
Bioretention Design for Tree Health:

Literature Review

San Francisco Bay Area, California

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1.0 INTRODUCTION

On June 30, the Bay Area Stormwater Management Agencies Association (BASMAA) convened over 40 experts at a biotreatment soil and tree round table to review the current soil specifications to determine if improvements to the specification can be made to positively impact the health of trees planted in bioretention areas. Participants at the Roundtable included numerous stakeholders: Municipal representatives, compost providers, soil suppliers, soil laboratory technicians, civil engineers, landscape architects, soil scientists, construction inspectors, and Water Board representatives. One outcome of the Round Table was the consensus that the standard design of bioretention areas should be evaluated to promote improved tree health.

To begin to improve bioretention basins for trees it is important to first understand the basic needs of urban trees. James Urban, one of the contributing designers of silva cells and structural planting soils, describes the six critical requirements to grow a successful tree paraphrased below (Urban 2013):

1. Sufficient soil volume
2. Room for growth at the base of the tree
3. Water flow in to the soil
4. Water draining out of the soil
5. Room for canopy growth
6. Quality nursery root stock

Bioretention generally adequately provides for items two through five. This report will focus on how to enhance the soil volume for trees in bioretention.

2.0 DESIGNING BIORETENTION FOR TREES

2.1 Soil Volume Guidelines

Soil volume is one of the most important factors effecting urban tree health and is relatively limited in bioretention systems as they are currently designed. While there have been studies of urban tree soil volume requirements on the east coast of the US, these studies don't apply in California where irrigation is the norm. Limited research on the minimum soil volume required for urban trees in summer dry climates has been conducted. In general, researchers suggest that irrigation can compensate for limited soil volume. We were not able to locate any research based guidelines applicable to the Bay Area for soil volume for trees. However, researchers recommended that soil volume should be maximized, especially considering the fast-draining engineered soils in bioretention. While general guidelines don't exist for the arid west, some cities have issued guidelines. The City of Emeryville has adopted minimum urban tree soil volume standards in Table 1.

Table 1. City of Emeryville Minimum Soil Volume Standards¹

Size	Volume (cubic feet)	SF needed in 18" deep soil
Large Tree	1200	800
Medium	900	600
Small	600	400

¹ Water Efficient Landscape Requirements referred to in Section 9-4.602 of the Emeryville Municipal Code. Found at: <http://emeryville.org/DocumentCenter/View/1754>

2.2 Increase Access to Native Soil

BASMAA bioretention standard designs require a minimum soil depth of 18" which is widely used as the standard depth. The biotreatment soil media (BSM) is underlain with a 12" aggregate layer (Figure 1). Loren Oki, Landscape Horticultural Specialist at UC Davis, indicates that trees roots are unlikely to utilize the drainage aggregate layer below the BSM for rooting because it does not contain soil and the roots are unable to access the water that may be stored there below the underdrain (Personal communication, 2016). Changes in soil texture (actually changes in soil pore space) create a texture interface that impedes water and air movement across the texture change. This impedes the movement of roots into the aggregate layer as well. Furthermore, the change in soil texture between the soil in the nursery grown root ball and the BSM can have the same effect. It is imperative that the root ball come to the soil surface with no BSM soil covering the root ball soil. The interface between the root ball and the BSM will impede water and air movement into the root ball.

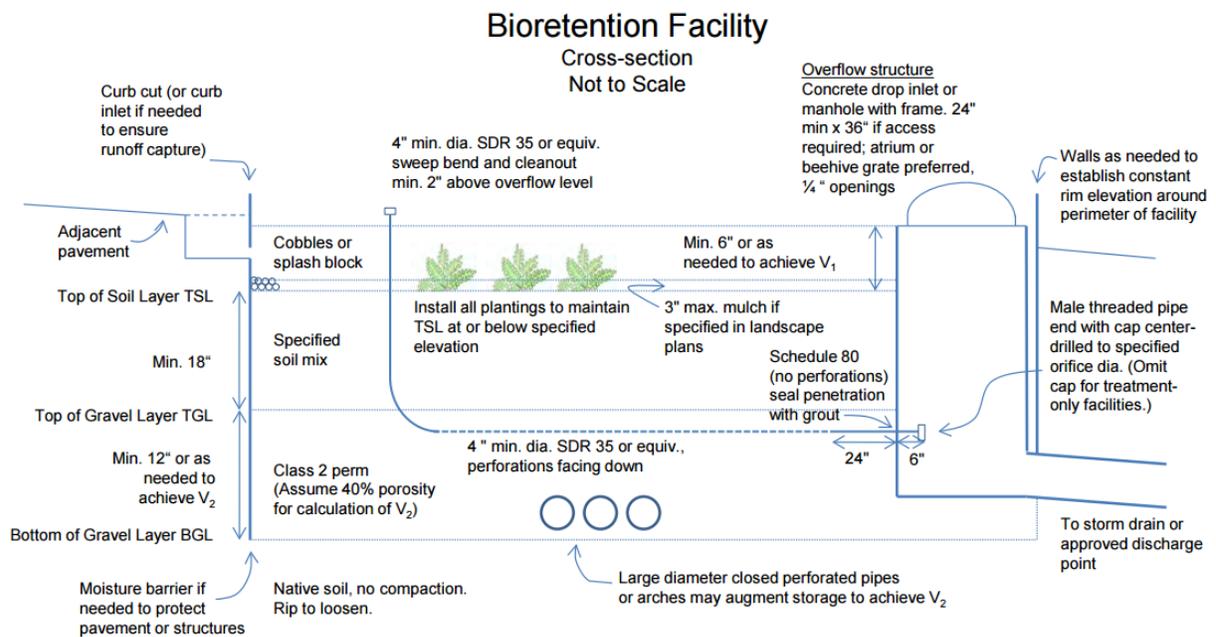


Figure 1. Contra Costa County (2012) Bioretention Facility Cross-section

In a traditional landscape planting, trees should be planted in a wide saucer-shaped planting hole with broadly sloped sides (Colorado Master Gardener 2016). This is because, if the roots have a hard time penetrating compacted site soil (due to low oxygen) sloped sides direct roots upward and outward toward higher oxygen soil near the surface. Roots that do not penetrate site soil begin to circle in the hole leading to trunk girdling roots.

Bioretention basins which are surrounded by increased height vertical curbs, retaining walls, adjacent to compacted soil, road base, pavement, utility corridors, and structures do not provide trees with access to native soil and promote circling roots (Colorado Master Gardener 2016). They are further limited by the aggregate layer that underlays the root ball. The urban Horticulture Institute at Cornell University suggests that limited volume planters can be designed with sleeves through the planter box walls to allow tree roots to access the structural or native soil adjacent to a bioretention area with vertical walls (Figure 2). Structural soil is discussed in more detail in Section 3.0.

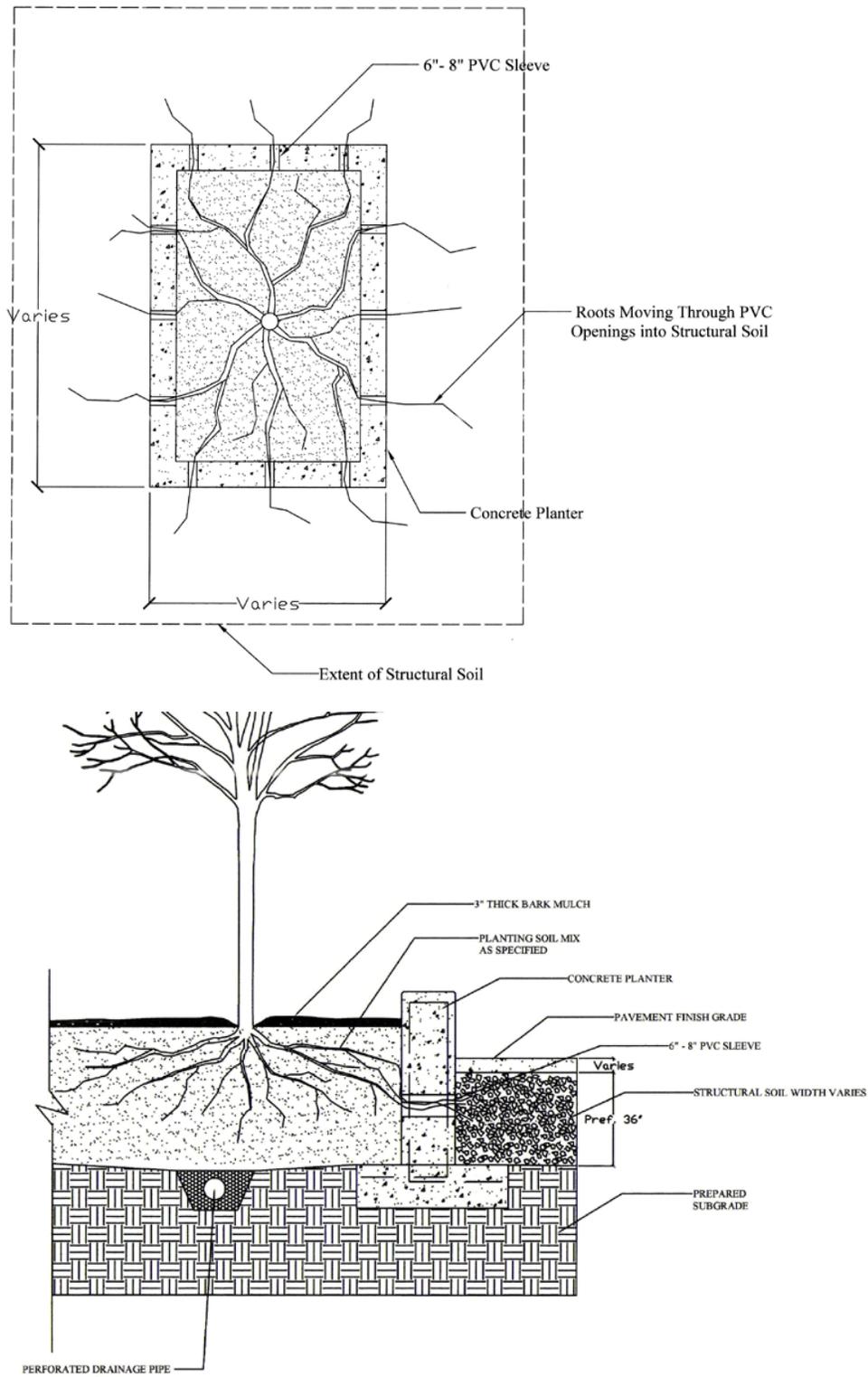


Figure 2. Roots move through PVC openings in concrete planter box wall into structural soil under pavement (Urban Horticulture Institute 2007).

Curtis Hinman, of Herrera Environmental Consultants, also reports that trees and plants, in

general, have thrived in bioretention systems around the Puget Sound (Hinman, personal communication 2016). Potentially, this could be a result of the different rainfall pattern with a much reduced drought period as compared to the Bay Area. However, it may also be significant to note that, according to Hinman, Portland also reports problems with tree survival. Portland and the Bay Area are similar in their design of bioretention systems in that both require a full width aggregate drain layer beneath the BSM layer. Seattle systems are designed such that the aggregate layer is only 12" wide and deep around the perforated drain (See Figure 3 below). The remaining areas of the basin bottom are in contact with the native soil, greatly expanding the available soil volume for trees. In the Bay Area systems, the drain rock provides added storage volume for infiltration but limits the tree's access to native soil. However, healthy trees have the potential to capture a significant volume of stormwater.

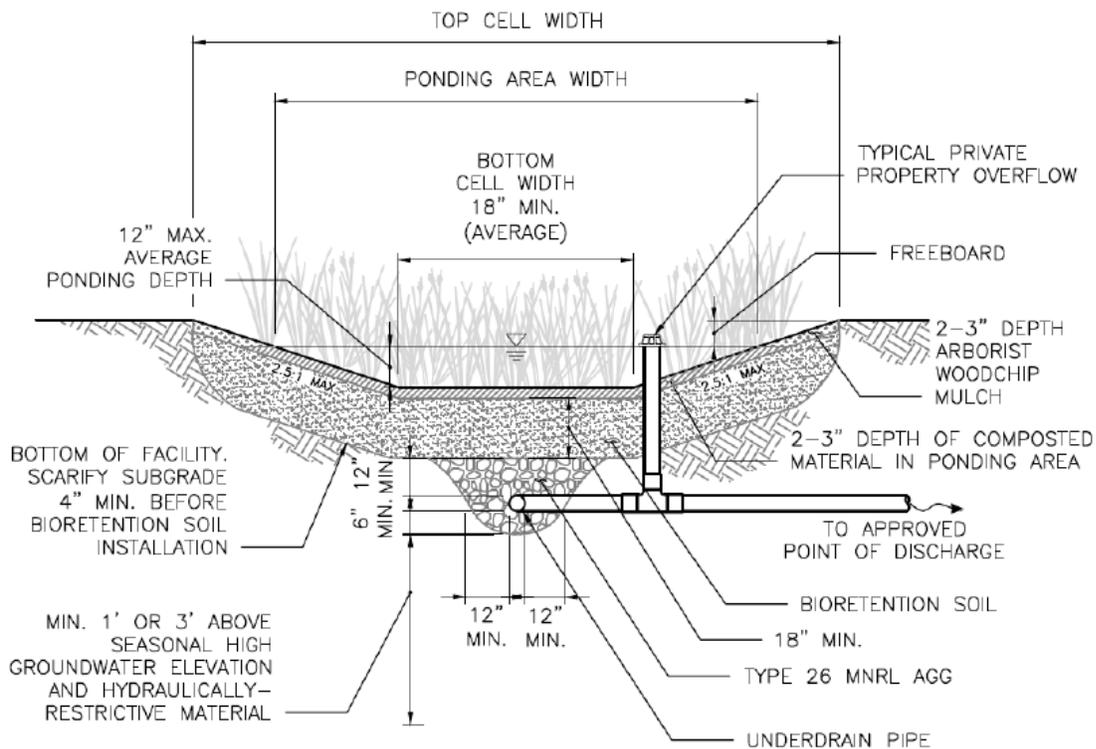


Figure 3. City of Seattle (2016) Infiltrating Bioretention Facility with Underdrain Standard Detail

2.3 Increase Soil Depth

Increasing the soil depth may also aid tree health. It is widely accepted that most tree roots grow near the surface, within the top 18" of the top of the soil. This is because tree roots require air, which is most plentiful near the surface. (Colorado Master Gardener Program 2016) However, engineered soils and structural soils may promote deeper root growth. In sandier and loamy soils that have oxygen and water moving freely through the soil column, similar to BSM, tree roots will move freely downward as long as they are not under drought stress (Urban 2010). Other municipalities around the country recommend deeper soil planting for trees in bioretention. The City of Arlington, Virginia recommends 4 feet deep planting holes for trees in bioretention.

2.4 Additional Example Cross Sections for Trees in Bioretention

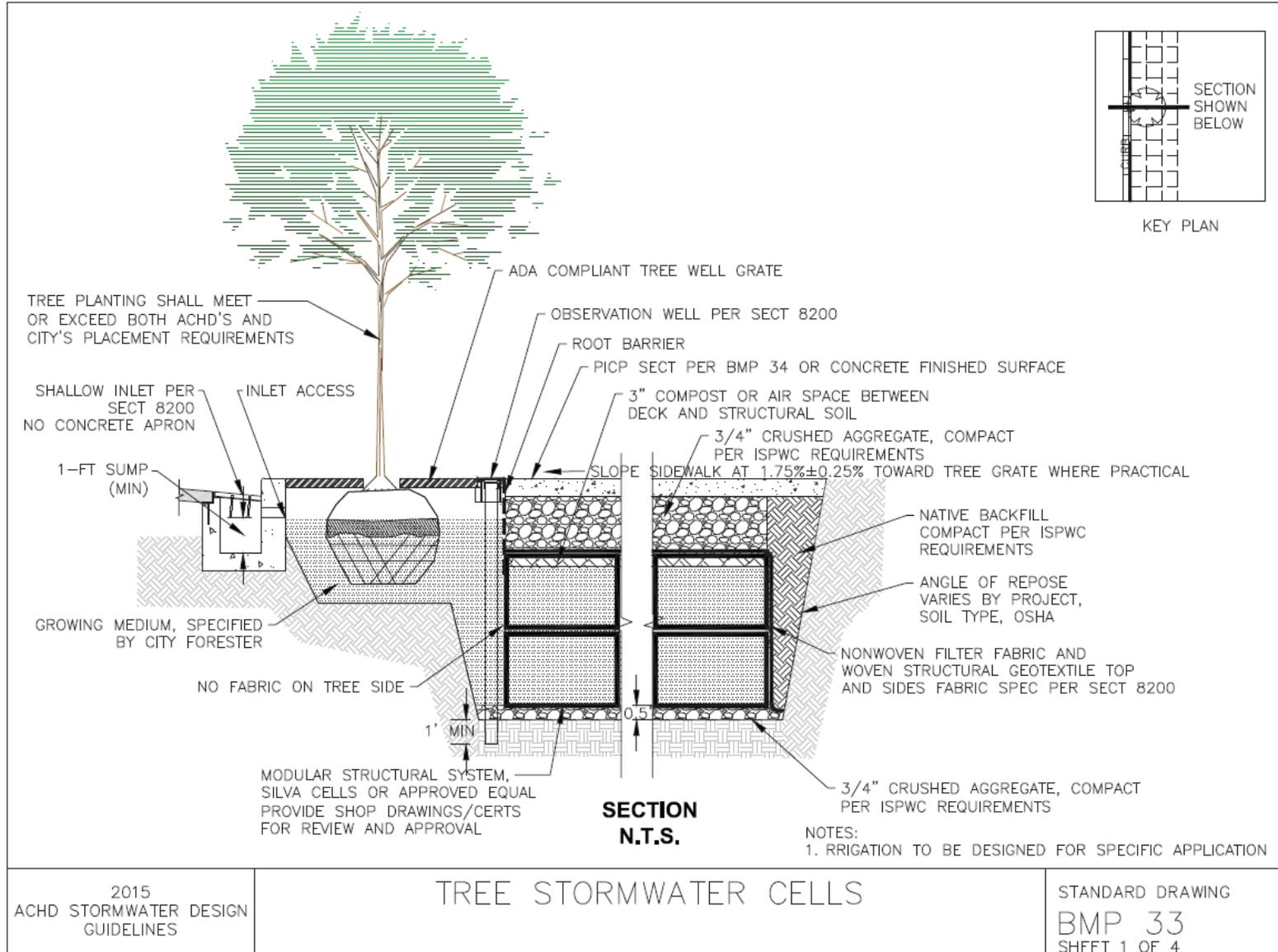


Figure 4. Ada County Highway District Tree Stormwater Cell Detail 1 of 3. (ACHD 2015)

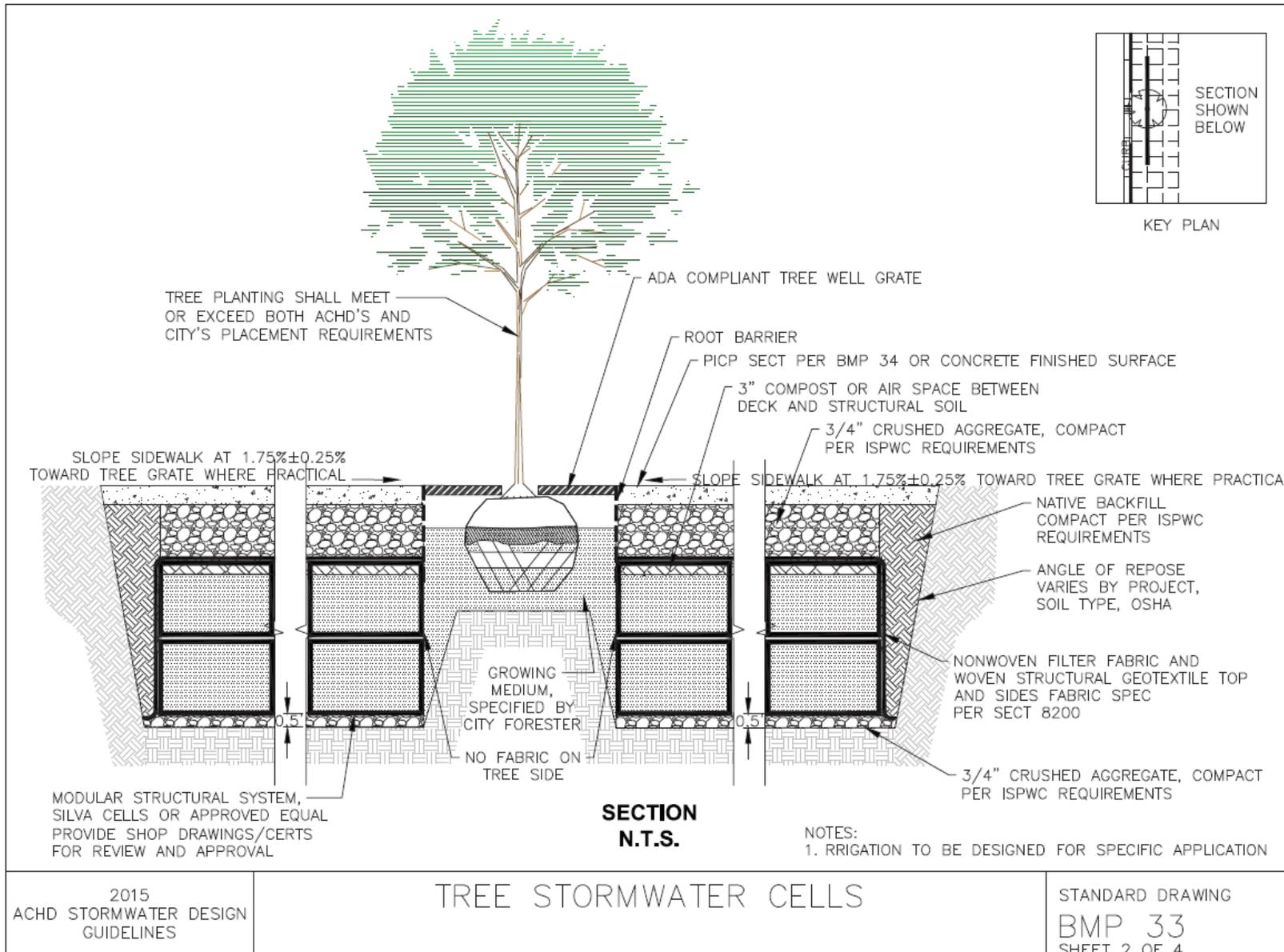


Figure 5. Ada County Highway District Tree Stormwater Cell Detail 2 of 3. (ACHD 2015)

