentage of mixtures, purity, weed seed content, and inert material. Seed that has become wet, mouldy, or otherwise damaged will not be acceptable.

On-site seeding shall be done in the presence of the Engineer. The seed mixture shall be sown at the rate of 35 g/m². Grass seed mixtures shall be listed by schedule with information as follows:

- a) botanical name
- b) common name
- c) proportion by weight
- d) minimum percentage of pure seed
- e) minimum percentage of germination
- f) maximum percentage of weed seed

Turf shall be strongly rooted, not less than 2 years old, free of weeds and undesirable native grass. Only turf that is capable of vigorous growth and development when laid shall be used.

Turf shall be of a uniform size in width and length. Broken pads or pads with uneven ends will not be acceptable.

ii. Grass Sowing

- (i) The soil shall be suitably moistened and then the operation of planting grass shall be commenced. The grass shall be dibbled at 10 cm, 7.5 cm, 5 cm apart in any direction or other spacing as specified to a depth of 15 cm. Dead grass and weeds shall not be planted. The Contractor shall be responsible for watering and maintenance of levels and the lawn for 30 days or till the grass forms a thick lawn free from weeds and fit for mowing whichever is later.

Generally planting in other direction at 15 cm, 10 cm, spacing is done in the case of large open spaces, at 7.5 cm spacing in residential lawn and at 5 cm spacing for Tennis Court and sports ground lawn.

- (ii) During the maintenance period, any irregularities arising in ground levels due to watering or due to trampling by labour, or due to cattle straying thereon, shall be constantly made up to the proper levels with earth as available or brought from outside as necessary. Constant watch shall be maintained to ensure that dead patches are replanted and weeds are removed.

29.4 IRRIGATION WATER

29.4.1 SALT CONTENTS

Irrigation water shall be provided by the Contractor from a source approved by the Engineer-in-Charge as being suitable for irrigation. Water shall be free from substances harmful to plant life. Water sources shall not exceed the following parameters:

- a) pH : 6 to 7
- b) total dissolved solids : less than 1000 ppm

29.4.2 CAPACITY

Each soil type has its own water holding capacity. The larger the soil particles, the less will be its water holding capacity.

Here is the capacity of 100 square feet of soil, 1 foot deep

- i) In Sand - 60 Gal. = 1" deep irrigation
- ii) In Loam - 60 Gal. = 1-1/2" deep irrigation
- iii) In Clay - 160 Gal. = 2-1/2" deep irrigation

Obviously the lighter soil must be watered more frequently than the heavy soil in order to keep moisture in it. In good deep soil grass roots will go down to from 24 to 30 inches, depending upon the type of grass, its age (a lawn root system goes deepest during the first year or two), and how the soil is watered. The root depth is however limited if the top soil is under laid with a layer of soil that is impervious to water.

29.4.3 RATES OF WATER LOSS

The average water loss in mild summer areas is about 1 inch of water each week. In the hot localities, especially when a dry wind is blowing, the weekly loss increases to 2 inches and more in a week.

29.4.4 HOW DEEP DOES THE WATER GO

In dry soil one inch of water will penetrate as follows:

- i) In Sand -12"
- ii) In Loam -6"
- iii) In Clay -4" to -5"

Water does not move down through soil until each soil particle has its film of water. After each particle has its quota, the additional water is free to move on the external particle. How deep one inch of water will penetrate depends on the moisture in the soil when water is applied.

For example an open field with a clay soil that was completely dried out by the time of a rain, had to receive 10 inches of rain before it becomes wet to a depth of 3 feet. But an added inch of water would penetrate 3 feet and more if the first were saturated.

29.4.5 INTERVALS FOR WATERING OF LAWN

Alternate wetting and partial drying out of soil, encourage healthier plant growth and deeper rooting in hot summer areas.

Normally the soils would need more than 1" deep irrigation every week depending upon the penetration, aeration and the wilting coefficient of soil. Deep watering once a week shall be preferable which is however practicable only in canal irrigated area. In other areas light irrigation is resorted every 2nd or 3rd day or daily sprinkling.

29.5 LAWN MAINTENANCE DURING PLANT ESTABLISHMENT PERIOD

The Contractor shall be responsible for maintenance of lawn as specified. Maintenance shall consist of watering, fertilising, weeding, mowing, trimming and other operations as required to establish a smooth acceptable lawn free of eroded or bare areas. If required, the Contractor shall apply maintenance fertiliser after the second mowing. Any additional fertiliser shall be added when grass is dry. After application of the fertiliser, the area shall be watered well.

The Contractor shall maintain lawns for not less than the period stated below and longer as required to establish an acceptable lawn.

