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ARAB ENGINEERING BUREAU

4 SOIL PREPARATION AND SOILMIXES

4.1 GENERAL REQUIREMENTS

4.1.1 Scope

- 1 General. Work covered under this section consists of furnishing all management, labour, equipment, materials, products and accessories necessary to perform all operations required for soil preparation and soil mixes herein specified.
- 2 Inclusive Work. Soil preparation is inclusive but not limited to the supply of all necessary components and soil amendments, whether in bulk or packaged, for the formulation of specified soil mixes suitable as a planting medium, irrigation water; testing of soils, materials and irrigation water samples. Work under this Part includes completing all soil preparation and mixing operations in a workmanship like manner, according to the provisions of the Project Documentation. In addition, work shall be according to best industry practices and international standards in horticulture and landscape contracting
- 3 Related Sections. The Contractor shall ensure full coordination with all other trades, disciplines, and work onsite that relate to the following:

- | | |
|------------|---------------------------------|
| Section 06 | Road works |
| Section 14 | Roofing |
| Section 12 | Earthworks Related to Buildings |
| Section 20 | Drainage Works for Buildings |
| Section 21 | Electrical Works |
| Section 27 | External Works |
| Section 28 | Landscape Irrigation |

4.1.2 References

- 1 The following standards are the minimum for work under this Part.
 - ASTM C136.....Standard Methods of Sieve and Screen Analysis of Fine and Coarse Aggregates
 - ASTM C516.....Specification for Vermiculite Loose Fill Thermal Insulation
 - ASTM C549.....Specification for Perlite Loose Fill Insulation
 - ASTM D422.....Standard Methods of Particle Size Analysis of Soils
 - ASTM D2607.....Standard Classification of Peat, Mosses, Humus, and Related Products
 - AS 3743Potting mixes. Standards Australia, Sydney Australia
 - AS 4419Soils for landscaping and garden use. Standards Australia, Sydney Australia
 - BS 1377Method of test of soils for civil engineering purposes

Environmental Guidelines, Use and Disposal of Bio-Solids Products, Environmental Protection Agency, NSW, Australia, Kirchhoff C, Malina J and Barrett (2003)

Characteristics of Compost: Moisture Holding and Water Quality Improvements. CRWR On-line Report, Centre for Water Resources, University of Texas, Austin

4.1.3 Quality Assurance

- 1 Compliance. Components and materials used for formulated soil mixes, and soil preparation conform to the relevant requirements of the respective standards, unless otherwise directed by the Engineer.

- 2 Experience. Work under this Part must be undertaken by an experienced subcontractor specialising in landscape work. Work shall be performed and supervised at all times by qualified personnel.
- 3 Certificates. All materials and products, whether in bulk or packaged, shall be shipped with certificates of inspection as required by the Engineer. Manufacturer's certified analysis for standard packaged products shall be provided.
- 4 Quality. Defective or unacceptable products and materials shall be considered to be any that are either:
 - (a) from an unapproved source or supplier
 - (b) unaccompanied by a certificate attesting to source and quality parameters.
 - (c) delivered in open, unlabelled, damaged, unsealed, or wet packaging.
 - (d) not in accordance with the Project Documentation [e.g., not the specified material, unauthorized substitute, contaminated material]

4.1.4 Submittals

- 1 Catalogs and Technical Product Literature. The Contractor shall submit catalogue data and literature of manufacturers and suppliers.
- 2 Manufacturers' and/or Suppliers' Certified Analyses. The Contractor shall submit manufacturers or suppliers' certified analysis of all standard products and materials. The certificates of origin for such shall clearly state that the product is used in the manufacturer's country.
- 3 Such analyses shall include quality certifications from independent third-party laboratories attesting to the physical and chemical properties of the materials and products.
- 4 Product and Material Certificates. The Contractor shall submit certificates confirming the type of product, its origin or source, properties, and that the same are free from debris, weeds and insects.
- 5 Samples that are representative of the material or product as so required by the Engineer shall be provided in labelled packaging, indicating material type, source, manufacturer or supplier, certified properties and analysis as a reference benchmark of quality.
- 6 Authority Approvals. The Contractor shall ensure that all materials and products for work under this Part, including irrigation water have the required authority approvals affixed.
- 7 Method Statements. The Contractor is to submit his method statements as required for work or parts of the work in this Part for the approval of the Engineer.
- 8 Materials Procurement Schedules. The Contractor shall submit such Materials Procurement Schedules within fourteen (14) days of the start of the Contract.
- 9 Weekly Work Schedules. 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 additional to a monthly report contains all the above in details.
- 10 Notice of Works for Approvals. A Notice of Work shall be submitted by the Contractor for all soils preparation and soil mixing works for landscaping prior to the proposed work. The Notice shall be for the Engineer's approval prior to commencing any works, and shall include:

- (a) **Certification of Material Properties.** The Contractor shall arrange for an approved independent third-party testing laboratory to attest to the physical and chemical properties of the soils, amendments and irrigation water to be used.
- (b) In the case of imported soils, the Notice shall be submitted at least **ten [10]** days prior to delivery. The Notice shall identify the source(s) from which imported soils are to be furnished. At a minimum, the materials shall be analysed for:
- (i) Total salts, as EC [i.e., as electro-conductivity of soil solution], for soils and irrigation water
 - (ii) pH, for soils and irrigation water
 - (iii) Sodium absorption rate, SAR
 - (iv) Particles size and texture
 - (v) Bulk density
 - (vi) Wettability
 - (vii) Permeability
 - (viii) Chloride content
 - (ix) Free carbonates
 - (x) Nitrates
 - (xi) Total Phosphorus
 - (xii) Boron
 - (xiii) Pathogens and heavy metals, to comply with US-EPA Standards
 - (xiv) Inert as percentage
 - (xv) Exchangeable Sodium, Calcium, Magnesium and Potassium
 - (xvi) Available phosphates
 - (xvii) Organic matter as a percentage
 - (xviii) Available Zinc, Manganese, Iron and Boron
 - (xix) Total Sulphates
- (c) **Corrective Measures.** For materials found to be deficient or non-compliant to the above, the laboratory shall also provide recommendations on corrective measures [e.g. The addition of soil amendments, fertiliser, micro-nutrients to the required rates] suitable for vigorous plant growth. The Report shall be submitted to the Engineer for approval before soil is placed.
- (d) **Sampling for Compliance.** Additional soil samples shall be taken at the rate as directed by the Engineer and analysed. The results will be compared with the original sample to ensure consistency and compatibility of supply.
- 11 An Operations and Maintenance [O+M] Manual is to be provided by the Contractor, well organized into Sections or Volumes as specified in Part 1, Landscaping of this Section 28.
- 12 Instructions for work under this Part shall be included and clearly identified in the O+M Manual, as part of landscape planting and subsequent landscape maintenance operations.
- 4.1.5 Job Conditions**
- 1 Working in Parts to Completion. The Contractor shall proceed with and complete soil preparation and mixing operations as rapidly as possible as portions of the site become available, working within seasonal limitations for each type of landscape work required.
- 2 Adverse Conditions. No work under this Part shall be carried out during periods of heavy rain, sandstorms, heavy winds, or during intense daytime heat.