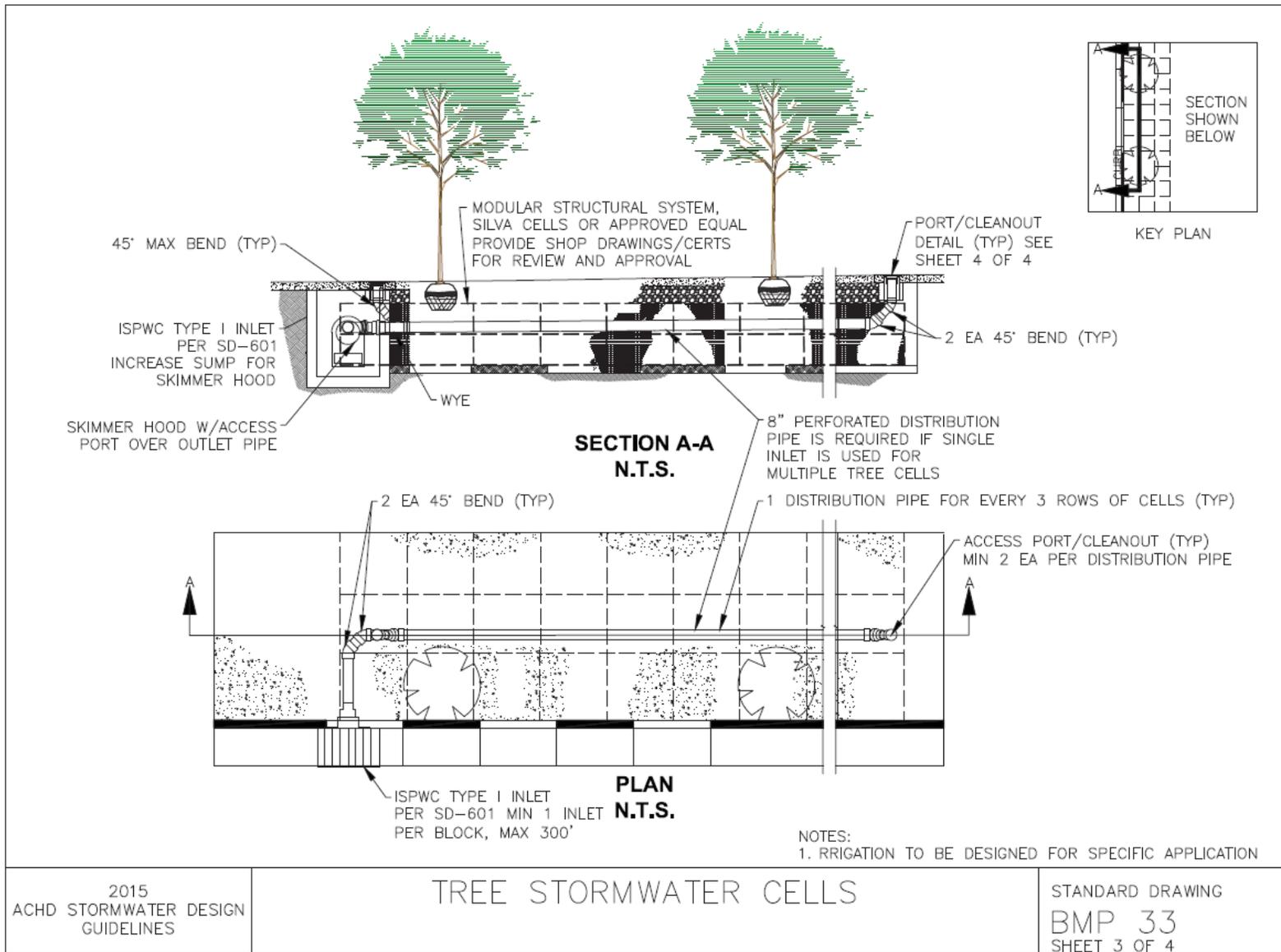
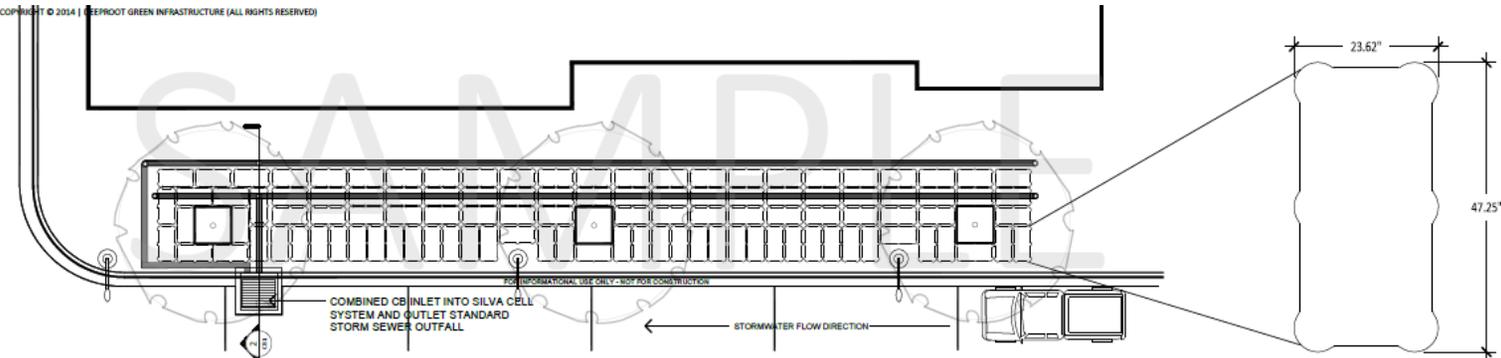
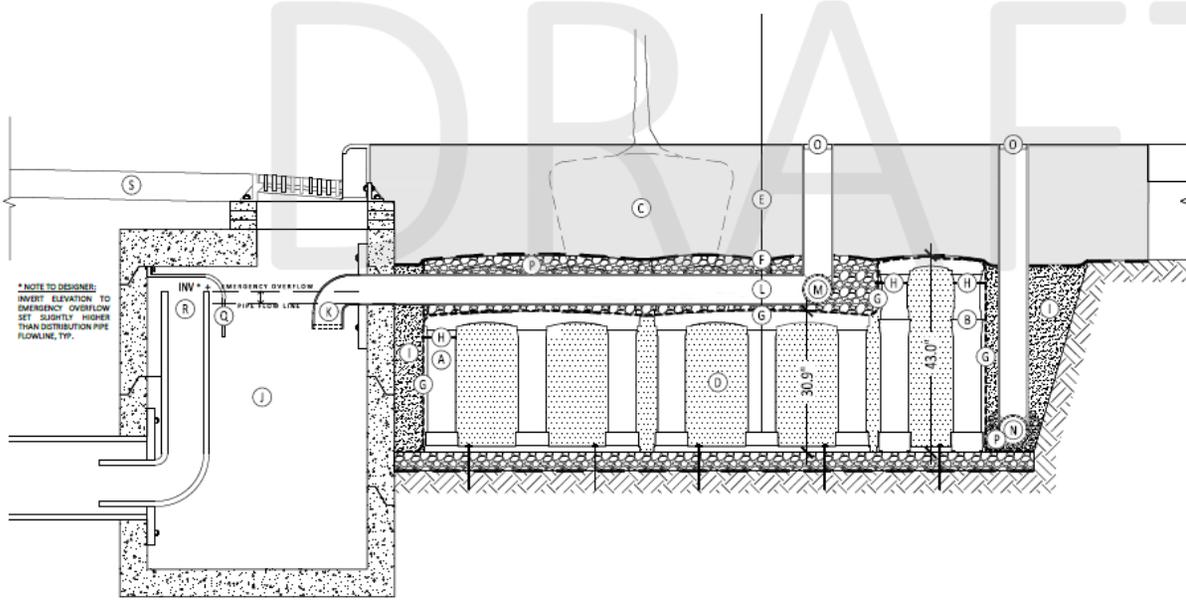


Figure 6. Ada County Highway District Tree Stormwater Cell Detail 3 of 3. (ACHD 2015)



1 STORMWATER TREE APPLICATION | STORM.xCB | SILVA CELL STORMWATER SYSTEM FOR VARIABLE PAVEMENT TYPES: STANDARD CATCH BASIN - SAMPLE LAYOUT
 CB1 NOT TO SCALE

3 TYPICAL SILVA CELL
 CB1 NOT TO SCALE



2 STORMWATER TREE APPLICATION | STORM.xCB | SILVA CELL STORMWATER SYSTEM FOR VARIABLE PAVEMENT TYPES: CATCH BASIN - SECTION
 CB1 NOT TO SCALE

- KEY PLAN
- (A) 2x SILVA CELL SYSTEM (DECK, BASE, AND POSTS)
 - (B) 3x SILVA CELL SYSTEM (DECK, BASE, AND POSTS)
 - (C) TREE IN STORMWATER SILVA CELL SYSTEM, SIZE VARIES
 - (D) BIORETENTION PLANTING SOIL, PER PROJECT
 - (E) PAVEMENT SECTION, PER PROJECT
 - (F) GEOTEXTILE 18" MIN OVERLAP PAST EXCAVATION
 - (G) GEOGRID, PER PROJECT SPECIFICATION. MAX. APERTURE SIZE DETERMINED BY AGGREGATE CLEAR STONE Ø FOR STORMWATER DISTRIBUTION PIPE. ATTACH TO CELL FRAMES WITH CABLE TIES.
 - (H) CABLE TIE, ATTACHING GEOGRID TO SILVA CELL LEG
 - (I) BACKFILL, PER PROJECT SPECIFICATIONS
 - (J) CATCH BASIN WITH CURB INLET AND GRATE PER PROJECT
 - (K) STORMWATER DISTRIBUTION PIPE INLET INTO SILVA CELLS WITH TRASH FILTER, SIZE AND MATERIAL PER PROJECT
 - (L) SOLID DISTRIBUTION PIPE INTO SILVA CELL SYSTEM.
 - (M) PERFORATED DISTRIBUTION PIPE IN AGGREGATE CLEAR STONE.
 - (N) UNDERDRAIN, ENSURE POSITIVE DRAINAGE TO STORMWATER OUTFALL
 - (O) CLEANOUT PIPE WITH CAP, PER PROJECT AND PER CITY STANDARDS. SECURE TO PAVEMENT AT SURFACE
 - (P) CLEAR STONE AGGREGATE, PER PROJECT
 - (Q) PIPE HOOD
 - (R) CATCH BASIN OUTLET, SIZE AND INVERT ELEVATION PER PROJECT TO PREVENT PRESSURE FLOW DISTRIBUTION INTO SILVA CELL SYSTEM
 - (S) ROADWAY

- NOTES
1. DETAIL TO BE USED IN CONJUNCTION WITH SILVA CELL STANDARD DETAILS, IN ACCORDANCE WITH ALL MANUFACTURER'S SPECIFICATIONS
 2. DEEPROOT ACCEPTS NO LIABILITY FOR PROJECT APPLICATION OF DETAILS SHOWN

Figure 7. Draft Silva Cells for Stormwater Tree Applications. (Deeprout 2014)

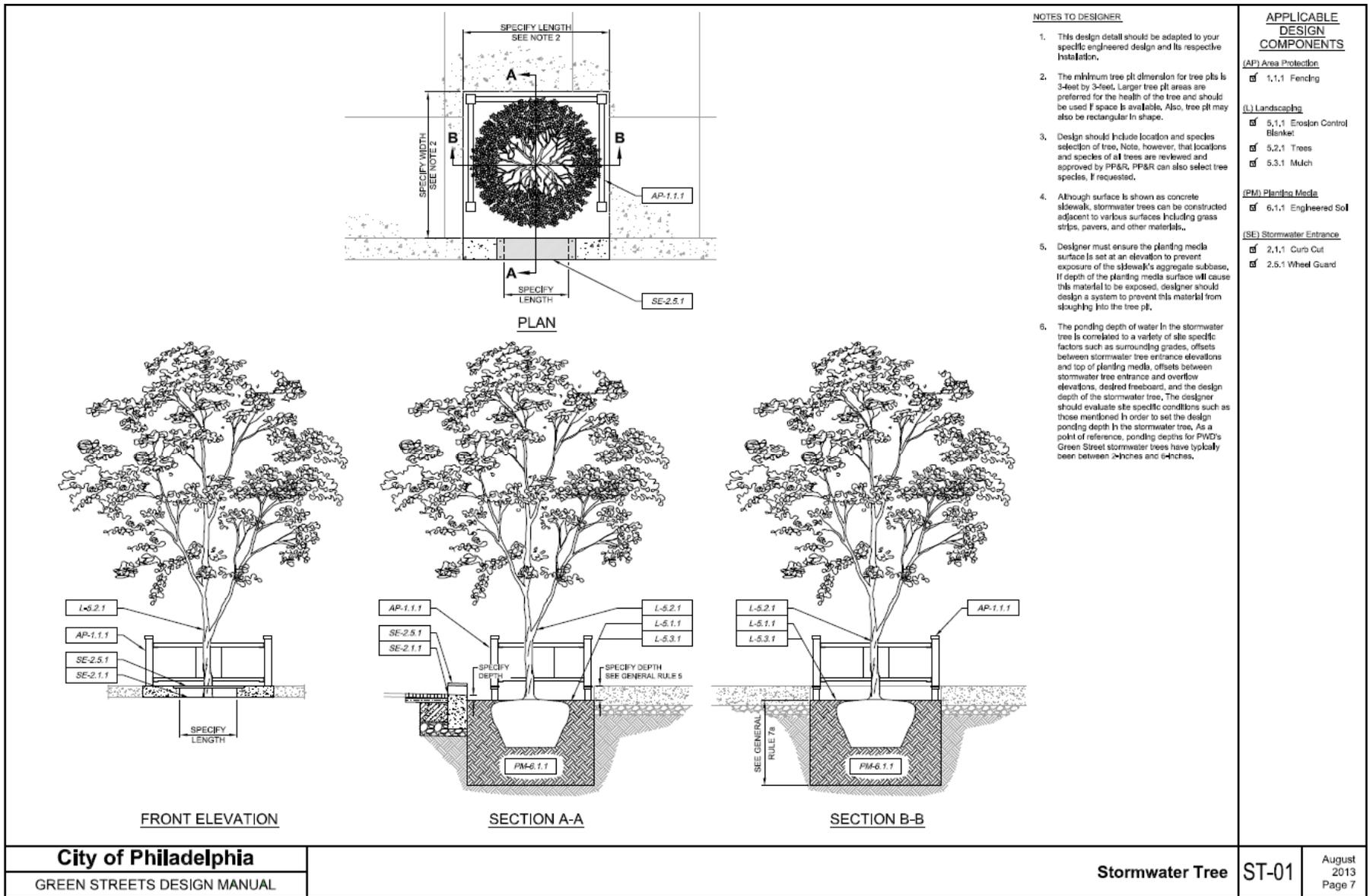


Figure 8. Stormwater Tree Standard Detail, City of Philadelphia. (City of Philadelphia 2013)

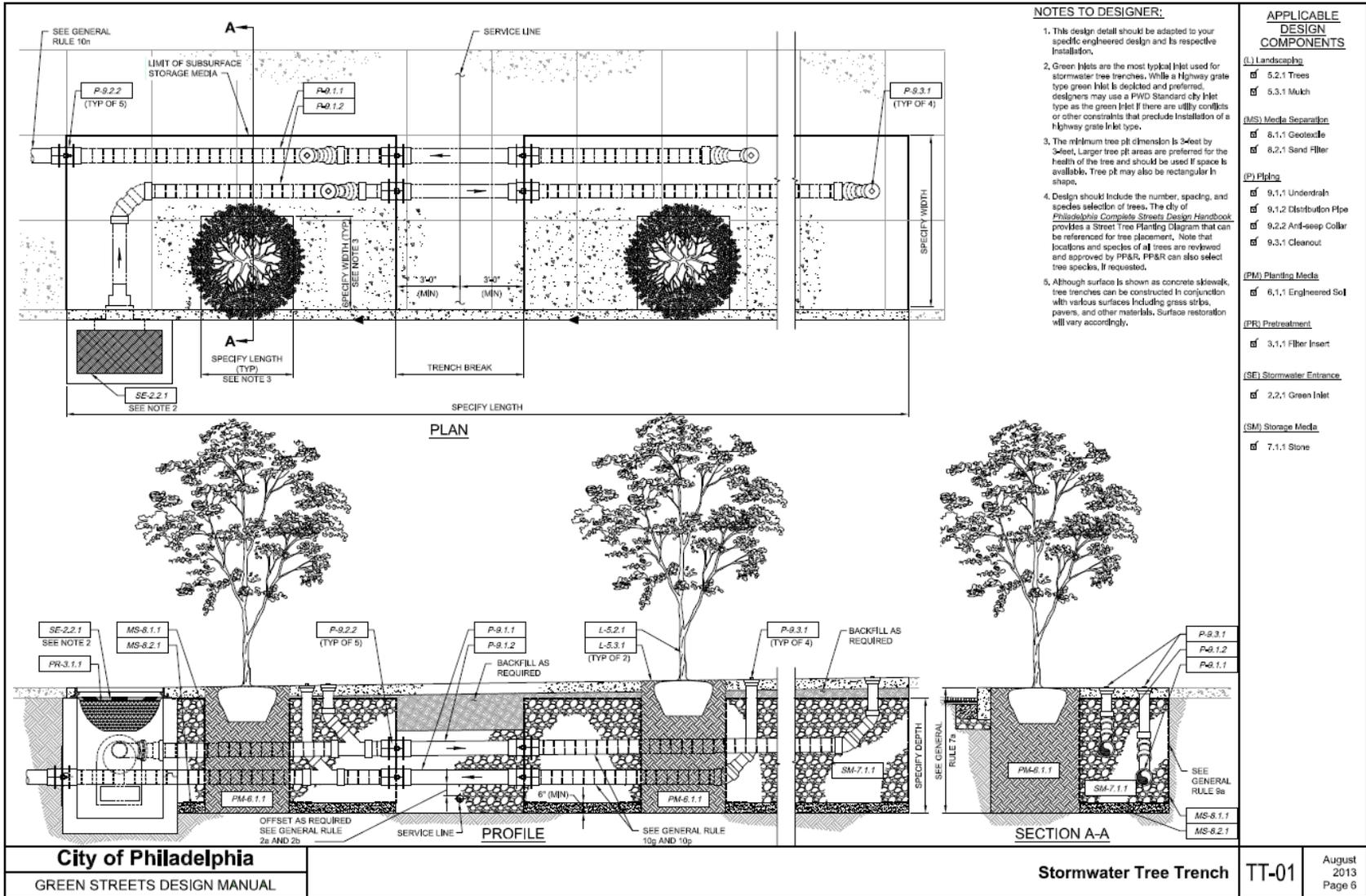


Figure 9. Stormwater Tree Trench Standard Detail, City of Philadelphia. (City of Philadelphia 2013)

2.5 Additional Design Recommendations for Trees in Bioretention

The following recommendations are compiled from a number of sources including the Center for Watershed Protection 2012, Colorado Master Gardener Program 2016, and Deeproot 2013 – 2016.

- **Compacted soils:** On extremely compacted soils, rototill a ring around the backfill area to a width of four, five, or more times the root ball diameter.
- **Select species** that do not provide excessive litter, particularly when planting near impervious surfaces.
- **Select species** that are tolerant of bioretention conditions
- **Root Ball Uncovered:** Do not cover the root ball soil with BSM soil as the texture change will impede the movement of air and water into the root ball.
- **Location:** Plant trees along the bioretention edge on side slopes and where there is no aggregate drainage layer below

3.0 OTHER TREE BMPS

Outside of bioretention, the benefits of trees for capturing and treating stormwater are well recognized. Best practices for urban trees in general have been developed by others as well. While they are not specific to stormwater or bioretention applications, there are numerous best practices that could improve the trajectory of trees in bioretention basins. Specifications for growing urban trees were developed by tree experts, Dr. Ed Gilman, Brian Kempf, and Jim Urban with the Urban Tree Foundation. The best practices guidelines are open source and include planting details and written specifications for planting, staking, soil modifications, irrigation and tree protection. These are included in Appendix A.

A variety of other stormwater BMPs have been developed specifically to support trees and manage stormwater as well. Tree BMPs can mimic certain physical, chemical, and biological processes that occur in the natural environment. Depending upon the design of a facility, different processes can be maximized or minimized depending on the type of pollutant loading expected. Tree BMPs may be able to be linked with bioretention in a treatment train, placed adjacent to a bioretention to share hydrology, or aspects of their design may inform bioretention basin design to enhance tree health.

Suspended Pavement Systems: In areas that do not have enough open space to grow large trees, techniques like structural cells or suspended pavement systems can be used to extend tree rooting volume under load-bearing surfaces and create favorable conditions to grow large trees in urban areas. This rooting volume can also be used for bioretention. While suspended pavement has been built in several different ways, all suspended pavement is held slightly above the soil by a structure that “suspends” the pavement above the soil so that the soil is protected from the weight of the pavement and the compaction generated from its traffic. Another option is modular pre-constructed soil cells that support pavement while allowing the soil below to be tailored to the desired functions like tree growth and stormwater management. Silvacells, Stratacell and Stratavault are three examples of this type of product. Examples are shown in Figures 7 and 10.



Figure 10. Silva Cell diagram (left), and installation (right)

Rock Based Structural Soil: Rock based structural soils are typically engineered to be able to be compacted to 95 percent Proctor density without impeding root growth. Rock based structural soils are typically gap graded engineered soils with the following components:

- Stones to provide load bearing capacity and protect soil in its void spaces from compaction. The stones should be uniformly graded and crushed or angular for maximum porosity, compaction, and structural interface (Bassuk et al., 2005). Mean pore size should be large enough to accommodate root growth (Lindsey, 1994). Significant crushing of stone should not occur during compaction (Lindsey 1994).
- Soil in rock void spaces for tree root growth. Soil needs to have adequate nutrient and water holding capacity to provide for the tree's needs. Although rock-based structural soils consist primarily of rock, with perhaps about 20 percent of the volume consisting of soil, a study by Grabowsky et al. (2009) showed the available water holding capacity of a Cornell University structural soil ranged from 7 to 11 percent. This compares to a typical water holding capacity of about 15 to 20 percent for a loam soil. The structural soil appears to retain water on the aggregate surfaces, meaning a structural soil with only 20 percent soil behaves more like a system with about 50 percent soil in terms of water holding capacity.
- Tackifier to keep the soil uniformly distributed in the rock void spaces (tackifier is only found in some kinds of rock based structural soil). Two (2) inch stones would be able to support most tree roots. The tackifier, if used, should be non-toxic and non-phototoxic.
- Tree species tolerant of extremely well drained soils (Bassuk 2010) because rock based structural soils drain quickly (greater than 24 inches per hour).
- Tree species tolerant of structural soil pH. If limestone-based structural soil is used, trees tolerant of alkaline pH must be selected, as limestone can raise the pH of soil to 8.0 or higher (Bassuk, 2010 soil debate; Urban, 2008).

4.0 REFERENCES

Bassuk, Nina. 2010. Using CU-Structural Soil to Grow Trees Surrounded by Pavement. In The Great Soil Debate Part II: Structural soils under pavement. ASLA Annual Meeting Handout.

Bassuk, Nina, Jason Grabosky, and Peter Trowbridge. 2005. Using CU-Structural Soil™ in the Urban Environment.

Colorado Master Gardener Program 2016, "The Science of Planting Trees" accessed at : <http://www.ext.colostate.edu/mg/gardennotes/633.html>

Cornell University. 2005. Using CU-Structural Soil™ in the Urban Environment.

Deeproot Green Infrastructure, L.P. 2010. "How Deep do Tree Roots Grow?" accessed at <http://www.deeproot.com/blog/blog-entries/how-deep-do-tree-roots-grow>

Deeproot Green Infrastructure, L.P. 2010. "Illustrated Guide to Using Trees and Soils to Manage Stormwater" accessed at <http://www.deeproot.com/blog/blog-entries/illustrated-summary-of-using-trees-and-soils-to-manage-stormwater>

Grabosky, Jason, Edward Haffner, and Nina Bassuk. 2009. Plant Available Moisture in Stone-soil Media for Use Under Pavement While Allowing Urban Tree Root Growth. *Arboriculture & Urban Forestry* 35(5): 271-278.

Minnesota Pollution Control Agency 2014. "Types of Tree BMPs" accessed at: http://stormwater.pca.state.mn.us/index.php/Types_of_tree_BMPs

Urban, James. 2008. *Up by Roots*. Published by International Society of Arboriculture. 479 pages.

Urban Horticulture Institute 2007. "CU-Structural Soil Graphics and Plan Views" accessed at <http://www.hort.cornell.edu/uhi/outreach/csc/graphics.html>

Xiao, Qingfu, and E. Greg McPherson. 2008. Urban Runoff Pollutants Removal Of Three Engineered Soils. USDA Center for Urban Forest Research and UC Davis Land, Air and Water Resources.

Appendix A
Urban Tree Foundation Open Source
Specifications

32 9100 Planting Soil

DISCLAIMER AND RESPONSIBILITY OF THE USER

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INSTRUCTIONS TO THE SPECIFICATION WRITER:

The following document is intended as a general specification to guide the writing of a project-specific specification. Each project is unique and it is required that the specification be developed accordingly. DO NOT USE THE FOLLOWING SPECIFICATION WITHOUT MAKING IMPORTANT ADJUSTMENTS to reflect local conditions, regulations, market standards, project schedules and local and regional practices. The following are specific items that need to be addressed.

1. General instructions for using this specification: These instructions are intended to guide the specification writer (the specifier) through the process of editing this document into a Planting Soil specification. Be sure to delete these instructions (i.e. all the text in red displayed above the paragraph) before issuing the specifications.