Seeded lawn areas shall be maintained through three (3) maintenance cuttings but not less than sixty (60) days after substantial completion.

Sprigged and turfed lawn areas shall be maintained through two (2) maintenance cuttings but not less than thirty (30) days after substantial completion.

29.6 FINAL ACCEPTANCE

Prior to the completion of the plant establishment period, a preliminary inspection shall be undertaken by the Engineer-in-Charge. The time for this inspection shall be established in writing.

The plant establishment and warranty period will end with this inspection provided the grass is growing in healthy condition. The Contractor shall repair any damages and defective turf shall be replaced. Replaced plants will be of the same size and species as originally specified.

A final inspection, if required, shall be undertaken by the Engineer-in-Charge to determine that the deficiencies noted in the preliminary inspection have been corrected. The time for this inspection shall be established in writing.

29.7 DECORATIVE BOULDERS

The stone boulders for placement in lawns shall be of size and shape as specified. The stones shall be of quartzite from river gravel limestone, sandstone from quarry as approved by the Engineer-in-

Charge. Stones shall be hard sound durable and free from weathering and defects and patches of loose or soft materials that may adversely affect strength and appearance.

The stones shall be placed in lawn as specified. The procurement shall be on the basis of sample stones presented by Contractor and approved by the Engineer-in-Charge.

29.8 TREE GUARDS

29.8.1 GENERAL

Tree guard shall be as specified and approved by the Engineer-in-Charge.

29.8.2 BITUMEN DRUMS GUARDS

Bitumen Drum shall be free of damage or any weathering. The drums shall be perforated as specified and painted with alternate lines of black/white enamel paint of an approved brand.

29.8.3 RCC GUARDS

RCC guards shall be of specified sizes and shape and produced complying with the requirements of Section 5 – Plain and Reinforced Concrete. The guards shall be given three inside and outside white washing coats complying with the provisions of Clause 15.3 – White Washing of Section Finishing. The guards shall be cast to the length shown on drawings and shall have a smooth surface.

29.8.4 SOLID BLOCK MASONRY GUARDS

Solid Block Masonry Blocky Guards for trees shall be of Block Masonry for the size and shape as specified with perforations as shown. The Block masonry shall comply with the provisions of Section – 9 Block Masonry. In general the perforations shall be 33% of the surface area of guards. The foundation shall be of 1:2:4 Plain Concrete as shown in Drawings complying with the requirements of Section 5 – Plain & Reinforced Concrete.

29.8.5 BRICK MASONRY GUARDS

The Brick Masonry Guards for trees shall be of size and shape as shown on Drawings complying with provisions of Section 11 – Brickwork. The white washing shall comply with applicable provisions of Section 15 – Finishes.

29.8.6 STEEL FRAME TREE GUARD

Steel frame Tree Guard shall be of size and shape as specified made of ASTM-A36 steel sections. The members shall be framed by welding according to AWS Code as specified using AWS 7016/7018 electrodes. The tree guards shall be given two coats of enamel paint over a primer as specified in accordance with applicable provisions of Section 15 – Finishes.

29.8.7 G.I. BARBED WIRE

GI barbed wire where specified shall be fixed as shown on Drawings. The work shall comply with applicable provisions of Sub-Section 28.1.7 under - Iron Steel & Aluminium Works.

29.9 MEASUREMENT AND PAYMENT

29.9.1 COMPOSITE RATE

The measurement and payment for the items of the work of horticulture hereof shall be made corresponding to the applicable CSR item as provided in Contract Agreement and shall constitute full compensation, for procurements, transportations, performance in all respect and completion of work as specified including the site clearance as approved by the Engineer-in-Charge.

29.9.2 LABOUR RATE

The measurement and payment for the items of the work of horticulture hereof shall be made corresponding to applicable CSR item as provided in Contract Agreement and shall constitute full compensation for procurements transportations, performance in all respect and completion of work

as specified including site clearance, as approved by the Engineer-in-Charge except the cost of materials to be provided by Department at designated location as defined in the Contract Agreement.

29.9.3 QUANTIFICATION

The unit of measurement shall be measured as mentioned below in accordance with corresponding CSR items.

1. For Volumetric items, the unit of measurement shall be cubic meter or cubic foot. Following items of CSR are measured in the above mentioned criteria;
Item No.: 29-13
2. For surface area items, the quantity of work shall be measured by surface area. The unit of measurement shall be Square meter or Square foot. Following item of CSR are measured according to this criteria;
Item No.: 29-1, 29-11, 29-12
3. The following Items of CSR shall be measured as Weight units i.e. Kilogram or Pound
Item No.: 29-20
4. The following items shall be measured as Each
Item No.: 29-14 to 29-19