- 3 Variance in Soil Preparation and Mixing Times. When special conditions warrant a variance to the planting time and conditions, the soil preparation and mixing shall be coordinated and scheduled with such times. Submit a schedule for such variance for the approval of the Engineer.
- 4 Precedence of Planting
 - (a) **Coordinate with Planting Precedence.** Schedule soil preparation and mixing ahead of planting schedules. Precedence of planting shall be as specified in **Part 1, Landscaping** of this Sec 28.
 - (b) **Coordinate With Irrigation Works.** Schedule soil preparation and mixing works with irrigation works.

4.2 SHIPPING, DELIVERY, STORAGE AND HANDLING

4.2.1 Shipping and Delivery

- 1 Record of Deliveries. Logs of all materials and products shipped and delivered onsite shall be kept and accurately logged and maintained in an organized record of deliveries, containing details of items and delivery dates and times, including those which had been rejected for removal off the site.
- 2 Inspections
 - (a) **Pre-Shipping Inspections.** Prior to handling and shipping, all materials shall be inspected in accordance with standard horticultural practices and procedures. The Engineer shall inspect all materials at the source prior to delivery to the Site. The Engineer shall be notified of the delivery schedules in advance so material can be inspected upon arrival at the Site.
 - (b) **Non-Waiver of Inspections.** Inspections of materials prior to shipping does not constitute a non-waiver of inspections of the same upon delivery onsite.
 - (c) **Rejected Deliveries Onsite.** All delivered materials and products that have been deemed non-conforming and unacceptable shall be segregated and removed from the site immediately. The Engineer reserves the right to reject any that does not meet the quality requirements of the Project Documentation.

3 Protection While in Transit

- (a) **General.** At all times, the Contractor shall protect materials and products while in transit. The load shall be properly secured and covered against spillage and loss
- (b) **Packaged Products and Materials** shall be delivered to the site in original unopened containers bearing the product type and trade name, manufacturers or supplier's guaranteed physical and chemical properties, name, and origins, dates of manufacture or packing and dates of expiry.

4.2.2 Storage

- 1 **Records of Storage.** Logs of all materials and products kept in storage onsite shall be kept and accurately logged and maintained in organized records of item inventory, quantities and containing details and delivery dates and times.
- 2 **Protection of Materials Onsite**
 - (a) Bulk Materials. Soil, compost, other organic materials, and other mineral amendments supplied and delivered in bulk shall be delivered to the Site and stored separately in approved locations and in a manner to avoid wetting and contamination from sand, debris, weeds, weed seed and other materials until soil mixing operations commence.

- (b) Packaged Products and Materials. Fertilisers, mineral soil amendments, compost in packaging, shall be delivered to the site in the manufacturer's or supplier's original unopened packaging or containers, each fully labelled, conforming to applicable regulations and bearing the trade name, production and expiry dates and warranty of the producer. All products if stored by the Contractor onsite shall remain his responsibility.

4.2.3 Handling

- 1 General. Materials and products onsite to be moved for preparing and mixing soil mixes shall be handled that can be quickly worked in batches. Care shall be taken such that materials shall not be contaminated by debris, weeds and undesirable material.
- 2 Expired Material. Products [e.g., chemicals, fertilizers, soil amendments] shall not be used in the project and shall be monitored and clearly segregated from the rest in storage to be removed immediately from the site. Logs of expired and about-to-expire [e.g., within three (3) months of expiry] products and materials shall be kept and maintained.
- 3 Original Packaging. Prior to disposal off the site, any original bags, packaging or containers of used products and materials [e.g., fertilizer, chemicals, soil amendments] shall be temporarily and neatly stored in a designated location with labels intact for the purpose of inspection by the Engineer to verify measurement or re-measurement of quantities consumed for the project.

4.3 PRODUCTS AND MATERIALS

4.3.1 GENERAL REQUIREMENTS

- 1 Certified True and Correct. All materials, products and accessories shall conform to the Project Documentation and be certified and guaranteed to be true and correct as established best practice in the international horticultural trade.
- 2 Substitutions shall only be made when an alternative as specified, is not commercially nor practically obtainable and the Engineer authorises a change order providing for use of the nearest equivalent obtainable.

4.3.2 BULK SOILS

- 1 General. These are materials sourced raw in bulk to be used for the formulation of soil-mixes. These shall require the mixing-in of approved amendments or conditioners to render them suitable for use as a planting medium.
- 2 Dune Sand. Pure raw dune sand shall be sourced from authority-approved quarries in designated locations.
- 3 Quality. Dune sand shall be free from excessive salts, weeds, stones, debris, rubble or other deleterious material. It shall be taken from a maximum depth of 500 mm, having removed any surface crust and gypsum-ferrous accumulations.
- 4 Salt Leaching. Irrigate at maximum rate for two [2] days before using into the mix to leach out any salts.
- 5 Physical Characteristics. Dune sand shall, at the minimum have the following physical properties of particle size, as in Table 1.

Table 1,
Particle Size Sieve Analysis

| Sieve Size | % of Material Passing |
|--------------|-----------------------|
| No 10 sieve | 100% |
| No 35 sieve | 85 to 100% |
| No 200 sieve | T 10% |

6 Chemical Characteristics. Dune sand shall at the minimum have the following characteristics.

- (a) Salinity (ECE x 1000, less than 4)
- (b) SAR (Sodium Absorption Ratio), less than 2
- (c) Boron (saturation extract), less than 1.0 ppm
- (d) pH between 6.0 – 8.5
- (e) free carbonates, less than 0.5% air dried soil.
- (f) Chlorides, less than 200 ppm in saturation extract
- (g) Sulphates, less than 15% in neutral saturation extract
- (h) Nitrates, less than 75 ppm in saturation extract
- (i) Phosphorous, 10 – 15 ppm in 1.5 ammonium nitrate extract (½ hour shake)
- (j) Exchangeable sodium, less than 15% in neutral normal ammonium acetate
- (k) Potassium, 100 – 400 ppm in 1.5 ammonium nitrate extract (½ hour shake)
- (l) Magnesium, 25 – 100 ppm in 1.5 ammonium nitrate extract (½ hour shake)
- (m) Heavy Metals shall comply with USEPA Standards

7 Loamy Sand. Loamy sand shall have a particle sieve size less than 0.002 mm.

8 Clay. Clay shall be sourced from an authority-approved designated location. Clay shall have uniform composition and structure, a lean clay character, and be free from roots, stones, debris, rubble and clods larger than 50 mm in greatest dimension, pockets of coarse, sand, noxious weeds, sticks and other litter. It shall not be infected with nematodes or other undesirable insects and plant disease organisms. Prior to mixing all lumps shall be thoroughly broken up.