2. General Requirements - Division 01 (Construction Specification Institute) specifications and other contract elements: This specification is designed to be used in conjunction with standard Division 01 specifications, which cover project general conditions and project wide contract elements. **THIS IS NOT A STAND-ALONE SPECIFICATION** and should not be used as a contract for the modification, purchase of and installation of planting soil. Important issues of project ownership, liability, insurance, contract language, project controls, Instructions to bidders, change orders and review and approval of the work are normally in the Division 01 specifications.

3. The construction team: A construction project is a team effort where the Owner, in effect, creates a partnership with all the Contractors to build a project. As with any good contract there are protections for all parties that the Owner will get the quality of project that they desire within the time limits and budget available; and the Contractor will be paid for the work satisfactorily completed. In between the initial bidding and the final completion there will be many places where parts of the construction do not work out as originally intended. This is normal and a good contract should allow for these changes in a manner that is equitable to both the Owner and the Contractor. To get there, a team approach and spirit must prevail. All parties must assume that each is operating in the best interest of the project goals. The clearer the goals and description of the project, the smoother the flow of a successful project. **The more each of the team members can trust the other members, the better the project.** This should be a critical principle in approaching interpretation of the specification.

4. Other project documents: This specification is intended to be used in conjunction with other project documents including the bid forms, the construction contract, Division 1 specifications, other specifications directly related to this section; other specifications that are not directly related to this work and most critically the Project construction drawings. It is very critical that all these documents be prepared with consistent terminology and that they be coordinated. The terms used for the parts of trees and other plants, different soil types, drainage features, irrigation features and structures such as paving, walls and planters must be consistent across disciplines. A very common mistake is the use of different terms and details for soil and the extent of soil work. The terms and details for planting, planting soil, subsoil and other materials must be well coordinated.

5. Related specification sections: This specification requires an additional specification section to describe several important related parts of the planting process.

Tree Protection: This specification assumes that there is a separate specification section and construction drawings and details for tree protection; remove this section if there are no existing trees to be protected on the project.

Planting: This specification assumes that there is a separate specification section and construction

drawings for installation of plants.

Irrigation: *This specification assumes that there might be a separate specification section for irrigation associated with the project planting.*

6. Reviewing and approval authority: *Each specification identifies a certain entity as responsible for the review and approval of the work, project submittals, changes to the work and final acceptance of the work. The entity is normally identified in Division 1. For the purposes of this specification, the term the “Owner’s Representative” has been used as a placeholder for this entity. Once the proper term is defined (for example Contracting Officer, The Architect, The Landscape Architect, The Engineer etc.) this term should replace the words “Owner’s Representative” wherever it appears in this specification.*

7. Header and footer requirements: *Change the header/footer language to meet the project requirements.*

8. Note to specifier: *Before issuing the document, be sure to remove all “Note to specifier” incorporated into this document in red text after you have read them and responded to the recommendations.*

9. Submittals: *Submittals are a critical part of any construction contract. This is where all products and materials are reviewed and approved in advance of the work. Planting Soil quality control is in this section. Including very specific requirements for approval of submittals, while a good practice, assumes that the reviewing authority has the skills needed to make these reviews and interpret the results. A common practice is to make very specific requirements but not have the time or expertise to enforce them. Lack of review of submittals does not automatically transfer quality control to the Contractor. In fact, lack of review or inappropriate review can make the reviewing authority responsible for having accepted the submittal even if it was not acceptable. **Do not put into the specification submittal requirements that you do not have the time, resources or knowledge, which you knew or should have known, to enforce.***

10. Specification modifications: *There are locations in this specification where additional information is required to reflect project region or contract conditions. Please insert the requested information.*

SECTION 32 9100

PLANTING SOIL

PART 1 – GENERAL

1.1 SUMMARY

Note to specifier: *Remove parts of this work description that do not apply.*

- A. The scope of work includes all labor, materials, tools, supplies, equipment, facilities, transportation and services necessary for, and incidental to performing all operations in connection with furnishing, delivery, and installation of Planting Soil and /or the modification of existing site soil for use as Planting Soil, complete as shown on the drawings and as specified herein.
- B. The scope of work in this section includes, but is not limited to, the following:
 - 1. Locate, purchase, deliver and install Imported Planting Soil and soil amendments.
 - 2. Harvest and stockpile existing site soils suitable for Planting Soil.
 - 3. Modify existing stockpiled site soil.
 - a. Modify existing site soil in place for use as Planting Soil.
 - b. Install existing or modified existing soil for use as Planting Soil.
 - 4. Locate, purchase, deliver and install subsurface Drain Lines.
 - 5. Fine grade Planting Soil.
 - 6. Install Compost into Planting Soil.
 - 7. Clean up and disposal of all excess and surplus material.

1.2 CONTRACT DOCUMENTS

- A. Shall consist of specifications, general conditions, and the drawings. The intent of these documents is to include all labor, materials, and services necessary for the proper execution of the work. The documents are to be considered as one. Whatever is called for by any parts shall be as binding as if called for in all parts.

1.3 RELATED DOCUMENTS AND REFERENCES

- A. Related Documents:

Note to specifier: *Coordinate this list with the other related specification sections. Add or delete sections as appropriate.*

- 1. Drawings and general provisions of contract, including general and supplementary conditions and Division I specifications, apply to work of this section.
- 2. Related Specification Section
 - a. Section - Planting
 - b. Section - Irrigation
 - c. Section – Lawn
 - d. Section – Tree and Plant Protection
- B. References: The following specifications and standards of the organizations and documents listed in this paragraph form a part of the Specification to the extent required by the references thereto. In the event that the requirements of the following referenced standards and specification conflict with this specification section the requirements of this specification shall prevail. In the event that the requirements of any of the following referenced standards and specifications conflict with each other the more stringent requirement shall prevail.
 - 1. ASTM: American Society of Testing Materials cited section numbers.
 - 2. U.S. Department of Agriculture, Natural Resources Conservation Service, 2003. National Soil

Survey Handbook, title 430-VI. Available Online.

3. US Composting Council www.compostingcouncil.org and http://compostingcouncil.org/admin/wp-content/plugins/wp-pdfupload/pdf/191/LandscapeArch_Specs.pdf.
4. *Methods of Soil Analysis*, as published by the Soil Science Society of America (<http://www.soils.org/>).
5. *Up by Roots: healthy soils and trees in the built environment*. 2008. J. Urban. International Society of Arboriculture, Champaign, IL.

1.4 VERIFICATION

- A. All scaled dimensions on the drawings are approximate. Before proceeding with any work, the Contractor shall carefully check and verify all dimensions and quantities, and shall immediately inform the Owner's Representative of any discrepancies between the information on the drawings and the actual conditions, refraining from doing any work in said areas until given approval to do so by the Owner's Representative.

1.5 PERMITS AND REGULATIONS

- A. The Contractor shall obtain and pay for all permits related to this section of the work unless previously excluded under provision of the contract or general conditions. The Contractor shall comply with all laws and ordinances bearing on the operation or conduct of the work as drawn and specified. If the Contractor observes that a conflict exists between permit requirements and the work outlined in the contract documents, the Contractor shall promptly notify the Owner's Representative in writing including a description of any necessary changes and changes to the contract price resulting from changes in the work.
- B. Wherever references are made to standards or codes in accordance with which work is to be performed or tested, the edition or revision of the standards and codes current on the effective date of this contract shall apply, unless otherwise expressly set forth.
- C. In case of conflict among any referenced standards or codes or among any referenced standards and codes and the specifications, the more restrictive standard shall apply or Owner's Representative shall determine which shall govern.

Note to specifier: *Remove the paragraph below if the project is not in California.*

- D. Comply with the requirements of the California code of regulation title 23 waters, division 2 department of water resources chapter 2.7 model water efficient landscape ordinance, 492.5 soil management report.
 1. Where requirements of specification section Planting Soil are more stringent than the California code, the more stringent requirements shall prevail.

1.6 PROTECTION OF WORK, PROPERTY AND PERSON

- A. The Contractor shall adequately protect the work, adjacent property, and the public, and shall be responsible for any damages or injury due to the Contractor's actions.

1.7 CHANGES IN WORK

- A. The Owner's Representative may order changes in the work, and the contract sum adjusted accordingly. All such orders and adjustments plus claims by the Contractor for extra compensation must be made and approved in writing before executing the work involved.
- B. All changes in the work, notifications and contractor's request for information (RFI) shall conform to the contract general condition requirements.

1.8 CORRECTION OF WORK

- A. The Contractor shall re-execute any work that fails to conform to the requirements of the contract and shall remedy defects due to faulty materials or workmanship upon written notice from the Owner's Representative, at the soonest possible time that can be coordinated with other work and seasonal

weather demands but not more than 180 (one hundred and eighty) days after notification.

1.9 DEFINITIONS

Note to specifier: Use the following definitions as needed to define words used in this specification. Delete and words that are not used.

- A. Acceptable drainage: Drainage rate is sufficient for the plants to be grown. Not too fast and not too slow. Typical rates for installed Planting Soil are between 1 - 5 inches per hour. Turf soils are often higher, but drainage rates above 2 - 3 inches per hour will dry out very fast. In natural undisturbed soil a much lower drainage rate, as low as 1/8th inch per hour can still support good plant growth. Wetland plants can grow on top of perched water layers or even within seasonal perched water layers, but could become unstable in high wind events.
- B. Amendment: material added to Topsoil to produce Planting Soil Mix. Amendments are classified as general soil amendments, fertilizers, biological, and pH amendments.
- C. Biological Amendment: Amendments such as Mycorrhizal additives, compost tea or other products intended to change the soil biology.
- D. Compacted soil: soil where the density of the soil is greater than the threshold for root limiting, and further defined in this specification.
- E. Compost: well decomposed stable organic material as defined by the US Composting Council and further defined in this specification.
- F. Drainage: The rate at which soil water moves through the soil transitioning the soil from saturated condition to field capacity. Most often expressed as saturated hydraulic conductivity (Ksat; units are inches per hour).

Note to specifier: The following is a general introduction to soil drainage terminology and is intended for the benefit of the specifier only. Do not include the following information in the completed specifications.

The drainage rate of any soil is also influenced by the drainage rate of the soil lower in the profile. A compacted hard pan or Cliché layer below a free drainage soil can create poor drainage in the upper soil profile. To understand soil drainage one must investigate the total profile. Measured drainage rates are also highly influenced by soil compaction particularly in installed soil. A soil that drains at 1 inch per hour at 200 psi might become anaerobic if compacted to 350 psi. The amount of organic matter also influences drainage particularly if the organic matter is the result of adding Compost to the soil. A little Compost (10% by volume) will almost always increase drainage, but at higher amounts of Compost above 20% by volume will begin to slow drainage in the lower level of the profile because the Compost also holds water. In general it is not advisable to add much Compost to Planting Soil Mixes that are to be placed deeper than 12 inches but lots of Compost can be added to the upper 6 inches of the soil profile.

- G. End of Warranty Acceptance: The date when the Owner's Representative accepts that the plants and work in this section meet all the requirements of the warranty. It is intended that the materials and workmanship warranty for Planting, Planting Soil, and Irrigation (if applicable) work run concurrent with each other, and further defined in this specification.
- H. Existing Soil: Mineral soil existing at the locations of proposed planting after the majority of the construction within and around the planting site is completed and just prior to the start of work to prepare the planting area for soil modification and/or planting, and further defined in this specification.
- I. Fertilizer: amendment used for the purpose of adjusting soil nutrient composition and balance.
- J. Fine grading: The final grading of the soil to achieve exact contours and positive drainage, often accomplished by hand rakes or drag rakes other suitable devices, and further defined in this specification, and further defined in this specification.
- K. Finished grade: surface or elevation of Planting Soil after final grading and 12 months of settlement of the soil, and further defined in this specification.

- L. Graded soil: Soil where the A horizon has been stripped and relocated or re-spread; cuts and fills deeper than 12 inches, and further defined in this specification.
- M. Installed soil: Planting soil and existing site soil that is spread and or graded to form a planting soil, and further defined in this specification.
- N. Minor disturbance: Minor grading as part of agricultural work that only adjusts the A horizon soil, minor surface compaction in the top 6 inches of the soil, applications of fertilizers, installation of utility pipes smaller than 18 inches in diameter thru the soil zone.
- O. Owner's Representative: The person or entity, appointed by the Owner to represent their interest in the review and approval of the work and to serve as the contracting authority with the Contractor. The Owner's Representative may appoint other persons to review and approve any aspects of the work.
- P. Ped: a clump or clod of soil held together by a combination of clay, organic matter, and fungal hyphae, retaining the original structure of the harvested soil.
- Q. Planting Soil: Topsoil, or Planting Soil Mixes which are imported or existing at the site, or made from components that exist at the site, or are imported to the site; and further defined in this specification.
- R. *Poor drainage: Soil drainage that is slower than that to which the plants can adapt. This is a wide range of metrics, but generally if the soil is turning grey in color it is reasonable preferable to either to plant moisture adaptive plants at smaller sizes that are young in age with shallow root balls or look at options to improve the drainage*
- S. Scarify: Loosening and roughening the surface of soil and sub soil prior to adding additional soil on top, and further defined in this specification.
- T. Soil Fracturing: Deep loosening the soil to the depths specified by using a back hoe, and further defined in this specification.

Note to specifier: *The following paragraph is a general introduction to soil fracturing terminology and is intended for the benefit of the specifier only. Do not include the following information in the completed specifications.*

The back hoe method of soil fracturing is more practical in small spaces and can be more selective in areas and depths loosened when constrained by utility lines and structures such as walks, curbing or walls. The back hoe digs into the soil lifting and then dropping the soil immediately back into the hole. The bucket then moves to the adjacent soil and repeats. Optimally, a layer of Compost is spread over the soil before fracturing is begun and the Compost falls into the spaces between the soil chunks created by the effort. The deeper the fracturing and the more compact and dryer the soil the more difficult the operation becomes, but is generally less limited by built objects than soil ripping. Fracturing is not practical when soil moisture is close to or above field capacity. Fracturing leaves the soil surface quite rough with large soil clods. These must be broken by additional tilling. Tilling in more Compost to the surface after fracturing will help create an A horizon soil and/or imported or reused Topsoil can be added on top of the fractured soil.

- U. Soil Horizons: as defined in the USDA National Soil Survey Handbook
http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242.
- V. Soil Ripping: Loosening the soil by dragging a ripping shank or chisel thru the soil to the depths and spacing specified, and further defined in this specification.

Note to specifier: *The following is a general introduction to soil ripping terminology and is intended for the benefit of the specifier only. Do not include the following paragraph in the completed specifications.*

Soil ripping requires large heavy equipment to be able to operate in the space. The deeper the ripping and the more compact and dryer the soil the more difficult the operation becomes. Ripping is not practical when soil moisture is close to or above field capacity. Existing shallow utilities such as electric and particularly irrigation lines make ripping near these lines difficult if not impossible.

- W. Soil Tilling: Loosening the surface of the soil to the depths specified with a **rotary tine tilling machine, roto tiller, (or spade tiller)**, and further defined in this specification.

Note to specifier: *The following is a general introduction to soil tilling terminology and is intended for the benefit of the specifier only. Do not include the following information in the completed specifications.*

Compost can be added at the time of tilling. Tilling has the advantage of using more compact equipment that can work in small spaces. The great disadvantage is that even large commercial tillers are limited to about 8 inches maximum tilling depth. Garden tillers typically have a maximum depth of 6 inches. The second disadvantage is that the tines create additional compaction below the tilled soil and drainage will be reduced between the tilled soil and the undisturbed subsoil.

*A new tiller called a **spade tiller** is becoming available that does a better job at breaking the interface between the tilled soil and the subsoil as well as retaining some of the original soil structure. This type of tiller, originally developed for the wine industry, is preferred if one is available.*

As with all soil modification techniques, Soil Tilling is more difficult the more compact and dryer the soil. Soil Tilling is not practical when soil moisture is close to or above field capacity.

- X. Soil trenching: Cutting narrow trenches thru the soil at the depths and spacing specified to loosen the soil profile, and further defined in this specification.

Note to specifier: *The following is a general introduction to soil trenching terminology and is intended for the benefit of the specifier only. Do not include the following paragraph in the completed specifications.*

Where space is limited and soil fracturing is not practical, the soil can be trenched using a standard chain trenching machine. This can cut trenches easily in compacted soil to depths of 30 inches or more. The trenches are dug about 3 feet on center and backfilled with Compost. This improves drainage and over time loosens the soil between the trenches. Trenching is usually combined with additional Compost and surface soil tilling to create a new A horizon. Soil trenching is not practical when soil moisture is close to or above field capacity but not very limited by dry soil conditions.

- Y. Subgrade: surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing Planting Soil.
- Z. Substantial Completion Acceptance: The date at the end of the Planting, Planting Soil, and Irrigation installation (if applicable) where the Owner's Representative accepts that all work in these sections is complete and the Warranty period has begun. This date may be different than the date of substantial completion for the other sections of the project, and further defined in this specification.
- AA. Topsoil: naturally produced and harvested soil from the A horizon or upper layers or the soil as further defined in this specification.
- BB. Undisturbed soil: Soils with the original A horizon intact that have not been graded or compacted. Soils that have been farmed, subjected to fire or logged but not graded, and natural forested land will be considered as undisturbed.

1.10 SUBMITTALS

- A. See the contract General Conditions for policy and procedures related to submittals.
- B. Submit all product submittals eight weeks prior to the start of the soil work.

Note to specifier: *Confirm submittal time above is appropriate for project schedule.*

- C. Product data and certificates: For each type of manufactured product, submit data and certificates that the product meets the specification requirements, signed by the product manufacturer, and complying with the following:
1. Submit manufacturers or supplier's product data and literature certified analysis for standard products and bulk materials, complying with testing requirements and referenced standards and

specific requested testing.

- a. For each Compost product submit the following analysis by a recognized laboratory:
 - 1.) pH
 - 2.) Salt concentration (electrical conductivity)
 - 3.) Moisture content %, wet weight basis
 - 4.) Particle size % passing a selected mesh size, dry weight basis
 - 5.) Stability carbon dioxide evolution rate mg CO₂-C per g OM per day
 - 6.) Solvita maturity test
 - 7.) Physical contaminants (inerts) %, dry weight basis
 - 8.) US EPA Class A standard, 40CFR § 503.13, Tables 1 and 3 levels Chemical Contaminants mg/kg (ppm)
 - b. For Coarse Sand product submit the following analysis by a recognized laboratory:
 - 1.) pH
 - 2.) Particle size distribution (percent passing the following sieve sizes):
 - 3/8 inch (9.5 mm)
 - No 4 (4.75 mm)
 - No 8 (2.36 mm)
 - No 16(1.18 mm)
 - No 30 (.60 mm)
 - No 50 (.30 mm)
 - No 100 (.15 mm)
 - No 200 (.075 mm)
- D. Samples: Submit samples of each product and material, where required by Part 2 of the specification, to the Owner's Representative for approval. Label samples to indicate product, characteristics, and locations in the work. Samples will be reviewed for appearance only.
1. Submit samples a minimum of 8 weeks prior to the anticipated date of the start of soil installation.
 2. Samples of all Topsoil, Coarse Sand, Compost and Planting Soil shall be submitted at the same time as the particle size and physical analysis of that material.
- E. Soil testing for Imported and Existing Topsoil, existing site soil to be modified as Planting Soil and Planting Soil Mixes.
1. Topsoil, existing site soil and Planting Soil Mix testing: Submit soil test analysis report for each sample of Topsoil, existing site soil and Planting Soil from an approved soil-testing laboratory and where indicated in Part 2 of the specification as follows:
 - a. Submit Topsoil, Planting Soil, Compost, and Coarse Sand for testing at least 8 weeks before scheduled installation of Planting Soil Mixes. Submit Planting Soil Mix test no more than 2 weeks after the approval of the Topsoil, Compost and Coarse Sand. Do not submit to the testing laboratory, Planting Soil Mixes, for testing until all Topsoil, Compost and Coarse Sand have been approved.
 - b. If tests fail to meet the specifications, obtain other sources of material, retest and resubmit until accepted by the Owner's Representative.
 - c. All soil testing will be at the expense of the Contractor.
 2. Submit all testing required by California Code of regulation Title 23 waters, Division 2 Department of Water resources Chapter 2.7 Model Water Efficient Landscape Ordinance, 492.5 Soil Management Report.
Note to specifier: Delete the above paragraph if the project is not in California.
 3. Provide a particle size analysis (% dry weight) and USDA soil texture analysis. Soil testing of Planting Soil Mixes shall also include USDA gradation (percentage) of gravel, coarse sand, medium sand, and fine sand in addition to silt and clay.
 4. Provide the following other soil properties:
 - a. pH and buffer pH.

- b. Percent organic content by oven dried weight.
- c. Nutrient levels by parts per million including: phosphorus, potassium, magnesium, manganese, iron, zinc and calcium. Nutrient test shall include the testing laboratory recommendations for supplemental additions to the soil for optimum growth of the plantings specified.
- d. Soluble salt by electrical conductivity of a 1:2 soil water sample measured in Milliohm per cm.
- e. Cation Exchange Capacity (CEC).

1.11 SOIL INSTALLATION MOCKUP

Note to specifier: *This section is designed to provide the construction team an opportunity to test means and methods and to record expectations on the finished soil installation. The Owner's Representative must understand enough about soil installation to make an assessment of the mockup and have sufficient observation fee budget to review the work. Mockups add to the cost of the project and this section should be evaluated for its critical nature to the soil installation scope.*

- A. Prior to installation or modification of Topsoil, site soil, Planting Soil, or Planting Soil Mixes, construct at the site, a mockup of each soil type using the means and methods and equipment proposed by the Contractor to complete the work. Installation of the mockup shall be in the presence of the Owner's Representative. The purpose of the mockup is to test the methods of installation and compaction of the soil and to serve as a benchmark for completed soil compaction and serve to calibrate penetrometer readings to the known proctor density of the mockup. The mockup shall be as follows:
 - 1. Following acceptance of the soil submittals, in areas that can be protected from disturbance and further compaction, install mockups of each soil type and soil modification, 20 foot X 20 foot X the full depth of the deepest installation, using the requirements of these specifications. Compaction methods, including the type of compaction equipment and number of passes required to achieve the required compaction, shall be evaluated and results measured.
 - 2. Compaction in the mockup soil shall be tested using the penetrometer. A minimum of four penetrometer readings from each Planting Soil shall be taken at the specified depths of the soil profile. Record the soil moisture at each penetrometer test site. In the event that the penetrometer readings exceed the specified densities, reconstruct the mockup, adjusting the soil density to achieve the desired results. Where the modification requires ripping, tilling or fracturing soils that are over compacted, start the procedure in a new location so that the process is working on soil that is similar to the density of the expected soil.
 - 3. Submit a report of the final methods of soil installation, the penetrometer and soil moisture readings to the Owner's Representative.
 - 4. The mockup area may remain as part of the installed work at the end of the project if protected from further compaction, contamination or other disturbance.
 - 5. Provide a protective 4 foot high fence on metal posts around each mockup to keep all work and equipment from entering the surface of the mockup area.

1.12 OBSERVATION OF THE WORK

- A. The Owner's Representative may observe the work at any time. They may remove samples of materials for conformity to specifications. Rejected materials shall be immediately removed from the site and replaced at the Contractor's expense. The cost of testing materials not meeting specifications shall be paid by the Contractor.
 - 1. The Owner's Representative may utilize the Contractor's penetrometer and moisture meter at any time to check soil compaction and moisture.
- B. The Owner's Representative shall be informed of the progress of the work so the work may be observed at the following key times in the construction process. The Owner's Representative shall be afforded sufficient time to schedule visit to the site. Failure of the Owner's Representative to make field observations shall not relieve the Contractor from meeting all the requirements of this specification.

1. SOIL MOCKUP REVIEW: At the time of construction of all soil mockups.
2. EXISTING SOIL CONDITIONS REVIEW: Prior to the start of any soil modification that will utilize or modify the existing soil.
3. EXCAVATION REVIEW: Observe each area of excavation prior to the installation of any Planting Soil.
4. DRAIN LINE INSTALLATION REVIEW: Upon completion of the installation of drain lines and prior to the installation of any Planting Soil
5. COMPLETION of SOIL MODIFICATIONS REVIEW: Upon completion of all soil modification and installation of planting soil.
6. COMPLETION OF FINE GRADING AND SURFACE SOIL MODIFICATIONS REVIEW: Upon completion of all surface soil modifications and fine grading but prior to the installation of shrubs, ground covers, or lawns.

1.13 PRE-CONSTRUCTION CONFERENCE

- A. Schedule a pre-construction meeting with the Owner's Representative at least seven (7) days before beginning work to review any questions the Contractor may have regarding the work, administrative procedures during construction and project work schedule.

1.14 QUALITY ASSURANCE

- A. Installer Qualifications: The installer shall be a firm having at least 5 years of experience of a scope similar to that required for the work, including the preparation, mixing and installation of soil mixes to support planting. The installer of the work in Section: Planting, shall be the same firm installing the work in this section.
 1. The bidders list for work under this section shall be approved by the Owner's Representative.
 2. Installer Field Supervision: When any Planting Soil work is in progress, installer shall maintain, on site, an experienced full-time supervisor who can communicate in English with the Owner's Representative.
 3. Installer's field supervisor shall have a minimum of five years experience as a field supervisor installing soil, shall be trained and proficient in the use of field surveying equipment to establish grades and can communicate in English with the Owner's Representative.
 4. The installer's crew shall be experienced in the installation of Planting Soil, plantings, and irrigation (where applicable) and interpretation of planting plans, soil installation plans, and irrigation plans (where applicable).
 5. Submit references of past projects and employee training certifications that support that the Contractors meet all of the above installer qualifications and applicable licensures.
- B. Soil testing laboratory qualifications: an independent laboratory, with the experience and capability to conduct the testing indicated and that specializes in USDA agricultural soil testing, Planting Soil Mixes, and the types of tests to be performed. Geotechnical engineering testing labs shall not be used.
- C. All delivered and installed Planting Soil shall conform to the approved submittals sample color, texture and approved test analysis.
 1. The Owner's Representative may request samples of the delivered or installed soil be tested for analysis to confirm the Planting Soil conforms to the approved material.
 2. All testing shall be performed by the same soil lab that performed the original Planting Soil testing.
 3. Testing results shall be within 10% plus or minus of the values measured in the approved Planting Soil Mixes.

4. Any Planting Soil that fails to meet the above criteria, if requested by the Owner's Representative, shall be removed and new soil installed.
- D. Soil compaction testing: following installation or modification of soil, test soil compaction with a penetrometer.
1. Maintain at the site at all times a soil cone penetrometer with pressure dial and a soil moisture meter to check soil compaction and soil moisture.
 - a. Penetrometer shall be AgraTronix Soil Compaction Meter distributed by Ben Meadows, www.benmeadows.com or approved equal.
 - b. Moisture meter shall be "general digital soil moisture meter" distributed by Ben Meadows, www.benmeadows.com or approved equal.
 2. Prior to testing the soil with the penetrometer check the soil moisture and penetrometer readings in the mockup soils. Penetrometer readings are impacted by soil moisture and excessively wet or dry soils will read significantly lower or higher than soils at optimum moisture.
 3. The penetrometer readings shall be within 20% plus or minus of the readings in the approved mockup when at similar moisture levels.

1.15 SITE CONDITIONS

- A. It is the responsibility of the Contractor to be aware of all surface and subsurface conditions, and to notify the Owner's Representative, in writing, of any circumstances that would negatively impact the health of plantings. Do not proceed with work until unsatisfactory conditions have been corrected.
1. Should subsurface drainage or soil conditions be encountered which would be detrimental to growth or survival of plant material, the Contractor shall notify the Owner's Representative in writing, stating the conditions and submit a proposal covering cost of corrections. If the Contractor fails to notify the Owner's Representative of such conditions, they shall remain responsible for plant material under the warrantee clause of the specifications.
 2. This specification requires that all Planting Soil and Irrigation (if applicable) work be completed and accepted prior to the installation of any plants.

1.16 SOIL COMPACTION – GENERAL REQUIREMENTS

- A. Except where more stringent requirements are defined in this specification. The following parameters shall define the general description of the threshold points of soil compaction in existing, modified or installed soil and subsoil.

Note to specifier: *All soil has some level of compaction and subsoil is naturally more compacted than Topsoil simply from the static weight of the upper level soil. There are three common ways to measure, quantify and assess levels of compaction that may be used to determine compaction levels.*

1. Bulk Density Method

Units - Bulk density lb./cf or g/cc dry weight. Threshold results that determine critical bulk density are different for each soil texture.

Measurement tool - Bulk density cores.

Pro/cons - Requires one day or more per test, accurate, somewhat expensive. Landscape architect can own and operate equipment or hire a soil testing service.

2. Standard Proctor Method ASTM D 698

Units - % maximum dry bulk density as tested by the standard proctor method. Threshold results that determine critical bulk density are the same for each soil texture. A proctor test will typically also provide results as Bulk density lb./cf dry weight.

Measurement Tool - Densitrometer

Pro/cons - Moderately slow 10 minutes per test, accurate, expensive, lab test required to determine every specific soil texture's Proctor density curve, readings are impacted by soil organic matter, must hire a soil testing service.

3. Penetration Resistance Method

Units – PSI (lb. pressure per sq. in.) Threshold results that determine critical bulk density are somewhat the same for each soil texture.

Measurement tool - Penetrometer

*Pro/cons - Fast less than one minute per test, **not very accurate**. The Owner's representative may interpret the results and require different limits based on soil type, and moisture content at the time the soil is tested.*

Inexpensive, limited by soil moisture and gravel, landscape architect can own and operate equipment, no soil testing service required.

- B. The following are threshold levels of compaction as determined by each method.
1. Acceptable Compaction: Good rooting anticipated, but increasing settlement expected as compaction is reduced and/or in soil with a high organic matter content.
 - a. Bulk Density Method – Varies by soil type see Chart on page 32 in Up By Roots.
 - b. Standard Proctor Method – 75-85%; soil below 75% is unstable and will settle excessively.
 - c. Penetration Resistance Method – about 75-250 psi, below 75 psi soil becomes increasingly unstable and will settle excessively.
 2. Root limiting Compaction: Root growth is limited with fewer, shorter and slower growing roots.
 - a. Bulk Density Method – Varies by soil type see Chart on page 32 in Up By Roots.
 - b. Standard Proctor Method – above approximately 85%.
 - c. Penetration Resistance Method – about 300 psi.
 3. Excessive Compaction: Roots not likely to grow but can penetrate soil when soil is above field capacity.
 - a. Bulk Density Method – Varies by soil type see Chart on page 32 in Up By Roots.
 - b. Standard Proctor Method – Above 90%.
 - c. Penetration Resistance Method – Approximately above 400 psi

1.17 DELIVERY, STORAGE, AND HANDLING

- A. Weather: Do not mix, deliver, place or grade soils when frozen or with moisture above field capacity.
- B. Protect soil and soil stockpiles, including the stockpiles at the soil blender's yard, from wind, rain and washing that can erode soil or separate fines and coarse material, and contamination by chemicals, dust and debris that may be detrimental to plants or soil drainage. Cover stockpiles with plastic sheeting or fabric at the end of each workday.
- C. All manufactured packaged products and material shall be delivered to the site in unopened containers and stored in a dry enclosed space suitable for the material and meeting all environmental regulations. Biological additives shall be protected from extreme cold and heat. All products shall be freshly manufactured and dated for the year in which the products are to be used.
- D. Deliver all chemical amendments in original, unopened containers with original labels intact and legible, which state the guaranteed chemical analysis. Store all chemicals in a weather protected enclosure.
- E. Bulk material: Coordinate delivery and storage with Owner's Representative and confine materials to neat piles in areas acceptable to Owner's Representative.

1.18 EXCAVATING AND GRADING AROUND UTILITIES

- A. Contractor shall carefully examine the civil, record, and survey drawings to become familiar with the existing underground conditions before digging.
- B. Determine location of underground utilities and perform work in a manner that will avoid damage. Hand excavate as required. Maintain grade stakes set by others until parties concerned mutually agree upon removal.
- C. Notification of the *local utility locator service, Insert PHONE NUMBER*, is required for all planting areas. The Contractor is responsible for knowing the location and avoiding utilities that are not covered by the *local utility locator service*.

Note to specifier: Insert the telephone number and correct name of the local utility locator service to the paragraph above if available.

PART 2 – PRODUCTS

Note to specifier: Delete all products not applicable to this specific project. Local conditions for the harvested materials will vary and these specifications may need to be revised to reflect local source requirements, availability, budgets and plants to be grown.

2.1 IMPORTED TOPSOIL

- A. Imported Topsoil definition: Fertile, friable soil containing less than 5% total volume of the combination of subsoil, refuse, roots larger than 1 inch diameter, heavy, sticky or stiff clay, stones larger than 2 inches in diameter, noxious seeds, sticks, brush, litter, or any substances deleterious to plant growth. The percent (%) of the above objects shall be controlled by source selection not by screening the soil. Topsoil shall be suitable for the germination of seeds and the support of vegetative growth. Imported Topsoil shall not contain weed seeds in quantities that cause noticeable weed infestations in the final planting beds. Imported Topsoil shall meet the following physical and chemical criteria:

Note to specifier: Make adjustments in the following to account for the fact that these idea soils may not be available in your area.

1. Soil texture: USDA loam, sandy clay loam or sandy loam with clay content between 15 and 25%. And a combined clay/silt content of no more than 55%.
 2. pH value shall be between 5.5 and 7.0.
 3. Percent organic matter (OM): 2.0-5.0%, by dry weight.
 4. Soluble salt level: Less than 2 mmho/cm.
 5. Soil chemistry suitable for growing the plants specified.
- B. Imported Topsoil shall be a harvested soil from fields or development sites. The organic content and particle size distribution shall be the result of natural soil formation. Manufactured soils where Coarse Sand, Composted organic material or chemical additives has been added to the soil to meet the requirements of this specification section shall not be acceptable. Retained soil peds shall be the same color on the inside as is visible on the outside.
- Note to specifier:** Make adjustments to the above to account for the fact that these idea soils may not be available in your area. Soil peds may not normally occur, especially where soils have a high sand content.
- C. Imported Topsoil for Planting Soil shall NOT have been screened and shall retain soil peds or clods larger than 2 inches in diameter throughout the stockpile after harvesting.
- D. Stockpiled Existing Topsoil at the site meeting the above criteria may be acceptable.
- E. Provide a two gallon sample from each Imported Topsoil source with required soil testing results. The sample shall be a mixture of the random samples taken around the source stockpile or field. The soil sample shall be delivered with soil peds intact that represent the size and quantity of expected peds in the final delivered soil.

2.2 COMPOST

- A. Compost: Blended and ground leaf, wood and other plant based material, composted for a minimum of 9 months and at temperatures sufficient to break down all woody fibers, seeds and leaf structures, free of toxic material at levels that are harmful to plants or humans. Source material shall be yard waste trimmings blended with other plant or manure based material designed to produce Compost high in fungal material.
1. Compost shall be commercially prepared Compost and meet US Compost Council STA/TMECC criteria or as modified in this section for “Compost as a Landscape Backfill Mix Component”.

http://compostingcouncil.org/admin/wp-content/plugins/wp-pdfupload/pdf/191/LandscapeArch_Specs.pdf

2. Compost shall comply with the following parameters:
 - a. pH: 5.5 - 8.0.
 - b. Soil salt (electrical conductivity): maximum 5 dS/m (mmhos/cm).
 - c. Moisture content %, wet weight basis: 30 – 60.
 - d. Particle size, dry weight basis: 98% pass through 3/4 inch screen or smear.
 - e. Stability carbon dioxide evolution rate: mg CO₂-C/ g OM/ day < 2.
 - f. Solvita maturity test: > 6.
 - g. Physical contaminants (inerts), %, dry weight basis: <1%.
 - h. Chemical contaminants, mg/kg (ppm): meet or exceed US EPA Class A standard, 40CFR § 503.13, Tables 1 and 3 levels.
 - i. Biological contaminants select pathogens fecal coliform bacteria, or salmonella, meet or exceed US EPA Class A standard, 40 CFR § 503.32(a) level requirements.
- B. Provide a two gallon sample with manufacturer's literature and material certification that the product meets the requirements.

2.3 COARSE SAND

- A. Clean, washed, sand, free of toxic materials
 1. Coarse concrete sand, ASTM C-33 Fine Aggregate, with a Fines Modulus Index of 2.8 and 3.2.
 2. Coarse Sands shall be clean, sharp, natural Coarse Sands free of limestone, shale and slate particles. Manufactured Coarse Sand shall not be permitted.
 3. pH shall be lower than 7.0.
 4. Provide Coarse Sand with the following particle size distribution:

Sieve	Percent passing
3/8 inch (9.5 mm)	100
No 4 (4.75 mm)	95-100
No 8 (2.36 mm)	80-100
No 16 (1.18 mm)	50-85
No 30 (.60 mm)	25-60
No 50 (.30 mm)	10-30
No 100 (.15 mm)	2-10
No 200 (0.75 mm)	2-5
- B. Provide a two gallon sample with manufacturer's literature and material certification that the product meets the requirements.

2.4 FERTILIZER, BIOLOGICAL AND OTHER AMENDMENTS

Note to specifier: *Fertilizers and specialty biological amendment products such as Mycorrhizal amendments or Compost Tea are not generally required or recommended at planting and are not included in this specification. If the project team would like to add any of these amendments, add the product descriptions here. These types of amendments, if used at all, should never be applied without a soil test that documents their need and application rate.*

2.5 LIME

- A. ASTM C 602, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent and as follows:
 1. Class: Class T, with a minimum 99 percent passing through No. 8 (2.36-mm) sieve and a minimum 75 percent passing through No. 60 (0.25-mm) sieve.
 2. Provide lime in form of dolomitic limestone.
- B. Provide manufacturer's literature and material certification that the product meets the requirements.

2.6 EXISTING SOIL (Acceptable for planting with minimum modifications)

Note to specifier: *If existing soil is to be retained and reused, it is prudent to document the condition of this soil prior to the start of construction. Documentation (called a soil report) should include standard agricultural chemical soil testing, soil profile condition, as well as documenting soil penetration resistance to anticipated rooting depth. Such testing is typically already needed in order to make the decision of reusing this resource and the testing and observations can easily be inserted into this section of the specification.*

Undisturbed soil or soil with minor disturbance to soil profiles (e.g. farming) has at least two of the following attributes:

- A. Site soils not excessively graded or not compacted at root limiting or above.*
- B. Soils previously disturbed have a restored A horizon (min 2.5% organic matter dry weight) at least 6 inches deep and B and/or C horizons that drain and have acceptable compaction.*
- C. Soils are currently supporting mature tree and or large shrub growth with high vitality.*
- D. Sufficient soil volumes meeting the above criteria above rock or other limiting structures to support the proposed plants.*

In addition to the above, the soil organic matter, pH, and chemistry in the A horizon should be suitable for the proposed plants, or may need to be modified if required. In dry climates and sandy soils plants are often adapted to grow in soil with very low organic matter and high pH. Raising the organic matter too high or lowering the pH may negatively impact native or adapted plant performance.

- A. General definition of existing soil: Surface soil in the areas designated on the soils plan as existing soil, that is not altered, compacted to root limiting density, graded or contaminated before or during the construction process and considered acceptable for planting and long term health of the plants specified either as it exists or with only minor modification.
 - 1. The Owner's Representative shall verify that the soil in the designated areas is suitable at the beginning of planting bed preparation work in that area. In the event that the work of this project construction has damaged the existing soil in areas designated for use as Planting Soil to the point where the soil is no longer suitable to support the plants specified, the Owner's Representative may require modification of the damaged soil up to and including removal and replacement with soil of equal quality to the soil that existed prior to construction. Examples of damage include further compaction, contamination, grading, creation of hard pan or drainage problems, and loss of the O, and or A horizon.
 - a. Do not begin work on additional modifications until changes to the contract price are approved by Owner's Representative.
 - 2. Soil testing results and soil observation notes that describe the pre-construction soil conditions in the existing soil areas are included as an appendix to this specification:

Note to specifier: *Delete the above sentence if no soil test are included.*
- B. Protect existing soil from compaction, contamination, and degradation during the construction process.
- C. Unless otherwise instructed, remove all existing plants, root thatch, and non-soil debris from the surface of the soil using equipment that does not increase compaction of soil to root limiting levels.
- D. Modifications:
 - 1. When results of soil tests recommend chemical adjustments, till surface soil to six inches or greater after chemical adjustments have been applied.
 - 2. Remove existing turf thatch, ground cover plants and weeds.
 - 3. Provide pre-emergent weed control if indicated.
 - 4. Make chemical adjustment as recommended by the soil test.

2.7 MODIFIED EXISTING SOIL (SOIL SUITABLE FOR PLANTING WITH INDICATED MODIFICATION)

Note to specifier: SOILS PLANS: *This specification assumes that there will be separate set of drawings in the construction documents titled Soils Plans. These plans and details will define the areas on the site where different type of soil modification practices will occur. The plan should be a simple diagram with each type of soil modification keyed to a detail. Details of different modifications are included in the set of details that accompany this set of specifications. Using this method allows a wide range of different modifications to be required such that the modifications can easily fix the existing soil conditions, the expectations for plant performance, the project budget and schedule.*

In the event that there is not a separate Soils Plan, this information can be added to the Planting Plan. On simple sites where one soil modification may be appropriate, the specification could be used without having a plan. If no Soils Plan is included, be sure to remove reference to a Soils Plan from these specifications and replace it with the appropriate reference that defines the limits of soil modification.

A. General definition: Surface soil in the areas designated on the soils plan as Modified Existing Soil has been altered and or graded before or during the construction process but is still considered acceptable for planting and long term health of the plants specified with the proposed modifications. Modifications respond to the soil problems expected or encountered. The Owner's Representative shall verify that the soil in the designated areas is suitable for modification at the beginning of planting bed preparation work in that area.

1. The Owner's Representative shall verify that the soil in the designated areas is suitable for the specified modification at the beginning of planting bed preparation work in that area. In the event that the work of this project construction has damaged the existing soil in areas designated for modification to the point where the soil is no longer suitable to support the plants specified with the specified modification, the Owner's Representative may require further modification of the damaged soil up to an including removal and replacement with soil of equal quality to the soil that would have resulted from the modification. Damage may include further compaction, contamination, grading, creation of hard pan or drainage problem, and loss of the O, and or A horizon.
2. General requirements for all soil modifications:
 - a. Take soil samples, test for chemical properties, and make appropriate adjustments.
 - b. Unless otherwise instructed, remove all existing plants, root thatch, and non-soil debris from the surface of the soil using equipment that does not add to the compaction in the soil.
 - c. All soil grading, tilling and loosening must be completed at times when the soil moisture is below field capacity. Allow soil to drain for at least two days after any rain event more than 1 inch in 24 hours, or long enough so that the soil does not make the hand muddy when squeezed.
 - d. Provide pre-emergent weed control after the soil work is complete and plants planted but prior to adding mulch to the surface, if indicated by weed type and degree of threat.

B. Modified existing soil – soil removed, stockpiled, and spread

1. Description of condition to be modified: Existing soil that is suitable for reuse as Planting Soil but is in the wrong place of elevation, or cannot be adequately protected during construction. Soil is to be harvested, stockpiled and re-spread with or without further modifications as indicated.

Note to specifier; *If existing soils are to be harvested and reused, the areas where soil may be reused and the depths of soil harvesting must be described on the drawings and the specifications. This requires that the specifier has site and soil knowledge sufficient to make these decisions. Additionally, one of the greatest limitations on reuse of soil at many projects is finding a suitable place to store the soil during construction. This coordination must be resolved during the design process with the project manager.*

2. Modifications:
 - a. Excavate existing soil from the areas and to depths designated on the drawings. Stockpile in

zones noted on the drawings or in areas proposed by the Contractor.

- 1.) Prepare a soil stock pile plan for approval.
- b. Excavate soil using equipment and methods to preserve the clumps and pedes in the soil. Generally this means using the largest piece of equipment that is practical for the project size and scope.
- c. Protect stock piles from erosion by compacting or tracking the soil surface, covering with breathable fabric or planting with annual grasses as appropriate for the season, location, and length of expected time of storage.
- d. Re-spread soil as required in Part 3 of this specification.

C. Modified existing soil – compacted surface soil (Tilling Option)

Note to specifier: *If the soil problem is limited to surface compaction, one of two options should be considered: Tilling option or Radial Trenching option. Tilling prepares an entire root zone for trees and other plants but is relatively shallow. The radial trenching goes deeper. As the level of compaction increases, these two methods become less effective. Select one of these options based on the project requirements and delete the other or use both options to treat the upper (Tilling) and lower (Trenching) portions of the soil profile..*

1. Description of condition to be modified: Surface soil compaction to a maximum of 6 inches deep from traffic or light grading. Original A horizon may be previously removed or graded but lower profile intact with acceptable compaction levels and limited grading. The soil organic matter, pH and chemistry in the A horizon may not be suitable for the proposed plants and may need to be modified as required.

2. Modifications:

Note to specifier: *A spade tiller is a superior tiller than the standard roto tiller. A spade tiller leaves a soil with larger pedes and less glazing between the loose soil and the subsoil. However these tillers are limited in availability and may be more costly than the conventional tiller. Check with local Contractors before requiring a spade tiller over roto tiller.*

- a. Till top 6 inches or deeper of the soil surface, with a *roto tiller, spade tiller, ripper* or agricultural plow. Spread 2 - 3 inches of Compost on the surface of the tilled soil and make any chemical adjustment as recommended by the soil test.

1.) If spade tillers are to be required, add a paragraph to that effect here.

- b. Till or disk the Compost into the loosened soil. Smooth out grades with a drag rake or drag slip.

D. Modified existing soil – compacted surface soil (Radial Trenching Option)

1. Description of condition to be modified: Surface soil compaction to a maximum of 24 inches deep from traffic or light grading. Original A horizon may be previously removed or graded but lower profile below 24 inches intact with acceptable compaction levels and limited grading. The soil organic matter, pH and chemistry in the A horizon may not be suitable for the proposed plants and may need to be modified as required.

2. Modifications:

- a. Using a trenching machine, dig trenches to the extent and depth shown on the plans and details.
- b. Backfill the trench with the soil removed from the trench. Add additional site soil if needed to fill the trench to be flush to the existing grade after the soil settlement.

E. Modified existing soil – compacted subsoil

1. Description of condition to be modified: Deep soil compaction the result of previous grading, filling and dynamic or static compaction forces. Original A horizon likely removed or buried. The soil organic matter, pH and chemistry in the A horizon is likely not suitable for the proposed plants and should be modified as required.

Note to specifier: *Select one of the following options as appropriate to the constraints at the site, and the project budget. Do not give the contractor the option to select any of the below alternative*

as they are not equal treatments. Soil fracturing is the most effective and may be the most cost effective in small to medium size spaces. Soil ripping is usually the cheapest option but only appropriate in large spaces, approximately ¼ acre or greater, accessible by large size grading machines, and where there are no underground utilities or where limited utility locations can be avoided. Soil trenching is only suitable for spaces where only small sized equipment such as a walk-behind chain trencher can access the area. If different treatments are appropriate for different locations on the same project be clear on the drawings the extent of each treatment.

The Trenching modification below is for compacted soil that is NOT within the root zone of existing trees and is substantially different from the modification “Radial Trenching” described above. The practice of radial trenching within the root zone of an existing tree is not described in this specification.