4.3.3 SOILMIXES

- 1 General. These are either proprietary processed products or custom-mixed formulations to the following specifications suitable for use as planting media for universal application in parks, streetscapes and open spaces.
- 2 The resulting planting soil mix, consisting of approved bulk soil and amendments [e.g., Coco peat, organic compost, pasteurized sludge pellets and other soil conditioners] shall be as specified in the Project Documentation.
- 3 Alternative Soil mixes. The approved soil mix shall be as from any of the specified alternative soil mixes provided in this Part.
- 4 Depending on the nature of the project or the project's complexity, more than one [1] alternative soil mixes may be used, upon approval by the Engineer.

- 5 Alternative A, Dune Sand Soil mix. This shall be a formulated mixture of max 75% dune sand, min 20% clay and min 5% organic matter.
- 6 Alternative B, Ready-Mix Planting Medium. Mekaines soil, is a ready-mix agricultural soil with minerals, composed of a homogeneous mixture of sand, silt and clay. The mix shall consist of 60-70% sand, 15-25% silt, and 5-10 % clay. It shall be further fortified with admixture of min 5% organic material as per specified ratio, laid for the end level and watered for at least one [1] week prior to any planting or test process.
- 7 Alternative C, Soil mix. The soil mix shall minimum comply, at the minimum, with the following physical and chemical properties.

4.3.4 Chemical Properties.

- 1 The mix shall conform to the following:
 - (a) pH, not less than 6.5 nor more than 8.5
 - (b) Electro-conductivity, less than 4 mm mhos/cm saturated extract at 25 C0
 - (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.
 - (h) heavy metals shall comply with US EPA Standards
 - (i) (Sodium Absorption Ratio) less than 2

4.3.5 Physical Properties.

- 1 The mix shall conform to the following particle sieve size analysis: in Table (2)

Table 2,
Particle Sieve Size Analysis

| Sieve Size (mm) | % By Mass Passing |
|-----------------|-------------------|
| 5.000 | 100 |
| 2.380 | 65 to 100 |
| 0.075 | 0 to 3 |

4.3.6 ACCESSORIES IN GENERAL

- 1 Samples and Technical Literature. For standard products and materials, The Contractor shall submit samples from approved sources, with accompanying manufacturers' or suppliers' analysis and technical literature containing any recommended application rates, mixing or preparation methods or other related information. These shall be for the approval by the Engineer.
- 2 Soil Amendments and Conditioners for Improving Texture. These are additives, of granular or fibrous material, to be mixed into the bulk soil to improve its texture and physical and chemical properties to create the specified soil mix. Test analysis results are to be provided by an approved independent third-party laboratory for the following, attesting to their physical and chemical properties:

- (a) Composted organic waste.
 - (b) Coco peat
 - (c) Vermiculite
 - (d) Perlite
 - (e) Lightweight expanded clay aggregate [LECA]
- 3 Soil Amendments for Improving Organic Matter Content. In addition to the above and not necessarily limited to the following, samples and technical literature of amendments that improve the organic matter content of soil mixes, shall be submitted for approval by the Engineer. These shall contain information on content of nutrient and trace elements.
- (a) Composted organic waste, stabilized.
 - (b) Organic manure, stabilized.
 - (c) Sewage sludge pellets, dried and stabilized.
- 4 Soil Moisture Amendment. This additive shall be a natural material, specifically for use to increase the moisture retention of soil mixes. It shall have a high water-holding capacity, containing no organic nor synthetic polymers, copolymers or pozzolans, meeting the following as a minimum:
- (a) Composition. The amendment shall have the following composition of percentage by volume:
 - (i) Rhyolitic tuff, 80%
 - (ii) Bentonite [clay], 18%
 - (iii) Natural cellulose compounds, 02%
 - (b) Properties. The soil additive shall conform to the properties as in the following (Table 3)
 - (c) Properties of soil Moisture Additive, and shall meet the criteria below as a minimum:
 - (i) at least 95% of the additive shall be an inorganic mineral.
 - (ii) minimum 380% WHC [water-holding capacity, by volume]
 - (iii) minimum 30Meq per 100g CAC [cation-exchange capacity]
 - (iv) have the ability to reduce irrigation water consumption by a minimum 45% for at least **Five [5]** years.
 - (v) have the ability to reduce irrigation water consumption by 50% immediately after Mixing into the soil mix.
 - (vi) High available mineral content [eg. N, P, K, Ca, Mg] and micro-nutrient trace Elements [e.g., Fe, Mn, Mo, B, Zn, Cu]

Table 3,
Properties of Soil Moisture Additive

| Composition | Percent % by Volume | Property | Value | Mineral Content | Ratio by Weight [mg per kg] | | | |
|-----------------------------|---------------------|--------------------------------|--------------------|-------------------------------------|-----------------------------|--|--|--|
| Rhyolitic tuff | 80 | WHC [water-holding capacity] | 380% min by volume | N Nitrogen | 1,580 | | | |
| Bentonite [clay] | 18 | | | P Phosphorus | 693 | | | |
| Natural cellulose compounds | 02 | CAC [cation-exchange capacity] | 30Meq per 100g min | K Potassium | 7,200 | | | |
| | | | | Ca + Mg, Calcium + Magnesium | 160 Meq per kg | | | |
| | | | | Micronutrients and Trace Elements | Quantity by Volume [ppm] | | | |
| | | | | Fe, Iron | 1,793 | | | |
| | | | | Mn, Manganese | 178 | | | |
| | | | | B, Boron | 25 | | | |
| | | | | Mo, Molybdenum | 01 | | | |
| | | | | Zn, Zinc | 15 | | | |
| | | | | Cu, Copper | 05 | | | |

- 5 Mycorrhizal Amendment. The mycorrhizal culture shall be an approved, naturally occurring beneficial fungi which shall be inoculated into the soil mix to create a beneficial symbiotic relationship among plant roots. To aid in establishing a disease-resistant and resilient landscape planting, the inoculant shall meet the following requirements as a minimum:
- (a) A mixture of endo. and ecto-mycorrhizae that is climate-appropriate for Qatar landscaping.
 - (b) Have the ability to reduce irrigation water consumption over time when used together with a soil moisture amendment.
 - (c) Have the ability to encourage robust root growth and drought-tolerance.
- 6 Compost, Stabilized. All composted products shall be stabilized and free of weeds, weed seed, pathogens and odours. The Contractor shall provide certification that compost conforms to the minimum requirements specified in Tables 4 and 5. The particle size distribution grades of the composted product must meet the criteria for a topdressing product [i.e., Table 5, as specified in AS 4419 soils for landscaping and garden use].