2. Soil Ripping:
 - a. Step one: After grading and removing all plants and debris from the surface, using a tracked dozer or similar large grading equipment, loosen the soil by dragging a ripping shank or chisel thru the soil to depths of 24 inches with ripping shanks spaced 18 inches or less apart in two directions. The number of shanks per pull is dependent on the degree of soil compaction and the size of the dozer.
 - b. Step 2: Spread 3-4 inches of Compost over the ripped area and till into the top 6 inches of the soil surface.
 3. Soil Fracturing:
 - a. Step one: After grading and removing all plants and debris from the surface, spread 2 – 3 inches of Compost over the surface of the soil. Loosen the soil to depth of 18 - 24 inches, using a backhoe to dig into the soil through the Compost. Lift and then drop the loosened soil immediately back into the hole. The bucket then moves to the adjacent soil and repeats the process until the entire area indicated has been loosened.
 - b. Step 2: Spread 3-4 inches of Compost over the ripped area and till into the top 6 inches of the soil surface.
 4. Trenching:
 - a. Step one: After grading and removing all plants and debris from the surface using a chain trenching machine, dig 24 inch deep trenches, 24 inches apart across the entire area. Maintain an 18-inch standoff from the edges of all curbs, paving and structures. Backfill the trenches with Compost.
 - b. Step 2: Spread 3-4 inches of Compost over the trenches area and till into the top 6 inches of the soil surface. Compost tilling treatment shall extend to the edges of curbs, paving and structures.
 5. Following soil ripping or fracturing the average penetration resistance should be less than 250 psi to the depth of the ripping or fracturing.
 6. Do not start planting into ripped or fractured soil until soil has been settled or leave grades sufficiently high to anticipate settlement of 10 – 15% of ripped soil depth.
- F. Modified existing soil – low organic matter
1. Description of condition to be modified: Low soil organic matter and/or missing A horizon but soil is not compacted except for some minor surface compaction. The soil organic matter, pH and/or chemistry are likely not suitable for the proposed plants and should be modified as required.
 2. Modifications:
 - a. Spread 3 - 4 inches of Compost over the surface of the soil and make chemical adjustment as recommended by the soil test.
 - b. Till Compost into the top 6 inches of the soil.
- G. Modified existing soil – soil within the root zone of existing established trees

Note to specifier: *Any of the above soil conditions may be present within the root zone areas of*

large existing trees to remain but these must be dealt with in a different manner in order to preserve the root system of the tree. Options are limited. On the other hand, usually problems with soil within the root zone of mature trees are limited to the surface 6 - 12 inches of soil. These are most often excess surface soil compaction, chemical changes from applied material, added soil over an existing soil, severed roots, and drainage problems caused by adjacent work that changed drainage patterns. Deep compaction and other deep soil disturbances would likely already have killed the tree or the tree has adapted to the condition.

Modifications to consider:

Surface compaction - There are several methods to remediate excess surface soil compaction within a root zone. The preferred method is to use a pneumatic digging device such as an Air Knife or Air Spade that can loosen soil without significant damage to roots. Compost is added to the soil as part of the loosening process. A specification section on this process is included. Other methods include vertical mulching, radial trenching, surface applications of Compost or mulch, Compost Tea injections into soil, and soil-injected air combined with added material. Each of these has demonstrated limited success depending on the level of compaction and many variables in the process. Due to the complexity of each of these options they will not be included in the specification. Consult a local soils and / or arboricultural expert to develop a specification.

Chemical changes - Changes in soil chemistry due to applications intentional and inadvertent are too complex to determine and remediate to be part of this specification. Consult a local soils and / or arboricultural expert to develop a specification.

Soil added over the root zone - Small amounts of soil added over the root zone may not be a problem for the tree, and leaving it there or mixing with an air knife may be the best option. Often the greatest damage to the tree is caused not by the soil, even at relatively deep layers of soil, but the damage caused by the equipment that brought in the soil or is used to remove the soil. Setting requirements to remediate soil added over the root zone are too complex to be part of this specification. Consult a local soils and / or arboricultural expert to develop a specification.

Drainage problems - The different types of conditions that cause drainage problems and how to remediate them around existing trees are too complex to be part of this specification. Consult a local soils and / or arboricultural expert to develop a specification.

1. Description of condition to be modified: Surface compaction near or above root limited levels in the upper soil horizon the result of traffic or other mechanical compaction.
2. Modifications:
 - a. Remove the tops of all plants to be removed from the root zone. Remove sod with a walk behind sod cutter. Do not grub out the roots of plants to be removed.
 - b. Use a pneumatic air knife to loosen the top 9 – 12 inches of the soil. Surface roots may move and separate from soil during this process but the bark on roots should not be broken
 - 1.) Pneumatic air knife shall be as manufactured by:
Concept Engineering Group, Inc., Verona, PA (412) 826-8800
or
Supersonic Air Knife, Inc., Allison Park, PA (866) 328 5723
 - c. Make chemical adjustment as recommended by the soil test and add 2 - 3 inches of Compost over the soil.
 - d. Using the pneumatic air knife, mix the Compost into the top 6 – 8 inches of the loosened soil.
 - e. Work in sections such that the entire process - including irrigation - can be completed in one day. Apply approximately one inch of water over the loosened soil at the completion of each day's work. Apply mulch or turf as indicated on the drawings within one week of the completion of work.

2.8 PLANTING SOIL MIXES

Note to specifier: *The subject of Planting Soil Mixes is quite complex and requires significant*

information about the goals of the planting. Mixes can include free draining high use turf planting soil mixes, bio-retention mixes, specialty mixes for palm planting or slow draining mixes designed to reduce water use and maintenance. The specifier will need to design the Planting Soil Mix that is best for each part of the project. The following specification is for a moderately slow draining Mix that would be good for trees and shrubs and can serve as a template for other mixes. The key adjustment for most applications is to change the proportion Topsoil/Coarse Sand and Compost. Local suppliers may also have their own specification or Mix design. These can be inserted into this specification.

Note that the topsoil and planting mix is not to be screened or mixed in a soil blending machine. Screening and blending breaks down important topsoil peds and reduces drainage in the soil. Machine blended and screened mixes typically will require more sand

- A. General definition: Mixes of Existing Soil or Imported Topsoil, Coarse Sand, and or Compost to make a new soil that meets the project goals for the indicated planting area. These may be mixed off site or onsite, and will vary in Mix components and proportions as indicated.
- B. Planting Mix - moderately slow draining soil for trees and shrub beds
 1. A Mix of Imported Topsoil, Coarse Sand and Compost. The approximate Mix ratio shall be:

Mix component	% by moist volume
Imported Topsoil unscreened	45-50%
Coarse sand	40-45%
Compost	10%
 2. Final tested organic matter between 2.75 and 4% (by dry weight).
 3. Mix the Coarse Sand and Compost together first and then add to the Topsoil. Mix with a loader bucket to loosely incorporate the Topsoil into the Coarse Sand/Compost Mix. DO NOT OVER MIX! Do not mix with a soil blending machine. Do not screen the soil. Clumps of Soil, Compost and Coarse Sand will be permitted in the overall Mix.
 4. At the time of final grading, add fertilizer if required to the Planting Soil at rates recommended by the testing results for the plants to be grown.
 5. Provide a two gallon sample with testing data that includes recommendations for chemical additives for the types of plants to be grown. Samples and testing data shall be submitted at the same time.

2.9 PRE-EMERGENT HERBICIDES

Note to specifier: *Pre-emergent herbicides have known environmental impacts. The project team must evaluate the risks and rewards of using chemical treatments to control weeds and consider specifying hand weed removal.*

- A. Chemical herbicides are designed to prevent seeds of selective plants from germinating. Exact type of herbicide shall be based on the specific plants to be controlled and the most effective date of application.
- B. Submit report of expected weed problems and the recommendation of the most effective control for approval by Owner's Representative. Provide manufacturer's literature and material certification that the product meets the requirements.

Note to specifier: *Insert additional products as needed for the specific project requirements.*

Note to specifier: *If soil drainage rates or subsurface conditions indicate that additional drainage beyond modification in needed subsurface drain lines may need to be added.*

There are many pipe options available from heavy duty Schedule 40 PVC pipes to lightweight ABS corrugated flexible pipes. This specification will provide three pipe options. The specifier must select the appropriate pipe from the below list that meets the budget and operational needs of the project and delete the other options. It is advised not to use the corrugated pipe as it is too easily crushed and tends to silt up faster than the other alternatives.

Note that filter fabric socks and other filter cloth applications around the pipe or the pipe bedding material is not include in this specification and is not recommended due to tendency of the filter cloth to clog.

2.10 HEAVY DUTY PIPE DRAIN PIPE

- A. Drain pipe shall be 4 inch diameter, perforated, PVC, Schedule 40 pipe. Holes in the pipe shall only be on the bottom quadrant. All fittings, elbows, unions, T's and screw caps shall be the same material and from the same manufacturer as the pipe. "T" and elbow joints shall be sanitary type connections. All joints shall be solvent welded. Submit manufacturers product literature for approval by the Owner's Representative.
 - 1. When pipe has perforations on all quadrants, drape a 12 inch wide 4 mil plastic sheet over the length of the pipe to force water to the bottom of the pipe.
- B. Clean out: Clean out risers shall be 4 inch diameter Schedule 40 PVC solid pipe compatible with the bottom fitting and clean out screw cap. Elbow fitting at the bottom of the clean out riser. When the cleanout is in the middle of a pipe run the fitting shall be a sanitary T fitting. Screw cap FITTING shall be PVC Schedule 40.

2.11 MEDIUM DUTY PIPE DRAIN PIPE

- A. Drain pipe shall be 4 inch diameter, perforated, PVC, double wall (smooth interior wall / corrugated exterior wall) pipe. Holes in the pipe shall only be on the bottom quadrant. All fittings, elbows, unions, T's and screw caps shall be the same material and from the same manufacturer as the pipe. "T" and elbow joints shall be sanitary type connections. All joints shall be gasketed bell and spigot. Example source A -2000 by Contech Construction Products or approved equal. Submit manufacturers product literature for approval by the Owner's Representative.
 - 1. When pipe has perforations on all quadrants, drape a 12 inch wide 4 mil plastic sheet over the length of the pipe to force water to the bottom of the pipe.
- B. Clean out: Clean out risers shall be 4 inch diameter Schedule 40 PVC solid pipe compatible with the bottom fitting and clean out screw cap. Elbow fitting at the bottom of the clean out riser. When the cleanout is in the middle of a pipe run the fitting shall be a sanitary T fitting. Screw cap FITTING shall be PVC Schedule 40.

2.12 LIGHT DUTY PIPE DRAIN PIPE

- A. Drain pipe shall be 4 inch diameter, perforated, HDPE, single wall corrugated exterior pipe. ASTM F405. All fittings, elbows, unions, T's and screw caps shall be the same material and from the same manufacturer as the pipe. All joints shall be gasketed bell and spigot. Example source ADS Single Wall Pipe by Advance Drainage Systems or approved equal. Submit manufacturers product literature for approval by the Owner's Representative.
 - 1. When pipe has perforations on all quadrants, drape a 12 inch wide 4 mil plastic sheet over the length of the pipe to force water to the bottom of the pipe.
- B. Clean out: Clean out risers shall be 4 inch diameter Schedule 40 PVC solid pipe compatible with the bottom fitting and clean out screw cap. Elbow fitting at the bottom of the clean out riser. When the cleanout is in the middle of a pipe run the fitting shall be a sanitary T fitting. Screw cap FITTING shall be PVC Schedule 40.

PART 3 – EXECUTION

3.1 SITE EXAMINATION

- A. Prior to installation of Planting Soil, examine site to confirm that existing conditions are satisfactory for the work of this section to proceed.

1. Confirm that the subgrade is at the proper elevation and compacted as required. Subgrade elevations shall slope toward the under drain lines as shown on the drawings.
 2. Confirm that surface all areas to be filled with Planting Soil are free of construction debris, refuse, compressible or biodegradable materials, stones greater than 2 inches diameter, soil crusting films of silt or clay that reduces or stops drainage from the Planting Soil into the subsoil; and/or standing water. Remove unsuitable material from the site.
 3. Confirm that no adverse drainage conditions are present.
 4. Confirm that no conditions are present which are detrimental to plant growth.
 5. Confirm that utility work has been completed per the drawings.
 6. Confirm that irrigation work, which is shown to be installed below prepared soil levels, has been completed.
- B. If unsatisfactory conditions are encountered, notify the Owner's Representative immediately to determine corrective action before proceeding.

3.2 COORDINATION WITH PROJECT WORK

- A. The Contractor shall coordinate with all other work that may impact the completion of the work.
- B. Prior to the start of work, prepare a detailed schedule of the work for coordination with other trades.
- C. Coordinate the relocation of any irrigation lines, heads or the conduits of other utility lines that are in conflict with tree locations. Root balls shall not be altered to fit around lines. Notify the Owner's Representative of any conflicts encountered.

3.3 GRADE AND ELEVATION CONTROL

- A. Provide grade and elevation control during installation of Planting Soil. Utilize grade stakes, surveying equipment, and other means and methods to assure that grades and contours conform to the grades indicated on the plans.

3.4 SITE PREPARATION

- A. Excavate to the proposed subgrade. Maintain all required angles of repose of the adjacent materials as shown on the drawings or as required by this specification. Do not over excavate compacted subgrades of adjacent pavement or structures. Maintain a supporting 1:1 side slope of compacted subgrade material along the edges of all paving and structures where the bottom of the paving or structure is above the bottom elevation of the excavated planting area.
- B. Remove all construction debris and material including any construction materials from the subgrade.
- C. Confirm that the subgrade is at the proper elevation and compacted as required. Subgrade elevations shall slope approximately parallel to the finished grade and/or toward the subsurface drain lines as shown on the drawings.
- D. In areas where Planting Soil is to be spread, confirm subgrade has been scarified.
- E. Protect adjacent walls, walks and utilities from damage or staining by the soil. Use 1/2 inch plywood and or plastic sheeting as directed to cover existing concrete, metal and masonry work and other items as directed during the progress of the work.
 1. At the end of each working day, clean up any soil or dirt spilled on any paved surface.
 2. Any damage to the paving or site features or work shall be repaired at the Contractor's expense.

3.5 SOIL MOISTURE

- A. Volumetric soil moisture level, in both the Planting Soil and the root balls of all plants, prior to, during and after planting shall be above permanent wilt point and below field capacity for each type of soil texture within the following ranges.

Soil texture	Permanent wilting point	Field capacity
Sand, Loamy sand, Sandy loam	5-8%	12-18%
Loam, Sandy clay, Sandy clay loam	14-25%	27-36%
Clay loam, Silt loam	11-22%	31-36%
Silty clay, Silty clay loam	22-27%	38-41%

- B. The Contractor shall confirm the soil moisture levels with a moisture meter (Digital Soil Moisture Meter, DSMM500 by General Specialty Tools and Instruments, or approved equivalent). If moisture is found to be too low, the planting holes shall be filled with water and allowed to drain before starting any planting operations. If the moisture is too high, suspend planting operations until the soil moisture drains to below field capacity.

3.6 EXISTING SOIL MODIFICATION

- A. Follow the requirements for modifying existing soil as indicated in Part 2 for the different types of soil modifications. The extent of the areas of different soil modification types are indicated on the Soils Plan or as directed by the Owner's Representative.

Note to specifier: *Note above that it is critical for the contract documents to define the extent of all soil improvement work on a Soil Plan and detail drawing that is part of the contract documents.*

3.7 DRAIN PIPE INSTALLATION

1. Trench lines to depths and widths shown on plans.
2. Place 2 – 3 inches Coarse Sand as bedding for pipes.
3. Place pipe (holes facing down) to invert elevations shown on the plan.
 - a. If pipe with holes on all sides is used drape a piece of 4 mil plastic 12 inches wide over top of pipe.
 - b. Cover sides and top of pipe with Coarse Sand with min 4 inches of Coarse Sand cover above top of pipe.
 - c. Backfill trench with Planting Soil compacted to same level as Planting Soil requirements.
4. Add cleanout pipe reaching the surface at the uphill end of each pipe run as shown on drawings.
5. Connect pipes to manhole or daylight outfall as shown on the drawings.

3.8 PLANTING SOIL AND PLANTING SOIL MIX INSTALLATION

Note to specifier: *These specifications are not intended to include Planting Soils over architectural structures that are waterproofed. If this condition exists, add special installation instructions in this paragraph.*

- A. Prior to installing any Planting Soil from stockpiles or Planting Soil Mixes blended off site, the Owner's Representative shall approve the condition of the subgrade and the previously installed subgrade preparation and the installation of subsurface drainage.
- B. All equipment utilized to install or grade Planting Soils shall be wide track or balloon tire machines rated with a ground pressure of 4 psi or less. All grading and soil delivery equipment shall have buckets equipped with 6 inch long teeth to scarify any soil that becomes compacted.
- C. In areas of soil installation above existing subsoil, scarify the subgrade material prior to installing Planting Soil.
 1. Scarify the subsoil of the subgrade to a depth of 3 – 6 inches with the teeth of the back hoe or loader bucket, tiller or other suitable device.

2. Immediately install the Planting Soil. Protect the loosened area from traffic. DO NOT allow the loosened subgrade to become compacted.
 3. In the event that the loosened area becomes overly compacted, loosen the area again prior to installing the Planting Soil.
- D. Install the Planting Soil in 12 - 18 inch lifts to the required depths. Apply compacting forces to each lift as required to attain the required compaction. Scarify the top of each lift prior to adding more Planting Soil by dragging the teeth of a loader bucket or backhoe across the soil surface to roughen the surface.
 - E. Phase work such that equipment to deliver or grade soil does not have to operate over previously installed Planting Soil. Work in rows of lifts the width of the extension of the bucket on the loader. Install all lifts in one row before proceeding to the next. Work out from the furthest part of each bed from the soil delivery point to the edge of the each bed area.

Note to specifier: *The following 4 paragraphs are not normal to most soil installation specifications but are deemed critical to the process. Be sure that the Owner's Representative is familiar with these requirements during construction observation.*

- F. Where possible place large trees first and fill Planting Soil around the root ball.
- G. Installing soil with soil or mulch blowers or soil slingers shall not be permitted due to the over mixing and soil ped breakdown cause by this type of equipment.
- H. Where travel over installed soil is unavoidable, limit paths of traffic to reduce the impact of compaction in Planting Soil. Each time equipment passes over the installed soil it shall reverse out of the area along the same path with the teeth of the bucket dropped to scarify the soil. Comply with the paragraph "Compaction Reduction" (section 3.9) in the event that soil becomes over compacted.
- I. The depths and grades shown on the drawings are the final grades after settlement and shrinkage of the compost material. The Contractor shall install the Planting Soil at a higher level to anticipate this reduction of Planting Soil volume. A minimum settlement of approximately 10 - 15% of the soil depth is expected. All grade increases are assumed to be as measured prior to addition of surface Compost till layer, mulch, or sod.

3.9 COMPACTION REQUIREMENTS FOR INSTALLED OR MODIFIED PLANTING SOIL

- A. Compact installed Planting Soil to the compaction rates indicated and using the methods approved for the soil mockup. Compact each soil lift as the soil is installed.
- B. Existing soil that is modified by tilling, ripping or fracturing shall have a density to the depth of the modification, after completion of the loosening, such that the penetrometer reads approximately 75 to 250 psi at soil moisture approximately the mid-point between wilting point and field capacity. This will be approximately between 75 and 82% of maximum dry density standard proctor.
- C. Installed Planting Soil Mix and re-spread existing soil shall have a soil density through the required depth of the installed layers of soil, such that the penetrometer reads approximately 75 to 250 psi at soil moisture approximately the mid-point between wilt point and field capacity. This will be approximately between 75 and 82% of maximum dry density standard proctor.
- D. Planting Soil compaction shall be tested at each lift using a penetrometer calibrated to the mockup soil and its moisture level. The same penetrometer and moisture meter used for the testing of the mockup shall be used to test installed soil throughout the work.
- E. Maintain moisture conditions within the Planting Soil during installation or modification to allow for satisfactory compaction. Suspend operations if the Planting Soil becomes wet. Apply water if the soil is overly dry.
- F. Provide adequate equipment to achieve consistent and uniform compaction of the Planting Soils. Use the smallest equipment that can reasonably perform the task of spreading and compaction. Use the same equipment and methods of compaction used to construct the Planting Soil mockup.

- G. Do not pass motorized equipment over previously installed and compacted soil except as authorized below.
 - 1. Light weight equipment such as trenching machines or motorized wheel barrows is permitted to pass over finished soil work.
 - 2. If work after the installation and compaction of soil compacts the soil to levels greater than the above requirements, follow the requirements of the paragraph "Over Compaction Reduction" below.

3.10 OVER COMPACTION REDUCTION

- A. Any soil that becomes compacted to a density greater than the specified density and/or the density in the approved mockup shall be dug up and reinstalled. This requirement includes compaction caused by other sub-contractors after the Planting Soil is installed and approved.
- B. Surface roto tilling shall not be considered adequate to reduce over compaction at levels 6 inches or greater below finished grade.

3.11 INSTALLATION OF CHEMICAL ADDITIVES

- A. Following the installation of each soil and prior to fine grading and installation of the Compost till layer, apply chemical additives as recommended by the soil test, and appropriate to the soil and specific plants to be installed.
- B. Types, application rates and methods of application shall be approved by the Owner's Representative prior to any applications.

3.12 FINE GRADING

- A. The Owner's Representative shall approve all rough grading prior to the installation of Compost, fine grading, planting, and mulching.
- B. Grade the finish surface of all planted areas to meet the grades shown on the drawings, allowing the finished grades to remain higher (10 – 15% of depth of soil modification) than the grades on the grading plan, as defined in paragraph Planting Soil Installation, to anticipate settlement over the first year.
- C. Utilize hand equipment, small garden tractors with rakes, or small garden tractors with buckets with teeth for fine grading to keep surface rough without further compaction. Do not use the flat bottom of a loader bucket to fine grade, as it will cause the finished grade to become overly smooth and or slightly compressed.
- D. Provide for positive drainage from all areas toward the existing inlets, drainage structures and or the edges of planting beds. Adjust grades as directed to reflect actual constructed field conditions of paving, wall and inlet elevations. Notify the Owner's Representative in the event that conditions make it impossible to achieve positive drainage.
- E. Provide smooth, rounded transitions between slopes of different gradients and direction. Modify the grade so that the finish grade before adding mulch and after settlement is one or two inches below all paving surfaces or as directed by the drawings.
- F. Fill all dips and remove any bumps in the overall plane of the slope. The tolerance for dips and bumps in shrub and ground cover planting areas shall be a 2 inch deviation from the plane in 10 feet. The tolerance for dips and bumps in lawn areas shall be a 1 inch deviation from the plane in 10 feet.

3.13 INSTALLATION OF COMPOST TILL LAYER

Note to specifier: The following paragraph is critical to building a proper A/O horizon in installed Planting Soil Mixes. This added layer of Compost must be shown on the soil details in the drawings.

- A. After Planting Soil Mixes are installed in planting bed areas and just prior to the installation of shrub or groundcover plantings, spread 3 – 4 inches of Compost over the beds and roto till into the top 4 - 6 inches of the Planting Soil. This step will raise grades slightly above the grades required in paragraph

“Fine Grading”. This specification anticipates that the raise in grade due to this tilling will settle within a few months after installation as Compost breaks down. Additional settlement as defined in paragraph “Planting Soil and Planting Soil Mix installation” must still be accounted for in the setting of final grades.

3.14 CLEAN-UP

- A. During installation, keep the site free of trash, pavements reasonably clean and work area in an orderly condition at the end of each day. Remove trash and debris in containers from the site no less than once a week.
 - 1. Immediately clean up any spilled or tracked soil, fuel, oil, trash or debris deposited by the Contractor from all surfaces within the project or on public right of ways and neighboring property.
- B. Once installation is complete, wash all soil from pavements and other structures. Ensure that mulch is confined to planting beds and that all tags and flagging tape are removed from the site. The Owner’s Representative seals are to remain on the trees and removed at the end of the warranty period.
 - 1. Make all repairs to grades, ruts, and damage to the work or other work at the site.
 - 2. Remove and dispose of all excess Planting Soil, subsoil, mulch, plants, packaging, and other material brought to the site by the Contractor.

3.15 PLANTING SOIL AND MODIFIED EXISTING SOIL PROTECTION

- A. The Contractor shall protect installed and/or modified Planting Soil from damage including contamination and over compaction due to other soil installation, planting operations, and operations by other Contractors or trespassers. Maintain protection during installation until acceptance. Utilize fencing and matting as required or directed to protect the finished soil work. Treat, repair or replace damaged Planting Soil immediately.
- B. Loosen compacted Planting Soil and replace Planting Soil that has become contaminated as determined by the Owner’s Representative. Planting Soil shall be loosened or replaced at no expense to the Owner.
 - a. Till and restore grades to all soil that has been driven over or compacted during the installation of plants.
 - b. Where modified existing soil has become contaminated and needs to be replaced, provide imported soil that is of similar composition, depth and density as the soil that was removed.