Table 4,
Contaminant Acceptance Concentration Limits, Quality of Compost and Sludge Compost
for Land Application

[Exceptional Quality USEPA Part 503 / EC Directive 86/278/EEC / NSW EPA/ GCC
Fertilizer Law 2006].

| Heavy Metal Contaminant | Maximum Allowable Concentration [mg/kg] | Organic Chemical Contaminant | Maximum Allowable Concentration [mg/kg] |
|-------------------------|---|------------------------------|---|
| Arsenic | 10 | DDT/DDD/DDE ⁽¹⁾ | 0.5 |
| Cadmium | 20 | Aldrin | 0.02 |
| Chromium (total) | 300 | Dieldrin | 0.02 |
| Copper | 1000 | Chlordane | 0.02 |
| Lead | 300 | Heptachlor | 0.02 |
| Mercury | 10 | HCB | 0.02 |
| Nickel | 200 | Lindane | 0.02 |
| Selenium | 50 | BHC | 0.02 |
| Zinc | 2500 | PCBs | Not detectable |

⁽¹⁾ Note: DDT- (*p,p'*-dichlorodiphenyltrichloroethane),

DDD- *p,p'*-dichlorodiphenyldichloroethane ,

DDE- *p,p'*-dichlorodiphenylchloroethylene .

- 7 **Reference Standard.** As a minimum requirement, all composted products to be used as a soil conditioner must meet the temperature, time and turning frequency as specified by the USEPA standard for pathogen disinfection and vector reduction.
- 8 **Pathogen Disinfections and Weed Seed Reduction** shall be achieved by aerobic, Thermophilic decomposition of organic matter which produces a humus-like material. Using the windrow composting method, the temperature of the windrow is maintained at 55°C [131°F] or higher for 15 consecutive days or longer. During the period when the compost is maintained at 55°C [131°F] or higher, there shall be a minimum of **five [5]** turnings of the windrow [USEPA].

Table 5: Chemical Testing Results Required for the < 2mm Fines of a Composted Soil Conditioner To Verify The Suitability Of The Soil Conditioning Properties Of The Composted Product For Qatar.

| Compost Parameter | Test Method | Parameter Requirements |
|---|--|---|
| Particle size | Top Dressing AS 4419 | <2% by wt > 5mm, <15% by wt pass a 5 mm sieve but not a 2 mm sieve |
| Heavy metal and organic chemical contaminants | NSW EPA - threshold levels for grade A Biosolids | Refer Table 4 |
| pH | 1:5 soil water extract# | 5.5 to 8.5 |
| Electrical Conductivity | 1:5 soil water extract# | < 2.5 dS/m |
| Wettability | Appendix C AS 3743 | < 2 minutes |
| Total water holding capacity | Appendix B AS 3743 | ≥ 40% |

| Compost Parameter | Test Method | Parameter Requirements |
|---|---|----------------------------|
| Chloride | *1:5 soil water extract | $\leq 600 \text{ mg/kg}$ |
| % Organic carbon | *Dichromate wet oxidation | $\geq 15\%$ by mass |
| Effective Cation Exchange Capacity (ECEC) | *1 M ammonium chloride pH7, no pretreatment for salts | $\geq 40 \text{ meq/100g}$ |
| Exchangeable sodium % (From exchangeable cations) | *1 M ammonium chloride pH7, no pretreatment for salts | $\leq 15\%$ |
| As received moisture content | *Oven-dry 105°C basis | $\leq 40\%$ by mass |

Methods indicated by a hatch (#) and the parameter requirements are based on the Australian Standard AS 4419 - soils for landscaping and garden use.

Reference to AS 3743 - potting mixes indicates that the method and the parameter requirements are based on this Australian standard (AS 3743).

Methods preceded by an asterisk (*) are internationally recognised for testing the chemical properties of soil and are described in the text Rayment and Higginson (1992), Australian Laboratory Handbook of soil and water chemical methods.

- 9 Contamination of the compost may occur due to poor source separation as with municipal green-waste and/or through poor control in turning and loading during production. These indicate poor composting practice and procedure. As such, any batches found to contain deleterious material (for example soil, sharps such as glass or metal, contaminants such as plastic or stones) shall be rejected by the supervising officer.
- 10 Fines of the compost (<10 mm particle size) shall be analysed for chemical and organic contaminants, to verify compliance with appropriate threshold levels [ie. Tables 4 and 5] for minimizing the contamination of soils with potentially hazardous substances [e.g., NSW EPA - threshold levels for Grade A Bio solids]. Where a case can be made that higher concentrations of trace elements such as copper and zinc may be beneficial, limits of 1,500 mg/kg and 2,800 mg/kg may be accepted (Kirchhoff et al 2003). No detectable PCB compounds are permitted, at a 0.2 mg per kg detection limit.
- 11 Attributes of the compost shall be appropriate for use as a soil conditioner in the sandy soils of Qatar, the composted product must be verified as possessing the following attributes:
- (a) **Water-Holding Capacity [WHC]**. Total WHC shall be high as to function in part as a replacement for sphagnum peat.
 - (b) **Cation-Exchange Capacity [CEC]**. High CEC nutrient-holding capacity to function in part as a replacement for sphagnum peat
 - (c) **Low Chloride Ion Concentration** and a **Low Exchangeable Sodium** percentage to minimize the salt concentration in the rooting zone.
 - (d) **High Proportion of Nitrogen and Phosphorus** fertilizer value of the product to be in slow-release organic form, to reduce the risk of leaching nutrients into the groundwater.

4.3.7 Soil Additives, Alternative Procedures

- 1 There are two [2] applicable alternative procedures. Contractors shall follow either Procedure A or Procedure B, as may be directed by the Engineer.