3.16 PROTECTION DURING CONSTRUCTION

- A. The Contractor shall protect planting and related work and other site work from damage due to planting operations, operations by other Contractors or trespassers.
 - 1. Maintain protection during installation until the date of plant acceptance (see specifications section – Planting). Treat, repair or replace damaged work immediately.
 - 2. Provide temporary erosion control as needed to stop soil erosion until the site is stabilized with mulch, plantings or turf.
- B. Damage done by the Contractor, or any of their sub-contractors to existing or installed plants, or any other parts of the work or existing features to remain, including large existing trees, soil, paving, utilities, lighting, irrigation, other finished work and surfaces including those on adjacent property, shall be cleaned, repaired or replaced by the Contractor at no expense to the Owner. The Owner’s Representative shall determine when such cleaning, replacement or repair is satisfactory. Damage to existing trees shall be assessed by a certified arborist.

3.17 SUBSTANTIAL COMPLETION ACCEPTANCE

- A. Upon written notice from the Contractor, the Owners Representative shall review the work and make a determination if the work is substantially complete.
- B. The date of substantial completion of the planting soil shall be the date when the Owner’s

Representative accepts that all work in Planting, Planting Soil, and Irrigation installation sections is complete.

3.18 FINAL ACCEPTANCE / SOIL SETTLEMENT

- A. At the end of the plant warrantee and maintenance period, (see Specification section - Planting) the Owner's Representative shall observe the soil installation work and establish that all provisions of the contract are complete and the work is satisfactory.
 - 1. Restore any soil settlement and or erosion areas to the grades shown on the drawings. When restoring soil grades remove plants and mulch and add soil before restoring the planting. Do not add soil over the root balls of plants or on top of mulch.
- B. Failure to pass acceptance: If the work fails to pass final acceptance, any subsequent observations must be rescheduled as per above. The cost to the Owner for additional observations will be charged to the Contractor at the prevailing hourly rate of the Owner's Representative.

APPENDIX TO 32 9100 PLANTING SOIL

Existing Soil Test Data

Note to specifier: *If existing soil test data is available, add such testing reports in this location. Include a plan of the site designating the extent of the different soil types identified and the location of all soil test pits. If no testing was completed, remove the appendix.*

END OF SECTION 32 9100

32 8400 Irrigation

DISCLAIMER AND RESPONSIBILITY OF THE USER

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INSTRUCTIONS TO THE SPECIFICATION WRITER:

The following document is intended as a general specification to guide the writing of a project-specific specification. Each project is unique and it is required that the specification be developed accordingly. DO NOT USE THE FOLLOWING SPECIFICATION WITHOUT MAKING IMPORTANT ADJUSTMENTS to reflect local conditions, regulations, market standards, project schedules and local and regional practices. The following are specific items that need to be addressed.

1. General instructions to use this specification: These instructions are intended to guide the specification writer (the specifier) through the process of editing this document into an Irrigation specification. Be sure to delete these instructions (i.e. all the text in red displayed above the paragraph) before issuing the specifications.

2. General Requirements - Division 01 (Construction Specification Institute) specifications and other contract elements: This specification is designed to be used in conjunction with standard Division 01 specifications, which cover project general conditions and project wide contract elements. THIS IS NOT A STAND-ALONE SPECIFICATION and should not be used as a contract for the purchase of and installation of an irrigation system. Important issue of project ownership, liability, insurance, contract language, project controls, Instructions to bidders, change orders and review and approval of the work are normally in the Division 01 specifications.

3. The construction team: A construction project is a team effort where the owner, in effect, creates a partnership with all the Contractors to build a project. As with any good contract there are protections for both sides; that the Owner will get the quality of project that they desire within the time limits and budget available; and the Contractor will be paid for the work satisfactorily completed. In between the initial bidding and the final completion there will be many places where parts of the construction do not work out as originally intended. This is normal and a good contract should allow for these changes in a manner that is equitable to both the Owner and the Contractor. To get there, a team approach and spirit must prevail. Both sides must assume that each is operating in the best interest of the project goals. The clearer the goals and description of the project, the smoother the flow of a successful project. **The more each of the team members can trust the other members, the better the project.** This should be a critical principle in approaching the interpretation of the specification.

4. Other project documents: This specification is intended to be used in conjunction with other project documents including the bid forms, the construction contract, Division 1 specifications, other specifications directly related to this section; other specifications that are not directly related to this work, and most critically the Project construction drawings. It is very critical that all these documents be prepared with consistent terminology and that they be coordinated. The terms used for the parts of trees and other plants, different soil types, drainage features, irrigation features and structures such as paving, walls and planters must be consistent across disciplines. A very common mistake is the use of different terms and details for soil and the extent of soil work. The terms and details for Planting Soil, subsoil and other materials must be well coordinated.

5. Relate specification sections: This specification requires additional specification sections to describe several important related parts of the planting process.

Tree Protection: This specification assumes that there is a separate specification section and construction drawings and details for tree protection; remove this section if there are no existing trees to be protected on the project.

Planting: This specification assumes that there is a separate specification section and separate plans and details for installation of Planting.

Planting Soil: This specification assumes that there may be a separate specification section for Planting Soil associated with the project planting.

6. Reviewing and approval authority: Each specification identifies a certain entity as responsible for the review and approval of the work, project submittals, changes to the work and final acceptance of the work. The entity is normally identified in Division 1. For the purposes of this specification, the term the “Owner’s Representative” has been used as a placeholder for this entity. Once the proper term is defined, for example another term such as; Contracting Officer, The Architect, The Landscape Architect, The Engineer etc.; this term should replace the words “Owner’s Representative” wherever it appears in this specification.

7. Header and footer requirements: Change the header/footer language to meet the project requirements.

8. Notes to specifiers: Before issuing the document, be sure to remove all “Notes to specifiers” incorporated into this document after you have read them and responded to the recommendations.

9. Submittals: Submittals are a critical part of any construction contract. This is where all products and materials are reviewed and approved in advance of the work. Including very specific requirements for approval of submittals, while a good practice, assumes that the reviewing authority has the skills needed to make these reviews and interpret the results. A common practice is to make very specific requirements but not have the time or expertise to enforce them. Lack of review of submittals does not automatically transfer quality control to the Contractor. In fact, lack of review or inappropriate review can make the reviewing authority responsible for having accepted the submittal even if it was not acceptable. **Do not put into the specification submittal requirements that you do not have the time, resources or knowledge, which you knew or should have known, to enforce.**

10. Specification modifications: There are locations in this specification where additional information is required to reflect project region or contract conditions. Please insert the requested information.

11. SPECIAL REQUIREMENTS OF THIS SPECIFICATION:

Product specification: This specification offers three approaches to product quality. The first is a generic quality non-proprietary product specification. The second option is to peg the generic product quality to a specific manufacture or several or equal manufactures product lines (inserted by the specifier) without specifying specific products. The third option is to allow the specifier to specify specific products where that product exactly fits the design premise of the system design and quality. If the specifier desires to specify specific products a schedule including the product descriptions and model numbers needs to be added either to the drawings or to the specification. **DO NOT** add a schedule to both documents.

Irrigation system design assumptions: This specification assumes that the specifier and the system designer understand the system design assumptions such as the supply pipe size and water pressure. This information must be incorporated onto the drawing. Other design features on the plan such as head type and spacing are a function of water pressure, requirements of completeness of water cover, topography and wind factors. This makes substitutions of head type, for example, have impact on the layout and spacing of heads and even the number of heads on a specific zone. Given the integration of design considerations, drawings and specifications, it is critical for the specifier to work closely with the system design team during the preparation of this document and the resulting construction observation and submittal process.

SECTION 32 8400

IRRIGATION

PART 1 – GENERAL

1.1 SUMMARY

Note to specifier: *Remove any parts of this work description that does not apply.*

- A. Irrigation system required for this work includes but is not limited to the furnishing of all labor, tools, materials, appliances, tests, permits, taxes, etc., necessary for the installation of a landscape irrigation system as herein specified and shown on the drawings, and the removal of all debris from the site.

Note to specifier: *Confirm if the installing Contractor or the general Contractor or the owner is paying for water and electric use fees and hook up charges. Amend the above paragraph if the installing Contractor is required to pay any of these fees.*

1. Locate, purchase, deliver and install piping, conduit, sleeves, 120 volt and low voltage electrical and water connections, valves, backflow preventer devices, controllers, rain sensors, spray and bubbler heads, drip irrigation lines, and associated accessories for a fully operational automatic irrigation system.
 2. Trenching and water settling of backfill material.
 3. Testing and startup of the irrigation system.
 4. Prepare an as built record set of drawings.
 5. Training of the Owner's maintenance personnel in the operational requirements of the Irrigation system.
 6. Clean up and disposal of all excess and surplus material.
 7. Maintenance of the irrigation system during the proscribed maintenance period.
- B. The system shall efficiently and evenly irrigate all areas and be complete in every respect and shall be left ready for operation to the satisfaction of the Owner's Representative.
- C. Coordinate with other trades, as needed to complete work, including but not limited to Water Meter, Point of Connection (POC) and Backflow Preventer Device (BFPD) location and electrical hookups.

1.2 CONTRACT DOCUMENTS

- A. Shall consist of specifications and its general conditions and the drawings. The intent of these documents is to include all labor, materials, and services necessary for the proper execution of the work. The documents are to be considered as one. Whatever is called for by any part shall be as binding as if called for in all parts.

1.3 RELATED DOCUMENTS AND REFERENCES

- A. Related Documents:

Note to specifier: *Coordinate this list with the other related specification sections. Add or delete sections as appropriate.*

1. Drawings and general provisions of contract, including general and supplementary conditions and Division I specifications, apply to work of this section.
2. Related Specification Sections
 - a. Section - Planting
 - b. Section - Planting Soil
 - c. Section – Lawn
 - d. Sections - Mechanical/Plumbing
 - e. Section – Tree and Plant Protection

f. Sections - Electrical

B. References:

1. American Society of Testing Materials (ASTM): cited section numbers.
2. National Sanitation Foundation (NSF): rating system.
3. Irrigation Association: Turf & Landscape Irrigation Best Management Practices

1.4 VERIFICATION

- A. Irrigation piping and related equipment are drawn diagrammatically. Scaled dimensions are approximate only. Before proceeding with work, carefully check and verify dimensions and immediately notify the Owner's Representative of discrepancies between the drawings or specifications and the actual conditions. Although sizes and locations of plants and or irrigation equipment are drawn to scale wherever possible, it is not within the scope of the drawings to show all necessary offsets, obstructions, or site conditions. The Contractor shall be responsible to install the work in such a manner that it will be in conformance to site conditions, complete, and in good working order.
- B. Piping and equipment is to be located within the designated planting areas wherever possible unless specifically defined or dimensioned otherwise.

1.5 PERMITS AND REGULATIONS

- A. The Contractor shall obtain and pay for all permits related to this section of the work unless previously excluded under provision of the contract or general conditions. The Contractor shall comply with all laws and ordinances bearing on the operation or conduct of the work as drawn and specified. If the Contractor observes that a conflict exists between permit requirements and the work outlined in the contract documents, the Contractor shall promptly notify the Owner's Representative in writing including a description of any necessary changes and changes to the contract price resulting from changes in the work.
- B. Wherever references are made to standards or codes in accordance with which work is to be performed or tested, the edition or revision of the standards and codes current on the effective date of this contract shall apply, unless otherwise expressly set forth.
- C. In case of conflict among any referenced standards or codes or between any referenced standards and codes and the specifications, the more restrictive standard shall apply or Owner's Representative shall determine which shall govern.

1.6 PROTECTION OF WORK, PROPERTY AND PERSON

- A. The Contractor shall adequately protect the work, adjacent property, and the public, and shall be responsible for any damages or injury due to the Contractor's actions.

1.7 CHANGES IN THE WORK

- A. The Owner's Representative may order changes in the work, and the contract sum being adjusted accordingly. All such orders and adjustments plus claims by the Contractor for extra compensation must be made and approved in writing before executing the work involved.
- B. All changes in the work, notifications and Contractor's request for information (RFI) shall conform to the contract general condition requirements.

1.8 CORRECTION OF WORK

- A. The Contractor shall re-execute any work that fails to conform to the requirements of the contract and shall remedy defects due to faulty materials or workmanship upon written notice from the Owner's Representative, at the soonest as possible time that can be coordinated with other work, and seasonal weather demands, but not more than 90 (ninety) days after notification.

1.9 DEFINITIONS

- A. Owner's Representative: The person appointed by the Owner to represent their interest in the review

and approval of the work and to serve as the contracting authority with the Contractor. The Owner's Representative may appoint other persons to review and approve any aspects of the work.

- B. Substantial Completion Acceptance: The date at the end of the Planting, Planting Soil, and Irrigation installation where the Owner's Representative accepts that all work in these sections is complete and the Warranty period has begun. This date may be different than the date of substantial completion for the other sections of the project.
- C. Final Acceptance: The date when the Owner's Representative accepts that the plants and work in this section meet all the requirements of specification. It is intended that the materials and workmanship warranty for Planting, Planting Soil, and Irrigation work run concurrently.

1.10 SUBMITTALS

- A. See the contract General Conditions for policy and procedures related to submittals.
- B. Product data
 - 1. Submit a minimum of (3) complete lists of all irrigation equipment to be used, manufacturer's brochures, maintenance manuals, warranties and operating instructions, within 15 days after the notice to proceed.
 - a. This submission may be done digitally and all documents shall be submitted in one PDF document.
 - 2. The submittals shall be packaged and presented in an organized manner, in the quantity described in Division 1 of the specifications. Provide a table of contents of all submitted items.
 - 3. Clearly identify on each submitted sheet by underlining or highlighting (on each copy) the specific product being submitted for approval. Failure to clearly identify the specific product being submitted will result in a rejection for the entire submittal. No substitutions of material or procedures shall be made concerning these documents without the written consent of an accepted equivalent by the Owner's Representative.
 - 4. Equipment or materials installed or furnished without prior approval of the Owner's Representative, may be rejected by the Owner's Representative and the Contractor shall be required to remove such materials from the site at their own expense.
 - 5. Approval of substitution of material and/or products, other than those specified shall not relieve the Contractor from complying with the requirements of the contract documents and specifications. The Contractor shall be responsible, at their own expense, for all changes that may result from the approved substitutions, which affect the installation or operations other items of their own work and/or the work of other Contractors.
- C. Samples: Samples of the equipment may be required at the request of the Owner's Representative if the equipment is other than that specified.
- D. Other Submittals: Submit for approval:
 - 1. Documentation of the installer's qualifications.
 - 2. As built record set of drawings.
 - 3. Testing data from all required pressure testing.
 - 4. Backflow prevention device certification: Certification from the manufacturer or their representative that the back flow prevention device has been installed correctly according to the manufacturer's requirements.
 - 5. Booster pump certification: Certification from the manufacturer or their representative that the booster pump has been installed correctly according to the manufacturer's requirements.
 - 6. Irrigation controller certification: Certification from the manufacturer or an authorized distributor that the Controller has been installed correctly according to the manufacturer's requirements.

1.11 OBSERVATION OF THE WORK

- A. The Owner's Representative may inspect the work at any time. They may remove samples of materials for conformity to specifications. Rejected materials shall be immediately removed from the site and replaced at the Contractor's expense. The cost of testing materials not meeting specifications shall be paid by the Contractor.
- B. The Owner's Representative shall be informed of the progress of the work so the work may be observed at the following key times in the construction process. The Owner's Representative shall be afforded sufficient time to schedule visit to the site. Failure of the Owner's Representative to make field observations shall not relieve the Contractor from meeting all the requirements of this specification.
 - 1. Trenching, directional boring, and sleeving review.
 - 2. Hydrostatic pressure testing.
 - 3. Adjustment and coverage test.
 - 4. Pre-maintenance observation.
 - 5. Final acceptance / system malfunction corrections.

1.12 PRE-CONSTRUCTION CONFERENCE

- A. Schedule a pre-construction meeting with the Owner's Representative at least seven (7) days before beginning work to review any questions the Contractor may have regarding the work, administrative procedures during construction and project work schedule.

1.13 QUALITY ASSURANCE

- A. It is the intention of this specification to accomplish the work of installing an automatic irrigation system, which will operate in an efficient and satisfactory manner. The irrigation system shall be installed and made operational according to the workmanlike standards established for landscape installation and sprinkler irrigation operation as set forth by the most recent Best Management Practices (BMP) of the Irrigation Association.
- B. The specification can only indicate the intent of the work to be performed rather than a detailed description of the performance of the work. It shall be the responsibility of the Contractor to install said materials and equipment in such a manner that they shall operate efficiently and evenly and support optimum plant growth and health.
- C. The Owner's Representative shall be the sole judge of the true intent of the drawings and specifications and of the quality of all materials furnished in performance of the contract.
- D. The Contractor shall keep one copy of all drawings and specifications on the work site, in good order. The Contractor shall make these documents available to the Owner's Representative when requested.
- E. In the event of any discrepancies between the drawings and the specification, the final decision as to which shall be followed, shall be made by the Owner's Representative.
- F. In the event the installation is contradictory to the direction of the Owner's Representative, the installation shall be rectified by the Contractor at no additional cost to the Owner. The Contractor shall immediately bring any such discrepancies to the attention of the Owner's Representative.
- G. It shall be distinctly understood that no oral statement of any person shall be allowed in any manner to modify any of the contract provisions. Changes shall be made only on written authorization of the Owner's Representative.
- H. Installer Qualifications: The installer shall be a firm having at least 5 years of successful experience of a scope similar to that required for the work.
 - a. Installer Field Supervision: The installer shall maintain on site an experienced full-time supervisor who can communicate in English with the Owner's Representative.
 - b. Submit the installer's qualifications for approval.

1.14 IRRIGATION SYSTEM WARRANTY:

- A. The Contractor shall Warrantee all workmanship and materials for a period of X year (s) following the acceptance of the work.

Note to specifier: *Insert above the length of time for the system warrantee period. It is advised to make the irrigation system and the plants have the same length of warrantee.*

- 1. Any parts of the irrigation work that fails or is defective shall be replaced or reconstructed at no expense to the Owner including but not limited to: restoring grades that have settled in trenches and excavations related to the work. Reconstruction shall include any plantings, soil, mulch or other parts of the constructed landscape that may be damaged during the repair or that results from soil settlement.
- B. The date of acceptance of the work and start of the Guarantee period shall be determined by the Owner's Representative, upon the finding that the entire irrigation system is installed as designed and specified, and found to be operating correctly, supplying water evenly to all planting and/or lawn areas.
- C. The system controller shall be warranted by the equipment manufacturer against equipment malfunction and defects for a period of X years, following the acceptance of the work.

Note to specifier: *Insert the length of time that the selected controller is warrantied. Verify material warranty with the controller manufacturer. If a specific controller is not specified, delete the above paragraph.*

- D. Neither the final acceptance nor any provision in the contract documents shall relieve the Contractor of responsibility for faulty materials or workmanship. The Contractor shall remedy any defects within a period of 7 days (s) from the date of notification of a defect.

1.15 SITE CONDITIONS

- A. It is the responsibility of the Contractor to be aware of all surface and sub-surface conditions, and to notify the Owner's Representative, in writing, of any circumstances that would negatively impact the installation of the work. Do not proceed with work until unsatisfactory conditions have been corrected.

1.16 DELIVERY, STORAGE, AND HANDLING

- A. All materials and equipment shall be stored properly and protected as required by the Contractor. The Contractor shall be entirely responsible for damages or loss by weather or other cause to work under the contract. Materials shall be furnished in ample quantities and at such times as to ensure uninterrupted progress of the work.
- B. Deliver the products to the job site in their original unopened container with labels intact and legible at time of use.
- C. Store in accordance with the manufacturers' recommendations.

1.17 PROTECTION

- A. The Contractor shall continuously maintain adequate protection of all their work from damage, destruction, or loss, and shall protect the owner's property from damage arising in connection with this contract. Contractor shall make good any such damage, destruction, loss or injury. Contractor shall adequately protect adjacent property as provided by law and the contract documents.
- B. The Contractor shall maintain sufficient safeguards, such as railings, temporary walks, lights, etc., against the occurrence of accidents, injuries or damage to any person or property resulting from their work, and shall alone be responsible for the same if such occurs.
- C. All existing paving, structures, equipment or plant material shall be protected at all times, including the irrigation system related to plants, from damage by workers and equipment. The Contractor shall follow all protection requirements including plant protection provision of the general contract documents. All damages shall be repaired or replaced at the Contractor's expense. Repairs and or

replacement shall be to the satisfaction of the Owner's Representative, including the selection of a Contractor to undertake the repair or maintenance. Repairs shall be at no cost to the owner.

1. For trees damaged to the point where they will not be expected to survive or which are severely disfigured and that are too large to replace, the cost of damages shall be as determined by the Owner's arborist using accepted tree value evaluation methods.
- D. The Contractor shall refrain from trenching within the drip line of any existing tree to remain. The Owner's Representative may require the Contractor to relocate proposed irrigation work, bore lines beneath roots or use air spade technology to dig trenches through and under the root system to avoid damage to existing tree root areas.

1.18 EXCAVATING AROUND UTILITIES

- A. Contractor shall carefully examine the civil, record, and survey drawings to become familiar with the existing underground conditions before digging.

1. Do not begin any excavation until all underground utilities have been located and marked.

Determine location of underground utilities and perform work in a manner that will avoid possible damage. Hand excavate, as required. Maintain stakes and or markings set by others until parties concerned mutually agree to their removal.

Note to specifier: *Insert the telephone number and correct name of the Local Utility Locator Service if available to the paragraph below.*

- B. Notification of *Local Utility Locator Service, Insert PHONE NUMBER*, is required for all excavation around utilities. The Contractor is responsible for knowing the location and avoiding utilities that are not covered by the *Local Utility Locator Service*.

Note to specifier: *If the project is not in California remove the following paragraph.*

- C. Section 4216/4217 of the government code requires a dig-alert identification number be issued before a "permit to excavate" will be valid. For your dig-alert identification number call underground service alert toll free 1-800-422-4133 two working days before beginning construction.

1.19 POINT OF CONNECTION

Note to specifier: *Confirm exactly where the irrigation Contractor is to connect to the water and high voltage electrical supply. Often the General Contractor and their plumber and electrician are to provide the connections, including the electrical junction box or plug receptacle, back flow preventer, main shutoff valve and other items. Where non-potable water is used another Contractor may provide some of the required equipment and connections. This specification provides two options, which may also need further modification by the specifier. The specifier must confirm assumptions and pick one of the following options.*

Point of connection option 1 - Irrigation Contractor provided

- A. The point of connection of the irrigation system to its electrical power sources shall be provided by the irrigation installer. All connections shall be made by a licensed electrical Contractor per governing codes at the location shown on the drawings.
- B. The point of connection of the irrigation system to its potable and or non-potable water sources, including the main shutoff valve and backflow preventer shall be provided by the irrigation installer. All connections shall be made by a licensed Contractor per governing codes, at the location shown on the drawings.

Point of connection option 2 – General Contractor provided

- A. The point of connection of the irrigation system to its electrical power sources shall be provided by the General Contractor's licensed electrical Contractor per governing codes at the location shown on the drawings. The irrigation Contractor will connect the power to provided junction box or grounded plug receptacle.

- B. The point of connection of the irrigation system to its potable and or non-potable water sources, including the main shutoff valve and backflow preventer shall be provided by the General Contractor's licensed plumbing Contractor per governing codes at the location shown on the drawings. The minimum size and water pressure of the pressurized line will be as noted on the irrigation drawing.

1.20 TEMPORARY UTILITIES

- A. All temporary piping, wiring, meters, panels and other related appurtenances required between source of supply and point of use shall be provided by the Contractor and coordinated with the Owner's Representative. Existing utilities may be used with the written permission of the owner.

1.21 CUTTING, PATCHING, TRENCHING AND DIGGING

- A. The Contractor shall do all cutting, fitting, trenching or patching of their work that may be required to make its several parts come together as shown upon, or implied by, the drawings and specifications for the completed project.
- B. Digging and trenching operations shall be suspended when the soil moisture is above field capacity.

1.22 USE OF PREMISES

- A. The Contractor shall confine their apparatus; the storage of materials, and the operations of their workers to limits indicated by the law, ordinances, or permits and shall not unreasonably encumber the premises with their materials.
- B. Contractor parking, and material and equipment storage shall in areas approved by the Owner's Representative.

1.23 AS BUILT RECORD SET OF DRAWINGS

- A. Immediately upon the installation of any buried pipe or equipment, the Contractor shall indicate on the progress record drawings the locations of said pipe or equipment. The progress record drawings shall be made available at any time for review by the Owner's Representative.
- B. Before final acceptance of work, the Contractor shall provide an as built record set of drawings showing the irrigation system work as built. The drawings shall be transmitted to the Owner's Representative in paper format and as a pdf file of each document on compact disk or flash drive. The drawings shall include all information shown on the original contract document and revised to reflect all changes in the work. The drawings shall include the following additional information
 1. All valves shall be numbered by station and corresponding numbers shall be shown on the as built record set of drawings.
 2. All main line pipe or irrigation equipment including sleeves, valves, controllers, irrigation wire runs which deviate from the mainline location, backflow preventers, remote control valves, grounding rods, shut-off valves, rain sensors, wire splice locations, and quick coupling valves shall be located by two (2) measured dimensions, to the nearest one-half foot. Dimensions shall be given from permanent objects such as buildings, sidewalks, curbs, walls, structures and driveways. All changes in direction and depth of main line pipe shall be noted exactly as installed. Dimensions for pipes shall be shown at no greater than a 50 ft. maximum interval.
 3. As built record set of drawings shall be signed and dated by the Contractor attesting to and certifying the accuracy of the as built record set of drawings. As built record set of drawings shall have "As Built Record Set of Drawings", company name, address, phone number and the name of the person who created the drawing and the contact name (if different).
- C. The Owner shall make the original contract drawing files available to the Contractor.

1.24 CONTROLLER CHARTS:

- A. Provide one controller chart for each automatic controller installed.

1. On the inside surface of the cover of each automatic controller, prepare and mount a color-coded chart showing the valves, main line, and systems serviced by that particular controller. All valves shall be numbered to match the operation schedule and the drawings. Only those areas controlled by that controller shall be shown. This chart shall be a plot plan, entire or partial, showing building, walks, roads and walls. The plan, reduced as necessary and legible in all details, shall be made to a size that will fit into the controller cover. This print shall be approved by the Owner's Representative and shall be protected in laminated in a plastic cover and be secured to the inside back of the controller cabinet door.
2. The controller chart shall be completed and approved prior to acceptance of the work.

1.25 TESTING

- A. Provide all required system testing with written reports as described in part 3.

1.26 OPERATION AND MAINTENANCE MANUALS AND GUARANTEES

- A. Prepare and deliver to the Owner's Representative within ten calendar days prior to completion of construction, two 3-ring hard cover binders containing the following information:
 1. Index sheet stating Contractor's address and telephone number, list of equipment with name and addresses of local manufacturers' representatives.
 2. Catalog and parts sheets on all material and equipment.
 3. Guarantee statement. The start of the guarantee period shall be the date the irrigation system is accepted by the Owner.
 4. Complete operating and maintenance instruction for all major equipment.
 5. Irrigation product manufacturers warranties.
- B. In addition to the above-mentioned maintenance manuals, provide the Owner's maintenance personnel with instructions for maintaining major equipment and show evidence in writing to the Owner's Representative at the conclusion of the project that this has been rendered.

PART 2 – PRODUCTS

2.1 MATERIALS GENERAL

- A. All materials shall be of standard, approved and first grade quality and shall be new and in perfect condition when installed and accepted.

Note to specifier: The following are three options for the use of specific manufacturer's product to set quality and capability of the installation. Confirm the desired approach and select only one of the following options, Modify the text as needed.

Option 1 – Use of a manufacturer's name on the drawing only as a general guide.

- B. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and configuration desired only. Other manufacturer's equipment may be submitted for approval with written approval by the Owner's Representative. Substituted equipment shall not substantially alter the operations of the system.

Option 2 – Use of a manufacturer's name or names in the specification as a specific requirement to use their products but where no specific products are required.

- B. All controllers, valves, and heads *(add other product categories if needed)* shall be manufactured by the following manufacturer(s) *(or approved equal)*.
 1. *Insert manufacturer's name(s) and contact information.*

Option 3 - Use of a specific manufacturer's name and product model for critical products. If this option is selected modify the product specific specifications that follow so that the text is consistent with the product required.

- B. See the parts schedule on the drawings *(or below)* for specific components and manufacturers.
1. Insert schedule of required parts with manufactures name(s) and contact information or add to the various product specifications below.
- C. Approval of any items or substitutions indicates only that the product(s) apparently meet the requirements of the drawings and specifications on the basis of the information or samples submitted. The Contractor shall be responsible for the performance of substituted items. If the substitution proves to be unsatisfactory or not compatible with other parts of the system, the Contractor shall replace said items with the originally specified items, including all necessary work and modifications to replace the items, at no cost to the owner.

Note to specifier: *Some of the following product specifications have a clause that say that further product descriptions are on the drawings. Confirm that this is the case. If this is the desired option for the specification, select Option 3 above. If this is not the case remove reference to the product being described on the drawings. Add additional specifications as needed to strengthen the product requirements as needed by the project goals and tolerance for tightening industry product options.*

Delete all products in the following paragraphs not applicable to this specific project.

2.2 RECLAIMED WATER SYSTEM DESIGNATION

- A. Where irrigation systems use reclaimed water, all products including valve boxes, lateral and main line pipe, etc. where applicable and/or required by local code shall have the reclaimed water purple color designation.

2.3 PIPING MATERIAL

- A. Individual types of pipe and fittings supplied are to be of compatible manufacturer unless otherwise approved. Pipe sizes shown are nominal inside diameter unless otherwise noted.
- B. Plastic pipe:
 - 1. All pipe shall be free of blisters, internal striations, cracks, or any other defects or imperfections. The pipe shall be continuously and permanently marked with the following information: manufacturer's name or trade mark, size, class and type of pipe pressure rating, quality control identifications, date of extrusion, and National Sanitation Foundation (NSF) rating.
 - 2. Pressure main line for piping upstream of remote control valves and quick coupling valves:
 - a. Pipe smaller than 2 inch diameter shall be plastic pipe for use with solvent weld or threaded fittings. Shall be manufactured rigid virgin polyvinyl chloride (PVC) 1220, Type 1, Grade 2 conforming to ASTM D 1785, designated as Schedule 40.
 - b. Pipe 2 - 3 inch diameter shall be manufactured rigid virgin polyvinyl chloride (PVC), Type 1, Grade 2 conforming to ASTM D 1785, designated as bell gasket Class 315.
 - c. Pipe larger than 3 inch diameter shall be manufactured rigid virgin polyvinyl chloride (PVC), Type 1, Grade 2 conforming to ASTM D 1785, designated as bell gasket Class 200 PVC.
 - 3. Non-pressure lateral line for piping downstream of remote control valves: plastic pipe for use with solvent weld or threaded fittings. Shall be manufactured rigid virgin polyvinyl chloride PVC 1220 (type 1, grade 2) conforming to ASTM d 1785, designated as Class 200, 3/4" minimum size.
- C. Galvanized pipe shall be used for above ground connections to, backflow prevention device assemblies, hose bibs, and booster pumps and as shown on the plans and details.
 - 1. Pipe shall be hot dip galvanized continuous welded, seamless, Schedule 40 conforming to applicable current ASTM standards.

2.4 FITTINGS AND CONNECTIONS:

- A. Polyvinyl chloride pipe fittings and connections: Type II, Grade 1, Schedule 40, high impact molded fittings, manufactured from virgin compounds as specified for piping tapered socket or molded thread type, suitable for either solvent weld or screwed connections. Machine threaded fittings and plastic saddle and flange fittings are not acceptable. Furnish fittings permanently marked with following information: nominal pipe size, type and schedule of material, and National Sanitation Foundation (NSF) seal of approval. PVC fittings shall conform to ASTM D2464 and D2466.
- B. Brass pipe fittings, unions and connections: standard 125 pound class 85% red brass fittings and connections, IPS threaded.
- C. PVC Schedule 80 threaded risers and nipples: Type I, grade 1, Schedule 80, high impact molded, manufactured from virgin compounds as specified for piping and conforming to ASTM D-2464. Threaded ends shall be molded threads only. Machined threads are not acceptable.
- D. Galvanized pipe fittings shall be galvanized malleable iron ground joint Schedule 40 conforming to applicable current ASTM standards.

2.5 SOLVENT CEMENTS AND THREAD LUBRICANT

- A. Solvent cements shall comply with ASTM D2564. Socket joints shall be made per recommended procedures for joining PVC plastic pipe and fittings with PVC solvent cement and primer by the pipe and fitting manufacturer and procedures outlined in the appendix of ASTM D2564.
- B. Thread lubricant shall be Teflon ribbon-type, or approved equal, suitable for threaded installations as per manufacturer's recommendations.
- C. Pipe Joint Compound (Pipe dope) shall be used on all galvanized threaded connections. Pipe Joint Compound is a white colored, non-separating thread sealant compound designed to seal threaded connections against leakage due to internal pressure. It shall contain PTFE (Polytetrafluoroethylene) to permit a tighter assembly with lower torque, secure permanent sealing of all threaded connections and allow for easy disassembly without stripping or damaging threads.

2.6 BACKFLOW PREVENTION DEVICES

- A. The backflow prevention device shall be certified to NSF/ANSI 372 shall be ASSE Listed 1013, rated to 180 degree F, and supplied with full port ball valves.
- B. The main body and access covers shall be low lead bronze (ASTM B 584)
- C. The seat ring and all internal polymers shall be NSF Listed Noryl and the seat disc elastomers shall be silicone.
- D. Backflow Preventer shall be as indicated on the drawings.

2.7 PRESSURE REGULATOR

- A. Pressure regulator shall certified to NSF/ANSI 372, consisting of low lead bronze body bell housing, a separate access cap shall be threaded to the body and shall not require the use of ferrous screws.
- B. The main valve body shall be cast bronze (ASTM B 584).
- C. The access covers shall be bronze (ASTM B 584 or Brass ASTM B 16)
- D. The assembly shall be of the balanced piston design and shall reduce the pressure in both flow and no flow conditions.
- E. Pressure regulator shall be as indicated on the drawings.

2.7. Wye Strainer

- A. Strainer shall conform to MIL -S-16293, and be ANSI 3rd party certified to comply with the states lead plumbing law 0.25% maximum weighted average lead content.
- B. The main body shall be low lead bronze (ASTM B 584)

- C. The access covers shall be yellow brass or cast bronze (ASTM B 16 or ASTM B 584)
- D. Strainer screen shall be 300 series stainless steel available in 20, 40, 60, 80, or 100 mesh.
- F. Wye strainer shall be as indicated on the plans.

2.8 BACKFLOW PREVENTER CAGE

- A. A heavy-duty steel mesh cage with rust proof finish. The caging shall be sized to allow space for the entire piping assembly associated with the Backflow Preventer unit, and all associated equipment.
- B. The cage shall include the manufacturers' standard tamper proof locking mechanism.
- C. Provide a concrete base as detailed on the drawings.
- D. Backflow Preventer Cage type, manufacturer and color shall be as indicated on the plans.

2.9 BOOSTER PUMP

Note to specifier: *Booster pumps are used when available static pressure is too low for the system to operate, demand is high requiring multiple stations to operate at once, future expansion of the system of the water window is very small due to maintenance practices or site use (such as in the case of parks, sports fields, or schools). It is the responsibility of the specifier to consider all such factors in determining whether or not a booster pump is required. IN many cases booster pumps are specified when they are not needed due to all of the variables not being taken into consideration.*

- A. Booster pump shall be housed in a sturdy, locking, weather-resistant case, furnished for maximum exterior protection.
- B. Booster pump shall be as indicated on the drawings. .

2.10 BALL VALVES

- A. Ball valves for 3/4 inch through 2-1/2 inch shall be of PVC, block, tru-union design with EDPDM seals and o-ring.
- B. Ball valves for 3 inch and larger shall be gate design and shall be iron body, brass or bronze mounted AWWA gate valves, and shall have a clear waterway equal to the full nominal diameter of the valve, and shall be rubber gasket, flanged or mechanical joint only, and shall be able to withstand a continuous working pressure of 150 PSI. Valve shall be equipped with a square-operating nut.
- C. All ball valves located in a valve manifold shall be the same size as the main line (1-1/2 inch size minimum). Provide pipe-reducing adapters down stream of valves, as required. All ball valves in line shall be the same size as the pipe.
- D. Ball valves shall be as indicated on the drawings.

2.11 CHECK VALVES

- A. Swing check valves 2 inch and smaller shall be 200 lbs., W.O.G., bronze construction with replaceable composition, neoprene or rubber disc and shall meet or exceed federal specification WW-V- 5ld, class a, type iv.
- B. Anti-drain valves shall be of heavy-duty virgin PVC construction with female iron pipe thread inlet and outlet. Internal parts shall be stainless steel and neoprene. Anti-drain valves shall be field adjustable against draw out from 5 to 40 feet of head.
- C. Check valves shall be as indicated on the drawings.

2.12 REMOTE CONTROL VALVES

- A. Remote control valves shall be electrically operated, single seat, normally closed configuration, equipped with flow control adjustment and capability for manual operation.

- B. Valves shall be actuated by a normally closed low wattage solenoid using 24 volts, 50/60 cycle solenoid power requirement. Solenoid shall be epoxy encased. A union shall be installed on the discharge end.
 - C. Remote control valves shall be wired to controller in same numerical sequence as indicated on drawings.
 - D. Remote control valves shall be as indicated on the drawings.
- 2.13 MASTER CONTROL VALVES
- Note to specifier:** *The master valve and flow sensor specifications must meet the requirements or recommendations of the controller manufacturer. Additional specifications are required for this product.*
- A. Master Control Valve shall be compatible with the irrigation controller.
 - B. Master control valves shall be as indicated on the drawings.
- 2.14 FLOW SENSOR
- A. Flow sensor shall be compatible with the irrigation controller.
 - B. Flow sensor shall be as indicated on the drawings.
- 2.15 HYDROMETER
- Note to specifier:** *The hydrometer specifications must meet the requirements or recommendations of the controller manufacture. The Hydrometer can be either Reed Switch or Photo Diode Register, specifier needs to verify with the controller manufacturer. Additional specifications are required for this product.*
- A. Hydrometer shall be compatible with the irrigation controller.
 - B. Hydrometer shall be as indicated on the drawings.
- 2.16 QUICK COUPLER VALVES
- A. Quick coupler valves shall be a one or two piece, heavy-duty brass construction with a working pressure of 150 PSI with a built in flow control and a self-closing valve.
 - B. Quick coupler shall be equipped with locking red brass cap covered with durable yellow thermo-plastic rubber cover. Key size shall be compatible with quick coupler and of same manufacturer.
 - C. Quick coupler valves shall be as indicated on the drawings.
- 2.17 SPRINKLER HEADS
- Note to specifier:** *The selection of irrigation heads is a complex decision and needs far stronger specifications than are listed here. Confirm the approach to selecting heads and revise the text.*
- A. All sprinkler heads shall have check valves installed.
 - B. All sprinkler heads shall be as indicated on the drawings.
 - C. Riser nipples for all sprinkler heads shall be the same size as the riser opening in the sprinkler body and fabricated as shown on the drawings.
- 2.18 AUTOMATIC CONTROLLER
- Note to specifier:** *Irrigation controllers vary upon the designer's preferences, users needs, and education of the owner/maintenance personal. The specifier shall develop these specifications based upon those factors.*
- A. Controller shall be housed in a sturdy, locking, weather-resistant case, furnished for maximum exterior protection.
 - B. Controller shall be equipped with evapo-transpiration (ET) sensor, which adjusts the controller programming based on local climatic conditions. The sensor shall also have a rain sensing shut-off switch, wind sensing shut off switch, and freeze sensing shut-off of switch.

1. If a moisture sensor is used in lieu of an evapo-transpiration sensor an additional sensor, which has a rain-sensing shut-off switch, wind sensing shut-off switch, and freeze sensing shut-off switch shall be provided.
 - C. Automatic controller shall be as indicated on the drawings.
- 2.19 CONTROLLER DECODERS
- Note to specifier: Controller decoders for 2-wire systems are specific to each controller manufacturer. In addition the installation warranty can be connected to the purchase of the 2-wire controller and decoders from the same distributor. The specifier shall develop these specifications based upon those factors.*
- A. All decoders shall be per the controller manufacturer's specifications.
 - B. Decoder model number shall be as shown on the drawings.
- 2.20 ELECTRICAL CONTROL WIRING
- A. Low voltage
 1. The electrical control wire shall be direct burial type UF, no. 14 AWG, solid, single conductor, copper wire UL approved or larger, if required to operate system as designed.
 2. For 2-Wire controllers all irrigation wire for the controller, flow sensor, master valve, hydrometer, remote control valves and moisture sensors shall be per the controller manufacturer's specifications and recommendations.
 3. Color code wires to each valve. Common wire shall be white.
 4. If multiple controllers are being utilized, and wire paths of different controllers cross each other, both common and control wires from each controller to be of different colors.
 5. Control wire splices: Splices are when required shall be placed in splice boxes.
 6. Wire connections shall be per the controller manufacturer's specifications and recommendations.
 - B. High voltage
 1. Shall be of type as required by local codes and ordinances.
 2. Shall be of proper size to accommodate needs of equipment it is to serve.
- 2.21 VALVE BOXES AND MATERIALS
- Note to specifier: Valve box color shall differentiate depending on the specifier's preference or the irrigation system is using non potable water.*
- A. Valve boxes: valve boxes shall be constructed of ABS (acrylonitrile butadiene styrene) plastic, **green** in color, with rigid base and sides and shall be supplied with bolt lock cover secured with stainless steel bolts. Cover shall be identified as shown on drawings. Provide box extensions as required.
 1. Master valves, flow sensors, remote control irrigation valves, gate valves, and ball valves 3 inch or less in size shall use a 14 inch x 19 inch x 12 inch rectangular box.
 2. Quick coupler valves, wire splices, and grounding rods shall use a 10 inch circular box.
- 2.22 CONCRETE THRUST BLOCKS
- A. Concrete thrust blocks shall be sized per the pipe manufactures requirement or as indicated on the drawings.
- 2.23 VALVE IDENTIFICATION TAGS
- A. Valve Identification Tags shall be 2.25 inch x 2.65 inch polyurethane. Color: potable water; yellow / Non-potable water; purple. Tags shall be permanently attached to each remote control valve with

tamper proof seals as indicated on the drawings.

2.24 EQUIPMENT TO BE FURNISHED TO OWNER

- A. Two (2) sets of keys for each automatic controller.
- B. Two (2) 48 inch tee wrenches for operating the gate valves.
- C. Three (3) sets of special tools required for removing, disassembling and adjusting each type of sprinkler and valve supplied on this project.
- D. Five (5) Extra sprinkler heads, nozzles, shrub adapters, nozzle filter screens, for each type used on the project.
- E. Two (2) quick coupler keys to match manufacturer type of quick coupler.

2.25 INCIDENTAL MATERIALS AND EQUIPMENT

- A. Furnish all materials and equipment not specified above, but which are necessary for completion of the work as intended.

2.26 MAIN LINE LOCATOR TAPE

- A. 3 - inch wide plastic detectable locator tape.

2.27 MAIN LINE AND LATERAL LINE BEDDING SAND

- A. Sand shall consist of natural or manufactured granular material, free of organic material, mica, loam, clay or other substances not suitable for the intended purpose.
- B. Sand shall be masonry sand ASTM C 144 or coarse concrete sand, ASTM C 33.

PART 3 – EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Code requirements shall be those of state and municipal codes and regulations locally governing this work, providing that any requirements of the drawings and specifications, not conflicting therewith, but exceeding the code requirements, shall govern unless written permission to the contrary is granted by the Owner's Representative.
- B. Extreme care shall be exercised at all times by the Contractor in excavating and working in the project area due to existing utilities and irrigation systems to remain. Contractor shall be fully responsible for expenses incurred in the repair of damages caused by their operation.
 - 1. The Contractor is responsible for identifying and maintaining existing irrigation main lines that supply water to areas on the site as noted on the drawings and outside of the proposed limit of work. The Contractor shall relocate or replace existing irrigation main line piping as required to provide a continuous supply of water to all areas of existing irrigation on site.
 - a. Providing continuous water supply shall include hand watering and or the use of watering trucks to provide adequate water.
- C. Plan locations of backflow preventers, valves, controllers, irrigation lines, sleeves, spray heads and other equipment are diagrammatic and indicate the spacing and relative locations of all installations. Final site conditions and existing and proposed plantings shall determine final locations and adjusted as necessary and as directed to meet existing and proposed conditions and obtain complete water coverage. Minor changes in locations of the above from locations shown shall be made as necessary to avoid existing and proposed trees, piping, utilities, structures, etc. at the Contractor's expense or when directed by the Owner's Representative.
 - 1. The Contractor shall be held responsible for relocation of any items without first obtaining the Owner's Representative's approval. The Contractor shall remove and relocate such items at their expense if so directed by the Owner's Representative.

- D. Prior to any work the Contractor shall stake out locations of all pipe, valves, equipment and irrigation heads and emitters using an approved staking method and maintain the staking of the approved layout in accordance with the drawings and any required modifications. Verify all horizontal and vertical site dimensions prior to staking of heads. Do not exceed spacing shown on drawings for any given area. If such modified spacing demand additional or less material than shown on the drawings, notify the Owner's Representative before beginning any work in the adjacent area.
- E. Stub out main line at all end runs and as shown on drawings. Stub out wires for future connection where indicated on plan and as directed.
- F. Point of connection shall be approximately as shown on drawings. Connect new underground piping and valves and provide all flanges, adapters or other necessary fittings for connection.
- G. Permission to shut off any existing in-use water line must be obtained 48 hours in advance, in writing from the Owner. The Contractor shall receive instructions from the Owner's Representative as to the exact length of time of each shut-off.
- H. No fittings shall be installed on pipe underneath pavement or walls.
- I. Prior to starting any work, Contractor shall obtain a reading of existing static water pressure (no flow condition) at the designated point of connection and immediately submit written verification of pressure with date and time of recording to Owner's Representative.

3.2 TRENCHING, DIRECTIONAL BORING AND SLEEVING

- A. Perform all trenching, directional boring, sleeving and excavations as required for the installation of the work included under this section, including shoring of earth banks to prevent cave-ins.
- B. The Contractor may directional bore lines where it is practical or where required on the plans.
 - 1. Extend the bore 1' past the edge of pavement unless noted differently on the plans
 - 2. Cap ends of each bore and locate ends at finished grade using metal stakes.
 - 3. All boring and sleeving shall have detectable locator tape placed at the ends of the pipe.
- C. Make trenches for mains, laterals and control wiring straight and true to grade and free of protruding stones, roots or other material that would prevent proper bedding of pipe or wire.
- D. Excavate trenches wide enough to allow a minimum of 4 - inch between parallel pipelines and 8 inch from lines of other trades. Maintain 3 - inch vertical clearance between irrigation lines. Minimum transverse angle is 45 degrees. All pipes shall be able to be serviced or replaced without disturbing the other pipes.
- E. Trenches for pipelines shall be made of sufficient depth to provide the minimum cover from finished grade as follows:

Note to specifier: *Mainline depths shall vary based on geography and climate conditions. For colder climates mainline depths shall be deeper. Specifier shall verify local and or state requirements.*

 - 1. Pressure main line: 18 inches below finish grade and 24-30 inches below paved areas in Schedule 40 PVC sleeves.
 - 2. Reclaimed water constant pressure main lines shall cross at least twelve (12) inches below potable water lines.
 - a. If a constant pressure reclaimed water main line must be installed above a potable water line or less than twelve (12) inches below a potable water line, then reclaimed water line shall be installed within an approved protective sleeve. The sleeve shall extend ten (10) feet from each side of the center of the potable line, for a total of twenty (20) feet. The sleeve shall be color-coded (purple) for use with reclaimed water.
 - 3. Lateral lines: 12 inches below finish grade and 18 inches below paved areas in Schedule 40 PVC sleeves.