- 2 Procedure A for Soil Additives shall consist of the following components that have been approved:
- (a) Composted Organic Waste shall be a recycled treated waste product as a fully natural authority-approved composted product, shredded and granulated to pass through a 12 mm mesh screen and conditioned in storage piles for at least 6 months. The compost shall be free from sticks, stones, roots, and other objectionable matter. It shall have a pH value of not less than 7 and nor more than 7.5. The minimum organic content on a dry-weight basis shall be 85% originating from animal sources [e.g. Manure, guano, bone meal, and residues of meat processing products] while it must be a minimum 40% for vegetative sources. Compost shall be delivered in undamaged recyclable bags in air-dried condition. The Compost shall not contain more than 1% (< 1% by dry weight) of foreign matter. The compost shall possess no objectionable odours and shall not resemble the raw material from which it was derived.
 - (b) Bio-Solids, Class A, shall be pasteurized dried pelletized sewage sludge with nitrogen, phosphoric acid and potassium and a pH value of 6.0 to 7.5. Bio-solids shall be free of stones, sticks and non-biodegradable material. Bio-solids shall be heat treated, free from pathogen, weeds and other pollutant. For further details. Refer to Appendix A of this Part.
 - (c) Vermiculite shall be horticultural-grade and free of any toxic material and conform to ASTM C516.
 - (d) Perlite shall conform to ASTM C549
 - (e) Inorganic fertilizer, Controlled Slow-Release:(N.P.K+2MgO+te) shall be commercial grade and uniform in composition. Fertilizer shall be either in tablet or granular form, containing fifty [50%] percent or more as controlled slow-release nitrogen, with a releasing longevity of at least 2 months under Qatar environmental conditions and shall bear the manufacturer's guaranteed statement of analysis.
 - (f) Fertilizers, Plant-Derived. Shall be used in all soil mixes as an alternative option to animal manure. It shall be heat-treated, free from seeds and nematodes and possess the following characteristics:
 - (i) Organic content, greater than 70%
 - (ii) C:N ratio, greater than 20%
 - (iii) Particle size, not larger than 2 mm for 80% of the mix
 - (iv) Humic acid, greater than 10%
 - (v) pH 5-6
 - (g) Dry Plant Fertilizers, Controlled-Release. Shall be commercial grade and uniform in composition either in tablet or granular form, having controlled - release nitrogen (CRN) used in Tables 3 and 8. It shall consist of, by percentage by weight, 5 % nitrogen (N), 10 % available phosphoric acid (P) and 5 % potassium (K) +2MgO +micro nutrients. Control released fertiliser may be in packet or tablet form.
 - (h) Irrigation Water
 - (i) General Requirements. Refer to Clause 1.4.11, Irrigation Water in Part 1, Land-scape Planting of Section 28, and Landscaping.
 - (j) Water Quality. Water shall be free from substances harmful to planting and shall not exceed the following minimum parameters:
 - (i) pH: 6 to 8.5
 - (ii) Salinity as Total Dissolved Solids [TDS]: less than 2000 ppm.

3 Procedure B for Soil Additives shall consist of the following components that have been approved:

- (a) Manure shall be fully decomposed animal manure, pasteurized dried pelletized sewage sludge or fully fermented pre-dried heat treated sheep, horses, goat, cow or chicken manure with nitrogen, phosphoric acid and potassium and a pH value of 6.0 to 7.5. Manure shall be free of stones, sticks and non-biodegradable material. Manure shall be heat treated, free from pathogen, weeds and other pollutant. A health certificate shall be submitted for the proposed sample. Animal manure shall not be used as topdressing for lawn turf
- (b) Soil Conditioner shall be as detailed in the following clauses:
 - (i) Soil Conditioner shall be added prior to planting with the organic manure only, it must meet the requirements in Table 6, Soil Additives Proportion for Plants. The amount of inorganic fertilizers shall base on the organic additives and soil tests.

Table 6,
Soil Additives Proportion for Plants

| Plant Type | Soil Conditioner | Organic or other Composted Waste | Organic Fertilizer | | Inorganic Fertilizer | Mixing Depth |
|-----------------------------|-------------------------------------|----------------------------------|---------------------|-----------------------|----------------------|--------------|
| | | | Animal Content | Plant Content | | |
| Palms | As per manufacturer recommendations | 5% soil volume | 25 kg/palm | 5 Kg/palm | #g/palm | 40 cm |
| Trees | | 5% soil volume | 12.5 kg/tree | 5 Kg/Tree | # g/Tree | 40 cm |
| Shrubs Large | | 5% soil volume | 7 kg/Shrub | 1 Kg/Shrub | # g/Shrub | 30 cm |
| Shrubs Small | | 5% soil volume | 5 kg/Shrub | 0.5 Kg/Shrub | # g/m ² | 30 cm |
| Hedges | | 5% soil volume | 5 kg/linear m | 0.5 kg/linear m | # g/ linear m | 20 cm |
| Vines and Climbers | | 5% soil volume | 5 kg/linear m | 0.5 kg/linear m | # g/ linear m | 20 cm |
| Ground Covers, and Seasonal | | 5% soil volume | 5 kg/m ² | 0.5 kg/m ² | # g/m ² | 20 cm |
| Lawn | | 5% soil volume | 5 kg/m ² | 1 kg/m ² | # g/m ² | 20 cm |

4.4 EXECUTION

4.4.1 PREPARATORY ACTIVITIES

- 1 Understanding of Scope of Work. Prior to any operations, the Contractor shall have fully satisfied himself of the correct understanding of the scope of work under this Part and related works covered by other Parts of this Section, and other Sections of the Specifications.
- 2 Site Examination. Prior to any operations, the Contractor shall investigate the site to ensure full awareness of existing site conditions affecting the performance of its work in this Section. The Contractor shall not proceed with planting operations until unsatisfactory conditions are discussed and resolved with the Engineer. Familiarity with site conditions include, but are not necessarily limited to:
 - (a) Site boundaries and extent of work
 - (b) Conditions of all adjoining developments in surrounding public realm and plots
 - (c) Site topography, in relation to site surface drainage
 - (d) Existing subsurface conditions [e.g. water tables, obstructions such as hardpans, rock formations]
 - (e) Locations and alignments of all existing above-grade and subsurface utility lines and structures
 - (f) Locations and alignments of all proposed above-grade and subsurface utility lines and structures by authorities
 - (g) Existing vegetation in numbers, species and footprint marked for retention, relocation or demolition
 - (h) Existing structures, pavements and infrastructure marked for retention, rehabilitation or demolition
- 3 Site Enclosures. The Contractor shall build temporary fencing to the boundaries of the entire project, and its parts, as indicated on plans as required for the protection of the public, for access control not necessarily limited to:
 - (a) Site storage yards
 - (b) Existing stands of vegetation to be protected for retention, as defined from the outer drip line and root zone of trees
- 4 Site Office Facilities. The Contractor shall build the required temporary onsite office facilities as indicated on plans and as approved by the Engineer.

4.4.2 COMPOST APPLICATION DURING ESTABLISHMENT AND MAINTENANCE PERIODS

- 1 Incorporating Compost. Approved compost shall be periodically incorporated into the soil to improve its physical and chemical properties at rates determined by the site, planting and soil parameters
- 2 Application Depth. Work compost into the soil to a depth of 20 cm. However, after a routine cultivation maintenance operation such as plugging in turf, a compost may be applied to the surface of the soil as a topdressing upon the direction of the Engineer.
- 3 Rate of Application. The rate of application shall be based on the fertilizer equivalence of the compost. For chemical testing [Refer to Table 5], the composite sample shall be screened through a sieve with an aperture size of 2 mm with the particles retained on the sieve excluded from the analysis. A bulk density test shall be undertaken on the compost [Refer to the method in Appendix B of AS 4419], to enable the calculation of fertilizer equivalence on a mass basis, to a volumetric basis for ease of application.
- 4 Maximum Application Rate permitted for incorporation into a soil shall be based on the results of the chemical testing of the compost and receiving soil.

- 5 Sampling. The Contractor shall ensure that the supplier takes from each separate batch, at least x10 random samples each having a volume of not less than 200ml that are blended to produce a composite sample of not less than 2 litres [Appendix A AS 4419]. Where necessary, the compost sample shall be air dried overnight (room temperature less than 35°C) to facilitate sieving. The size of a batch will be determined in accordance with the HACCP procedures.
- 6 Testing Methods. Internationally accepted testing methods must be applied to the com-post samples and a certificate of analysis supplied with each compost consignment or as requested by the supervising officer.
- 7 Chemical Testing for Fertiliser Equivalence of the Compost. The following method shall be used for determining the fertilizer equivalence of compost for testing of mineral content. Subtracting the fertilizer value of the nutrient from the total value indicates the slow-release [organic] nutrient pool. In the case of nitrogen, subtracting the ammonium concentration [Refer to Table 7] from the total kjeldahl Nitrogen value will indicate the slow-release (organic) nutrient pool. Potassium is a component of the cell sap in organic materials, with very little locked up in the organic, slow-release form. The as received moisture content is required to enable calculations of the oven-dry application rates to be adjusted for the field moisture content of the product.

Table 7,
Chemical Testing Results Required To Determine
The Fertiliser Equivalence Of The Compost.

| Compost Parameter | Test Method | Reference [Rayment + Higgins] |
|------------------------------|---|----------------------------------|
| Fertilizer phosphorus | Bicarbonate extractable P | 9B |
| Total phosphorus | X-ray fluorescence or sodium carbonate fusion | 9A |
| Fertilizer potassium | Bicarbonate extractable P | 18A1 |
| Nitrate Nitrogen | In the presence of nitrite | 7C1b |
| Total Nitrogen | Kjeldahl | 7A |
| Exchangeable Cations | from ECEC in Tables 4 and 5 | 15A1 |
| As received moisture content | from Tables 4 and 5 | 2B1 |

4.4.3 Contractor's Responsibilities

- 1 The Contractor shall verify that the compost has been produced according to a HACCP-based site and product management plan, and that production temperature and turning records comply with the US-EPA pathogen disinfection and vector reduction requirements of the relevant sections of the specification.

- 2 The contractor shall use the results of the chemical tests listed in Table 4 and Table 5, to calculate the plant-available [immediate fertilizer] and controlled slow-release fertilizer equivalence of each specific batch of compost intended for use as a soil conditioner. The results shall be expressed on the oven-dry mass basis of the <2mm particle size grade.
- 3 The Contractor shall also calculate the maximum [field weight basis] application of the composted soil conditioner on the fertilizer [plant-available] equivalence of the least limiting major nutrient [most commonly phosphorus or potassium] in the compost, and the annual fertilizer application recommendations for the receiving soil.
- 4 The Contractor shall ensure that the supplier has provides all documentation to the Contractor as required by same – this shall include:
 - (a) HACCP (or equivalent) certification; temperature and turning records of the material; physical and chemical testing results for each batch of compost supplied.
 - (b) Soil Analysis during Establishment Period. Arrange analysis of representative soil samples according to a Method Statement to be approved by the Engineer.
 - (c) Sample Locations, sample Size. Unless otherwise directed by the Engineer, samples from locations within the project shall be at six [6] month intervals. The number of samples shall be according to the size of the project.
 - (d) Test Results shall be by an approved independent third-party laboratory and shall comply at the minimum to specified standards for pH levels of planting medium. If samples do not comply, take corrective measures to achieve the required pH level.
- 5 CLEAN-UP
 - (a) Excess and Waste Material shall be removed daily. Pavements and work areas shall always be kept in a clean and orderly fashion. Pedestrian access points and vehicular access points shall be maintained and kept clear and accessible at all times. All rubbish and litter shall be cleared as it accumulates within the landscape work area.
 - (b) Onsite Holding Area, Designated Offsite Disposal Area. When soil mixing works have been completed, all debris including excess agricultural soil, litter, debris and all unwanted material shall be stored onsite in a temporary holding area while awaiting disposal.
 - (c) All material for removal and disposal offsite shall be disposed to a location or locations as agreed with the Engineer.
 - (d) Restoring, Restitution Adjoining Work. Any existing adjoining planted areas, pavements, facilities, utility lines and structures that have been damaged from work under this Part shall be restored and made good to their original conditions at the Contractor's expense. Restored work shall meet and merge with original lines and grades.
 - (e) Site Cleaning and Waste Management. All softscape and hardscape portions of the site shall always be kept clean, tidy and free of debris and litter at all times according to established best practices in a Method Statement for approval by the Engineer.
 - (f) Handling. All litter handled onsite shall be bagged or containerized and removed daily to an offsite location or locations approved by a Qatar municipality.
 - (g) Waste Segregation at Source. Segregate compostable waste generated by yard litter

END OF PART

APPENDIX: A

Public Works Authority - Public Parks Dept.

Bio-Solids

CLASS-A

BIOSOLIDS

APPENDIX A

**Bio-Solids
Class - A**

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APPENDIX A

Bio-Solids
Class - A

1 CHARACTERISTICS

1.2 INTRODUCTION

- 1 Thermal drying facility at Doha North STW comprises treatment of aerobically digested indigenous sludge and imported dewatered sludge to Class-A Bio-solids. This is achieved by thermal drying of dewatered sludge with hot gases in a rotary kiln.
- 2 The resulting high quality product – Pasteurized Dried Pellet Bio solids is nutrient rich, low water content, and meets Class-A Bio solids standard. The beneficial of bio solids as a soil amendment are generally recognized and when added to soil, bio solids contribute nutrients and improve soil properties.
- 3 The Bio-solids are transported to a final costumer in bulk, using articulated trucks. For a smaller scale applications, a standard, 10 kg plastic bag, packaging is used and delivered to the customers by flatbed trucks.
- 4 The Bio-solids are subject of thorough testing of their physical and chemical properties before being dispatched to the final costumer. The Bio-solids analysis is provided by approved laboratories.

Table (1) Shows the Bio-solids following basic characteristics:

| | |
|-------------------------|-------------------|
| Dryness | 90-95 % by weight |
| Moisture | 5-10 % by weight |
| Colour | Grey |
| Shape | Granular |
| Median size as d_{50} | 3-6 mm |

Image (1) Thermally Dried Class-A Bio-solids



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1.3 QUALITY PARAMETERS

- 1 Bio-solids undergoes different heavy metal, microorganism and organic chemical contaminant tests to ensure their presence is within limit as per USEPA Class-A Bio-solids & QCS2014 guidelines.

Table (2) – US-EPA Limits of heavy metals in Bio-solids

| S/N | Parameter | Unit | USEPA Exceptional Quality (EQ) | DNSTW Bio-solids Quality* |
|-----|-----------------|-----------|--------------------------------|---------------------------|
| A | Faecal Coliform | MPN/g DS | <1,000 per g | Not Detected |
| | Salmonella | MPN/4g TS | < 3 per 4 g | TBC |
| | Heavy Metals | | | |
| | Arsenic | mg/kg DS | 41 | 2.9 |
| | Cadmium | mg/kg DS | 39 | 1.1 |
| | Copper | mg/kg DS | 1,500 | 505 |
| | Lead | mg/kg DS | 300 | 20.5 |
| | Mercury | mg/kg DS | 17 | 0.55 |
| | Nickel | mg/kg DS | 420 | 32.6 |
| | Selenium | mg/kg DS | 100 | <3.0 |
| | Zinc | mg/kg DS | 2,800 | 754.0 |

- 2 *The DNSTW quality is based on the past six months data.

Table (3)- average levels of Heavy metals in Bio-solids produced from Doha North STW

| S/N | Parameter | Unit | Table 4 of Section 28 of QCS2014 | DNSTW Bio-solids Quality |
|-----|--------------------------|-------|----------------------------------|--------------------------|
| A | Heavy Metals | | | |
| | | mg/kg | 10 | 2.9 |
| | | mg/kg | 20 | 1.1 |
| | | mg/kg | 300 | 41.5 |
| | | mg/kg | 1,000 | 505 |
| | | mg/kg | 300 | 20.5 |
| | | mg/kg | 10 | 0.55 |
| | | mg/kg | 200 | 32.6 |
| | | mg/kg | 50 | <3.0 |
| | Zinc | mg/kg | 2,500 | 754.0 |
| | Organic Chemicals | | | |
| | | mg/kg | 0.5 | TBC |
| | DDE | mg/kg | 0.02 | TBC |

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Bio-Solids Class - A

| S/N | Parameter | Unit | Table 4 of Section 28 of QCS2014 | DNSTW Bio-solids Quality |
|-----|------------|-------|----------------------------------|--------------------------|
| | Deldrin | mg/kg | 0.02 | TBC |
| | Chlordane | mg/kg | 0.02 | TBC |
| | Heptachlor | mg/kg | 0.02 | TBC |
| | HCB | mg/kg | 0.02 | TBC |
| | Lindane | mg/kg | 0.02 | TBC |
| | BHC | mg/kg | 0.02 | TBC |
| | PCBs | mg/kg | Not detectable | TBC |

- 3 Sampling and monitoring shall be done in accordance with USEPA 40 CFR Part 503 standards.

Table (4) C. Typical N-P-K Values

| Nutrients | % w/w |
|--------------------|---------|
| Total Nitrogen (N) | 4-6 |
| Phosphorus (P) | 2-4 |
| Potassium (K) | 0.2-0.4 |

Note:Please refer **Attachment 1** for detail information on Bio-solids characteristics & FAQs (Frequently Asked Questions).

2 PACKAGING INFORMATION

- 1 Bio-solids are retained in granular form at the end of treatment process. The granules are packed in plastic bags and stacked on standard pallet for safe handling and transportation to end customer. Each bag of Bio-solids contains print showing basic storage information, production time, date and batch number.

2.3 PACKAGE SIZE

- 1 1 Bio-solids granules are filled into plastic bag which is then thermally sealed. A few small holes are provided on bag ensuring there will be no air trapped inside the bag. Each bag weights 10 kg and has size of approximately 50cm X 35cm.

2.4 PALLET SIZE

- 1 Wooden pallets are used to store and transport the Bio-solids bags. Each pallet shall have 60 bags stacked as 12 layers i.e. 600 kg of Bio-solids. Final weight of each pallet after packaging is 615 kg (weight of Bio-solids bags, plastic packaging material and wooden pallet) with overall size of 1m X 1.05m wide and 1m high.

2.5 PACKAGING MATERIAL

- 1 A 140 micron Plastic film is used by bagging machine to form each Bio-solids bag. A 25 micron wrapping film is wrapped around each pallet to secure stacked bags for safe and easy handling. Wooden pallet has dimension of 1m X 1.05m X 0.140 m and it is suitable for 4 ways handling

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Class - A**

Image (2) Standard Packing of Bio-solid



3 TRANSPORTATION, HANDLING AND STORAGE

3.2 STANDARD PACKAGING TRANSPORTATION

- 1 Standard packaging transportation is offered to the user to deliver Bio-solids from the Manufacturer. DNSTW provides flatbed trucks, which can be loaded with up to 12 pallets of Bio-solids, i.e. 7.2 tons of Bio-solids.

Image (3) Standard Packing Transportation



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Bio-Solids
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2.1 HANDLING

- 2 For standard packaging of Bio-solids, each pallet should be loaded and unloaded from delivering/transporting truck with forklift or similar machine with minimal capacity of 1.5 ton. Use of sling and crane is not recommended. Each bag of Bio-solids shall be opened just before its application or intended purpose.
- 3
- 4 A knife or scissor can be used to cut plastic bag which has to be recycled after use. Guidelines & Simple precautions:
 - (a) Apply Bio-solids mechanically if possible rather than by hand.
 - (b) Avoid spreading Bio-solids in windy conditions.
 - (c) Wear protective clothing during Bio-solids application, particularly gloves and dust mask.
 - (d) Avoid breathing dust or direct skin contact while handling the Bio-solids.
 - (e) Wash with soap and water after handling Bio-solids or Bio-solids spreading equipment.
 - (f) Prevent contamination of water while handling the Bio-solids.

3.3 STORAGE

- 1 Always store Bio-solids in the original package. Once the bulk or standard packaging of Bio-solids are transferred/delivered to demand location, it has to be stored in cool, dry, shaded designated area and out of reach of children and animals. Do not store in damp places, close to wells, drains or other water resources.
- 2 Note: Please refer to Attachment 2-Safety Data sheet for further information on First Aid Measure.

Image (4) Bio-solids Storage.



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Bio-Solids
Class - A

4 APPLICATION RATES

- 1 There is no prior experience in Qatar for the usage of Bio-solids for Landscaping, the application rates for the Bio-solids as manure for the landscaping is derived from the Dried Sludge Disposal Study conducted in 2009 focussed on the usage of Bio-solids as manure. The disposable study is based on:
 - (g) QCS 2007 Section 1 Landscaping
 - (h) International Practice of Dried Sludge Usage for Landscaping,
 - (i) Quality of sludge from different locations of Qatar and
 - (j) The soil conditions in various strategic locations in Qatar.
- 2 The table provided under Section 4.1 and 4.2 are only the recommended application rates. However, the optimum application rate for different agricultural crops can only be determined accurately by conducting field trials so that effects of the local climatic, soil conditions and husbandry factors can be properly assessed. For sludge use in landscaping, individual areas of plantings to which sludge may be applied tend to be small and the rate of application is dependent on the type of planting. For strategic planning purposes, an average rate of application on a hectare basis is required, nominally 10 t/ha.
- 3 Below Mentioned Tables have been extracted from the Dried Sludge Disposal Study.

4.3 APPLICATION DURING CONSTRUCTION

- 1 The QCS has standards for soil preparation prior to planting (Table 5). The QCS permits Bio-solids to be used as a substitute for manure subject to approval of the Engineer.

Table 5 – QCS Requirements for Plantings

| Type of planting | Planting pit dimensions | Planting media mix proportions | | |
|--------------------------------------|-------------------------|--------------------------------|------|---------------------|
| | | Soil | Peat | Manure (Bio-solids) |
| Palm trees | 2 x 2 x 2 m | 80% | 10% | 10% |
| Ornamental trees | 1.5 x 1.5 x 1.5 m | 80% | 10% | 10% |
| Shrubs | 1 x 1 x 1 m | 85% | 10% | 5% |
| Groundcover, seasonal flowers, grass | Area x 0.5 m depth | 85% | 10% | 5% |

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Table (6) gives the quantities of Bio-solids required on a hectare basis, calculated from the required proportions of Bio-solids in the planting media and normal planting densities.

Table (6) – Bio-solids Requirements for Plantings

| Type of planting | Volume of media required | Bio-solids per pit or Area | Plant Spacing | No. of Plants per ha | Bio-solids required (m ³ /ha) | Bio-solids required (t/ha) |
|--------------------------------------|------------------------------------|----------------------------|---------------|----------------------|--|----------------------------|
| Palm trees | 8 m ³ | 0.8 m ³ | 10 | 100 | 80 | 48 |
| Ornamental trees | 3.4 m ³ | 0.34 m ³ | 10 | 100 | 34 | 20.4 |
| Shrubs | 1 m ³ | 0.2 m ³ | 5 | 400 | 80 | 48 |
| Groundcover, seasonal flowers, grass | 0.5 m ³ /m ² | 0.25 m ³ | | | 250 | 150 |

- 2 If Bio-solids is used as a direct replacement for animal manure and compost, the rates of application would be in the range of 34 – 250 m³/ha or equivalent to 20 – 150 t/ha (Assuming that the Bio-solids has a minimum density of 0.6 t/m³).

4.4 APPLICATION FOR MAINTENANCE

- 1 1 Bio-solids annual application rate for maintenance purpose is given below in Table 7.

Table 7 – Recommended Bio-solids Application rate

| Type of planting | Bio-solids applied annually | Plant density (No./ha) | Derived application rate (t/ha) |
|--------------------------------------|-----------------------------|------------------------|---------------------------------|
| Palm trees | 25 kg/tree | 100 | 2.5 |
| Ornamental trees | 12.5 kg/tree | 100 | 1.25 |
| Shrubs | 7 kg/tree | 400 | 2.8 |
| Groundcover, seasonal flowers, grass | 5 kg/m ² | | 50.0 |

4.5 APPLICATION AREAS

- 1 The most common areas of application are:
- Home lawns and gardens.

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- b. Public contact sites.
 - c. Urban landscaping.
 - d. Agriculture.
 - e. Forestry.
 - f. Soil and site rehabilitation.
- 2 2 Do not use Bio-solids on vegetables eaten raw (e.g. lettuce, tomatoes) or fruit grown in contact with the soil (e.g. strawberries) or top dressing of grass. Do not allow animals to graze until one month after Bio-solids application.

4.6 BENEFITS

- 1 1 Bio-solids is eco-friendly organic material free of stones, sticks and non-biodegradable materials. It has multi benefits:
- g. Improves crop production.
 - h. Provides valuable sources of nutrient & organic matter.
 - i. Slow release of the nutrients which benefit and improve plant growth.
 - j. Helps aerate soil.
 - k. Builds a more humus soil.
 - l. Buffers high salt & pH effects.

4.7 IMPORTANT REMARK

- 1 Contractor needs to arrange for a protectant treatment with systemic pesticides of both Fungicides & insecticides after one week from application to control any possible outbreak of pests that might be in peak and prevent any kind of pests from passing the economic threshold, types of pesticides to be specified by the engineer.
- 2 Instructions to End-User, it is instructed that end users shall keep record of quantity of Bio- solids received and their use while strictly adhering to QCS regulations for all kind of applications.

4.8 PACKAGING MATERIAL RECYCLE

- 1 After the use of Bio-solids the original container or Plastic Bag and shrink wrap has to be properly disposed for waste recycling purpose whereas the wooden pallets might be returned to manufacturer for reuse.

4.9 ORDERING INFORMATION

- 1 For ordering Bio-solids, duly complete the order form enclosed in this manual and mail to kinhong.ng@keppelseghers.com or yefeng.ang@keppelseghers.com
- 2 Generally the estimated Delivery lead time is one week upon receiving completed order form. However the delivery time may vary depending on the quantity and distance to the delivery site.
- 3 Options available for order
- a. 10kg x 60 bags in wooden pallet

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Class - A**

- b. Loose pellets in tipper truck
- 4 Options for mode of delivery
 - a. Self-collection
 - b. Delivery by flatbed (minimum order of 6 pallets) – unloading at delivery site is customers responsibility (minimum 1.5 ton forklift is required for unloading)
 - c. Delivery by tipper truck (minimum order of 7.2 tones, maximum of 13.2 tonnes per truck)

4.10 OTHER USEFUL SOURCES OF INFORMATION

- 1 USEPA (United States Environmental Protection Agency) Electronic Code of Federal Regulations PART 503—STANDARDS FOR THE USE OR DISPOSAL OF SEWAGE SLUDGE
- 2 https://www.ecfr.gov/cgi-bin/retrieveECFR?gp=&SID=409b6ee7f78753c04e1c8d57b183fb90&mc=true&n=pt40.32.503&r=PART&ty=HTML#se40.32.503_113

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Order Ref No.:

Biosolids Order Form

(Complete sections 1 to 4. Please email this order form to kinhong.ng@keppelseghers.com or yefeng.ang@keppelseghers.com at least ONE WEEK before the requested delivery date. The delivery of your order is subjected to change and confirmation will be sent to you.)

1. Municipality Particulars

Municipality Name: _____

Name of Municipality Engineer: _____

Office/Mobile No.: _____ Email Address: _____

2. Project Particulars

Project Name: _____

Name of Project Manager: _____

Office/Mobile No.: _____ Email Address: _____

3. Order and Delivery Details

(Dried pellets come in palletized form on wooden pallet. Each pallet = 60x10kg bags. Net weight per pallet = 600kg.)

Total Quantity Required (No. of Pallet): _____

*Delivery Date: _____ Delivery Time: _____
(*Please attach your delivery plan on a separate sheet together with this order form if delivery date is more than one date.)

Delivery Address: _____

Name of Recipient: _____ Office/Mobile No.: _____

4. Order Form Completed By:

Name : _____

Designation : _____

Contact No. : _____

Company Name: _____

| | |
|--|--|
| | |
|--|--|

Signature/Date

Company Stamp

IMPORTANT NOTE:

1. Please note that unloading of dried pellets at delivery site is customer responsibility. A minimum of 1.5 ton forklift is required to be available at delivery site.
2. All empty wooden pallets might be returned after use. Collection of empty pallets will be done on the next scheduled delivery.

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