4. Control wiring: to the side of pressure main line and 24 inches below paved areas in Schedule 40 PVC sleeves.
- F. On new on-site systems (post-meter), the required horizontal separation between potable water lines, reclaimed water constant pressure main lines and sewer lines shall be a minimum of four (4) feet apart as directed by the project engineer and/ or regulatory agency. Measurements shall be between facing surfaces, not pipe centerlines.
- G. When trenching through areas of imported or modified soil, deposit imported or modified soils on one side of trench and subsoil on opposite side.
- H. Backfill the trench per the requirements in paragraphs "Backfilling and Compacting" below.

3.3 PIPE INSTALLATION

A. General Pipe Installation

1. Exercise caution in handling, loading and storing, of plastic pipe and fittings to avoid damage.
 - a. The pipe and fittings shall be stored under cover until using, and shall be transported in a vehicle with a bed long enough to allow the length of pipe to lay flat so as not to be subjected to undue bending or concentrated external load at any point.
 - b. All pipe that has been dented or damaged shall be discarded unless such dent or damaged section is cut out and pipe rejoined with a coupling.
2. Trench depth shall be as specified above from the finish grade to the top of the pipe.
3. Install a detectable pipe locator tape 6 to 8 inches above all main line pipes.

B. Polyvinyl Chloride Pipe (PVC) Installation

1. Under no circumstance is pipe to rest on concrete, rock, wood blocks, construction debris or similar items.
2. No water shall be permitted in the pipe until a period of at least 24 hours has elapsed for solvent weld setting and curing.
3. Install assemblies and pipe to conform to respective details and where shown diagrammatically on drawings, using first class workmanship and best standard practices as approved. All fittings that are necessary for proper connections such as swing joints, offsets, and reducing bushings that are not shown on details shall be installed as necessary and directed as part of the work.
4. Dielectric bushings shall be used in any connections of dissimilar metals.
5. Gasketed plastic pipe: pipe-to-pipe joints or pipe to fittings shall be made in accordance with manufacturer's specifications.
6. Solvent weld or threaded plastic pipe:
 - a. Installation of all pipe and fittings shall be in strict accordance with manufacturer's specifications.
 - b. Pipe shall be cut using approved PVC pipe cutters only. Sawed joints are disallowed. All field cuts shall be beveled to remove burrs and excess before gluing.
 - c. Welded joints shall be given a minimum of 15 minutes to set before moving or handling. Excess solvent on the exterior of the joint shall be wiped clean immediately after assembly.
 - d. Plastic to metal connections shall be made with plastic adapters and if necessary, short (not close) brass threaded-nipples. Connection shall be made with two (2) wraps of Teflon tape and hand tightened plus one turn with a strap wrench.
 - e. Snake pipe horizontally in trench to allow one (1) foot of expansion and contraction per 100 feet of straight run.
 - f. Threaded pipe joints shall be made using Teflon tape. Solvent shall not be used with threaded joints. Pipe shall be protected from tool damage during assembly. All damaged pipe shall be removed and replaced. Take up threaded joints with light wrench pressure.
 - g. No close nipples or risers are allowed. Cross connections in piping is disallowed.

- h. Center load pipe at 10 feet on center intervals with small amount of backfill to prevent arching and slipping under pressure. Other than this preliminary backfill all pipe joints, fittings and connections are to remain uncovered until successful completion of hydrostatic testing and written approval of the testing report.
- i. Concrete thrust blocks shall be constructed behind all pipe fittings 1-1/2 inch diameter and larger at all changes of direction of 45 degrees or more.

C. Galvanized Pipe Installation

- 1. All joints shall be threaded with pipe joint compound used on all threads.
- 2. Dielectric bushings shall be used in any connections of dissimilar metals.

3.4 TRENCHING, DIRECTIONAL BORING, AND SLEEVING REVIEW:

- A. Upon completion and installation of all trenching, directional boring, and sleeving, all installed irrigation control wiring, lines and fittings shall be visually observed by the Owner's Representative unless otherwise authorized. Do not cover any wires, lines or fittings until they have been tested and observed by the Owner's Representative.

3.5 FLUSHING

- A. Openings in piping system during installation are to be capped or plugged to prevent dirt and debris from entering pipe and equipment. Remove plugs when necessary to flush or complete system.
- B. After completion and prior to the installation of any terminal fittings, the entire pipeline system shall be thoroughly flushed to remove dirt, debris or other material.

3.6 HYDROSTATIC PRESSURE TESTING

- A. After flushing, and the installation of valves the following tests shall be conducted in the sequence listed below. The Contractor shall furnish all equipment; materials and labor necessary to perform the tests and all tests shall be conducted in the presence of the Owner's Representative.
- B. Water pressure tests shall be performed on all pressure main lines before any couplings, fittings, valves and the like are concealed.
- C. Immediately prior to testing, all irrigation lines shall be purged of all entrapped air or debris by adjusting control valves and installing temporary caps forcing water and debris to be discharged from a single outlet.
- D. Test all pressure main line at 150 PSI. For a minimum of four (4) hours with an allowable loss of 5 PSI. Pressure and gauges shall be read in PSI, and calibrated such that accurate determination of potential pressure loss can be ascertained.
- E. Re-test as required until the system meets the requirements. Any leaks, which occur during test period, will be repaired immediately following the test. All pipe shall be re-tested until final written acceptance.
- F. The Contractor is responsible for proving documentation stating the weather conditions, date, the start time and initial water pressure readings, the finish time and final water pressure readings and the type of equipment used to perform the test. The documentation must be signed by a witness acceptable to the Owner, verifying all of the above-mentioned conditions.
- G. Submit a written report of the pressure testing results with the other above required information to the Owner's Representative for approval.

3.7 BACKFLOW PREVENTER TESTING

- A. The backflow preventer shall be tested according to procedures and results per the requirements of the Foundation for Cross-Connection Control and Hydraulic Research, University of Southern California or American Water Works Association whichever is more stringent.
- B. Testing shall be performed by a Backflow Prevention Assembly Tester with a current certification

from the American Backflow Preventer Association.

3.8 CONTROLLER AND BOOSTER PUMP TESTING AND CERTIFICATION

Note to specifier: *Testing and certification of the installation of the controller and the booster pump (if installed) is sometimes preferred by the specifier for a third party verification that the equipment was installed and working in accordance with the manufacturer's specifications. The specifier's knowledge of the manufacturer's installation requirements, along with their level of construction observation and administration on the project, should be taken into consideration on whether or not to proceed with certification. Not having the installation certified does not relieve the Contractor of any responsibility for installation but does provide the specifier with an additional mechanism so that the equipment is installed correct and technical support, if a non-manufacturing issue were to arise with the equipment, is available. Remove this section if certification is not required.*

- A. Controller and booster Pump shall be certified by xxxxx of (name the company). Contact xxxxxxxx at xxx.xxx.xxxx.

3.9 BACKFILLING AND COMPACTING

- A. Irrigation trenches shall be carefully backfilled with material approved for backfilling and free of rocks and debris one (1) inch in diameter and larger. When back filling trenches in areas of imported or modified planting soil, replace any excavated subsoil at the bottom and the imported soil or modified planting soil at the top of the trench.
- B. Backfill shall be compacted with approved equipment to the following densities
 - 1. Backfill under pavement and within 2 feet of the edge of pavement: Compact to 95% or greater of maximum dry density standard proctor.
 - 2. Backfill of subsoil under imported planting mixes or modified existing planting soil: Between 85 and 90% of maximum dry density standard proctor.
 - 3. Backfill of imported planting mixes or modified existing planting soil: Compact to the requirements of the adjacent planting mix or planting soil as specified in section "Planting Soil".
- C. Finish grade of all trenches shall conform to adjacent grades without dips or other irregularities. Dispose of excess soil or debris off site at Contractor's expense.
- D. Any settling of backfill material during the maintenance or warranty period shall be repaired at the Contractor's expense, including any replacement or repair of soil, lawn, and plant material or paving surface.

3.10 RESURFACING PAVING OVER TRENCHES

Note to specifier: *In some projects paving restoration may be the responsibility of the General Contractor. Coordinate with other specification sections and amend this paragraph as needed.*

- A. Restore all surfaces and repair existing underground installations damaged or cut as a result of the excavation to their original condition, satisfactory to the Owner's Representative.
- B. Trenches through paved areas shall be resurfaced with same materials quality and thickness as existing material. Paving restoration shall be performed by the project paving Sub-contractor or an approved Contractor skilled in paving work.
- C. The cost of all paving restoration work shall be the responsibility of the irrigation Contractor unless the trenching thru the paving was, by previous agreement, part of the general project related construction.

3.11 INSTALLATION OF EQUIPMENT

- A. General:
 - 1. All equipment shall be installed to meet all installation requirements of the product manufacturer. In the event that the manufacturer's requirements cannot be implemented due to particular condition at the site or with other parts of the design, obtain the Owner's Representative's written authorization and approval for any modifications.

2. Install all equipment at the approximately at the location(s) and as designated and detailed on the drawings. Verify all locations with the Owner's Representative.
 3. Install all valves within a valve box of sufficient size to accommodate the installation and servicing of the equipment. Group valves together where practical and locate in shrub planting areas.
 4. All sprinkler irrigation systems that are using water from potable water systems shall require backflow prevention. All backflow prevention devices shall meet and be installed in accordance with requirements set forth by local codes and the health department.
- B. Pressure regulator:
1. Set regulator for required PSI per manufacturer's specifications.
- C. Check Valve:
1. Install check valves approximately at the locations necessary to prevent low head run off.
- D. Remote control valves:
1. Install one remote control valve per valve box.
 2. Remote control valve manifolds and quick coupler valves shall be separate allowing use of a quick coupler with all remote control valves shut off.
 3. Install boxes no farther than 12 inches from edge of paving and perpendicular to edge of paving and parallel to each other. Allow 12 inches clearance between adjacent valve boxes.
- E. Quick coupler valve:
1. Install each quick coupler valve in its own valve box.
 2. Install thrust blocks on quick couplers.
 3. Place no closer than 12 inches to adjacent paving.
 4. Install 18 inches off set from main line.
- F. Sprinkler heads:
1. All main lines and lateral lines, including risers, shall be flushed and pressure tested before installing sprinkler heads.
 2. Install specified sprinkler heads as shown in details at locations shown on the drawings. Adjust layout for full coverage, spacing of heads shall not exceed the maximum spacing recommended by the manufacturer.
 3. All sprinkler heads shall be set perpendicular to finish grade unless otherwise designated on the drawings or details.
- G. Irrigation controllers:
1. Remote control valves shall be connected to controller in numerical sequence as shown on the drawings.
 2. Controller shall be tested with complete electrical connections. The Contractor shall be responsible for temporary power to the controller for operation and testing purposes.
 3. Connections to control wiring shall be made within the pedestal of the controller. All wire shall follow the pressure main insofar as possible.
 4. Electrical wiring shall be in a rigid gray PVC plastic conduit from controller to electrical outlet. The electrical Contractor shall be responsible for installing all wiring to the controller, in order to complete this installation. A disconnect switch shall be included.
- H. Wiring:
1. Low Voltage
 - a. Control wiring between controller and electrical valves shall be installed in the same trench as

the main line where practical. The wire shall be bundled and secured to the lower quadrant of the trench at 10 foot intervals with plastic electrical tape.

- b. When the control wiring cannot be installed in the same main line trench it shall be installed a minimum of 18 inches below finish grade and a bright colored plastic ribbon with suitable markings shall be installed in the trench 6 inches below grade directly over the wire.
- c. An expansion loop shall be provided every 500 feet in a box and inside each valve box. Expansion loop shall be formed by wrapping wire at least eight (8) times around a ¾ inch pipe and withdrawing pipe.
- d. Provide one control wire to service each valve in system.

Note to specifier: *A majority of the newer irrigation controllers have more than one port for common wire allowing for multiple directional runs. Depending on the controller location within the irrigation system it might be more efficient to have more than one common wire in the system. The specifier must confirm the number of common wires and fill in below.*

- e. Provide **XX** common wire(s) per controller.
- f. Run two (2) spare #14-1 wires from controller along entire main line to last electric remote control valve on each and every leg of main line. Label spare wires at controller and wire stub to be located in a box.
- g. All control wire splices not occurring at control valve shall be installed in a separate splice valve box.
- h. Wire markers (sealed, 1 inch to 3 inch square) are to identify control wires at valves and at terminal strips of controller. At the terminal strip mark each wire clearly indicating valve circuit number.

2. High Voltage

- a. All electrical work shall conform to local codes, ordinances and any authorities having jurisdiction. All high voltage electrical work to be performed by licensed electrician.
- b. The Contractor shall provide 120-volt power connection to the automatic controller unless noted otherwise on drawings.

I. Valve boxes:

1. Install one valve box for each type of valve installed as per the details.
2. Gravel sump shall be installed after compaction of all trenches. Final portion of gravel shall be placed inside valve box after valve is backfilled and compacted.
3. Permanently label valve number and or controller letter on top of valve box lid using a method approved by the Owners Representative.

J. Tracer wire:

1. Tracer wire shall be installed with non-metallic plastic irrigation main lines where controller wires are not buried in the same trench as the main line.
2. The tracer wire shall be placed on the bottom of the trench under the vertical projection of the pipe with spliced joints soldered and covered with insulation type tape.
3. Tracer wire shall be of a color not used for valve wiring. Terminate wire in a valve box. Provide enough length of wire to make a loop and attach wire marker with the designation "tracer wire".

K. Drip Installation:

1. Clamp fittings with Oetiker clamps or approved equal when operating pressure exceeds specific drip tubing fitting requirements.
2. When installing drip tubing, install soil staples as listed below:
 - a. Sandy Soil - One staple every three (3') feet and two (2) staples on each change of direction (tee, elbow, or cross).
 - b. Loam Soil - One staple every four (4') feet and two (2) staples on each change of direction (tee, elbow, or cross).
 - c. Clay Soil - One staple every five (5') feet and two (2) staples on each change of direction (tee, elbow, or cross).

3. Cap or plug all openings as soon as lines have been installed to prevent the intrusion of materials that would obstruct the pipe. Leave in place until removal is necessary for completion of installation.
4. Thoroughly flush all water lines before installing valves and other hydrants.

3.12 ADJUSTMENT AND COVERAGE TEST

A. Adjustment:

1. The Contractor shall flush and adjust all sprinkler heads, valves and all other equipment to ascertain that they function according to the manufacturer's data.
2. Adjust all sprinkler heads not to overspray onto walks, roadways and buildings when under maximum operating pressure and during times of normal prevailing winds.

B. Coverage test:

1. The Contractor shall perform the coverage test in the presence of the Owner's Representative after all sprinkler heads have been installed, flushed and adjusted. Each section is tested to demonstrate uniform and adequate coverage of the planting areas serviced.
2. Any systems that require adjustments for full and even coverage shall be done by the Contractor prior to final acceptance at the direction of the Owner's Representative at no additional cost. Adjustments may also include realignment of pipes, addition of extra heads, and changes in nozzle type or size.
3. The Contractor at no additional cost shall immediately correct all unauthorized changes or improper installation practices.
4. The entire irrigation system shall be operating properly with written approval of the installation by the Owner's representative prior to beginning any planting operations.

3.13 REPAIR OF PLANTING SOIL

- A. Any areas of planting soil including imported or existing soils or modified planting soil which become compacted or disturbed or degraded as a result of the installation of the irrigation system shall be restored to the specified quality and compaction prior to beginning planting operations at no additional expense to the Owner. Restoration methods and depth of compaction remediation shall be approved by the Owner's Representative.

3.14 CLEAN-UP

- A. During installation, keep the site free of trash, pavements reasonably clean and work area in an orderly condition at the end of each day. Remove trash and debris in containers from the site no less than once a week.
 - a. Immediately clean up any spilled or tracked soil, fuel, oil, trash or debris deposited by the Contractor from all surfaces within the project or on public right of ways and neighboring property.
- B. Once installation is complete, wash all soil from pavements and other structures.
 1. Make all repairs to grades ruts, and damage to the work or other work at the site.
 2. Remove and dispose of all excess soil, packaging, and other material brought to the site by the Contractor.

3.15 PROTECTION

- A. The Contractor shall protect installed irrigation work from damage due to operations by other Contractors or trespassers.
 1. Maintain protection during installation until Acceptance. Treat, repair or replace damaged work immediately. The Owner's Representative shall determine when such treatment, replacement or repair is satisfactory.

3.16 PRE-MAINTENANCE OBSERVATION:

- A. Once the entire system shall be completely installed and operational and all planting is installed, the Owner's Representative shall observe the system and prepare a written punch list indicating all items to be corrected and the beginning date of the maintenance period.
- B. This is not final acceptance and does not relieve the Contractor from any of the responsibilities in the contract documents.

3.17 GENERAL MAINTENANCE AND THE MAINTENANCE PERIOD

- A. General maintenance shall begin immediately after installation of irrigation system. The general maintenance and the maintenance period shall include the following:
 - 1. On a weekly basis the Contractor shall keep the irrigation system in good running order and make observations on the entire system for proper operation and coverage. Repair and cleaning shall be done to keep the system in full operation.
 - 2. Records of all timing changes to control valves from initial installation to time of final acceptance shall be kept and turned over to the Owner's Representative at the time of final acceptance.
 - 3. During the last week of the maintenance period, provide equipment familiarization and instruction on the total operations of the system to the personnel who will assume responsibility for running the irrigation system.
 - 4. At the end of the maintenance period, turn over all operations logs, manuals, instructions, schedules, keys and any other equipment necessary for operation of the irrigation system to the Owner's Representative who will assume responsibility for the operations and maintenance of the irrigation system.
- B. The maintenance period for the irrigation system shall coincide with the maintenance period for the Planting. (See specification section "Planting")

3.18 SUBSTANTIAL COMPLETION ACCEPTANCE

- A. Upon written notice from the Contractor, the Owners Representative shall review the work and make a determination if the work is substantially complete.
- B. The date of substantial completion of the irrigation shall be the date when the Owner's Representative accepts that all work in Planting, Planting Soil, and Irrigation installation sections is complete.

3.19 FINAL ACCEPTANCE / SYSTEM MALFUNCTION CORRECTIONS

- A. At the end of the Plant Warrantee and Maintenance period, (See specification section "Planting") the Owner's Representative shall inspect the irrigation work and establish that all provisions of the irrigation system are complete and the system is working correctly.
 - 1. Restore any soil settlement over trenches and other parts of the irrigation system.
 - 2. Replace, repair or reset any malfunctioning parts of the irrigation system.
- B. The Contractor shall show all corrections made from punch list. Any items deemed not acceptable shall be reworked and the maintenance period will be extended.
- C. The Contractor shall show evidence that the Owner's Representative has received all charts, records, drawings, and extra equipment as required before final acceptance.
- D. Failure to pass review: If the work fails to pass final review, any subsequent observations must be rescheduled as per above. The cost to the Owner for additional observations will be charged to the Contractor at the prevailing hourly rate of the reviewer.

END OF SECTION 32 8400

32 9300 Planting

DISCLAIMER AND RESPONSIBILITY OF THE USER

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INSTRUCTIONS TO THE SPECIFICATION WRITER:

The following document is intended as a general specification to guide the writing of a project-specific specification. Each project is unique and it is required that the specification be developed accordingly. DO NOT USE THE FOLLOWING SPECIFICATION WITHOUT MAKING IMPORTANT ADJUSTMENTS to reflect local conditions, regulations, market standards, project schedules and local and regional practices. The following are specific items that need to be addressed.

1. General instructions for using this specification: These instructions are intended to guide the specification writer (the specifier) through the process of editing this document into a Planting specification. Be sure to delete these instructions (i.e. all the text in red displayed above the paragraph) before issuing the specifications.

2. General Requirements - Division 01 (Construction Specification Institute) specifications and other contract elements: This specification is designed to be used in conjunction with standard Division 01 specifications, which cover project general conditions and project-wide contract elements. THIS IS NOT A STAND-ALONE SPECIFICATION and should not be used as a contract for the purchase of and installation of plants. Important issues of project ownership, liability, insurance, contract language, project controls, instructions to bidders, change orders and review and approval of the work are normally in the Division 01 specifications.

3. The construction team: A construction project is a team effort where the Owner, in effect, creates a partnership with all the Contractors to build a project. As with any good contract there are protections for all parties; that the Owner will get the quality of project that they desire within the time limits and budget available; and the Contractor will be paid for the work satisfactorily completed. In between the initial bidding and the final completion there will be many places where parts of the construction do not work out as originally intended. This is normal and a good contract should allow for these changes in a manner that is equitable to both the Owner and the Contractor. To get there, a team approach and spirit must prevail. All parties must assume that each is operating in the best interest of the project goals. The clearer the goals and description of the project, the smoother the flow of a successful project. **The more each of the team members can trust the other members, the better the project.** This should be a critical principle in approaching interpretation of the specification.

4. Other project documents: This specification is intended to be used in conjunction with other project documents including the bid forms, the construction contract, Division 1 specifications, other specifications directly related to this section; other specifications that are not directly related to this work and most critically the project construction drawings. It is very critical that all these documents be prepared with consistent terminology and that they be coordinated. The terms used for the parts of trees and other plants, different soil types, drainage features, irrigation features and structures such as paving, walls and planters must be consistent across disciplines. A very common mistake is the use of different terms and details for soil and the extent of soil work. The terms and details for planting soil, subsoil and other materials must be well coordinated.

5. Related specification sections: This specification requires an additional specification section to describe several important related parts of the planting process.

Tree Protection: This specification assumes that there is a separate specification section and construction drawings and details for tree protection; remove this section if there are no existing trees to be protected on the project.

Planting Soil: This specification assumes that there is a separate specification section and construction

drawings and details for installation of planting soils.

Irrigation: *This specification assumes that there might be a separate specification section for irrigation associated with the project planting.*

6. Reviewing and approval authority: *Each specification identifies a certain entity as responsible for the review and approval of the work, project submittals, changes to the work, and acceptance of the work. The entity is normally identified in Division 1. For the purposes of this specification, the term the “Owner’s Representative” has been used as a placeholder for this entity. Once the proper term is defined (for example Contracting Officer, The Architect, The Landscape Architect, The Engineer etc); this term should replace the words “Owner’s Representative” wherever it appears in this specification.*

7. Header and footer requirements: *Change the header/footer language to meet the project requirements.*

8. Notes to specifiers: *Before issuing the document, be sure to remove all “Notes to specifiers” incorporated into this document in red text after you have read them and responded to the recommendations.*

9. Submittals: *Submittals are a critical part of any construction contract. This is where all products and materials are reviewed and approved in advance of the work. Planting soil quality control is in this section. Including very specific requirements for approval of submittals while a good practice assumes that the reviewing authority has the skills needed to make these reviews and interpret the results. A common practice is to make very specific requirements but not have the time or expertise to enforce them. Lack of review of submittals does not automatically transfer quality control to the Contractor. In fact, lack of review or inappropriate review can make the reviewing authority responsible for having accepted the submittal even if it was not acceptable. **Do not put into the specification submittal requirements that you do not have the time, resources or knowledge, which you knew or should have known, to enforce.***

10. Specification modifications: *There are locations in this specification where additional information is required to reflect project region or contract conditions. Please insert the requested information.*

11. SPECIAL REQUIREMENTS OF THIS SPECIFICATION:

Plant observations: *The area of plant observations is one of the most critical points in the planting process. Ideally this should take place at the growing nursery prior to digging and or shipping the plant. This is very time consuming but its importance cannot be over stated. This is the only time where meaningful alterations can be made to find and correct many of the most common root quality issues found in nurseries. If you cannot make these observations do not require them. Failure of the Owner or their representative to make observations where they are required can result in the Contractor being able to defend the use of poor quality plants. Once a plant is shipped from the nursery, it is very difficult to reject. The defects must be very severe and visible. Often root defects and buried root collars are quite difficult to identify within the root ball package.*

Many plants are purchased from re-wholesale yards. These plants are more difficult to observe than in the field but if observed prior to purchase by the Contractor there is a better chance of rejecting them. Re-wholesale plants may have other problems such as having been held too long without adequate water, and loss of the ability to make corrections in root collar depth in the root ball package.

Root ball package options: *There are many root ball packages available in the industry in certain regions. That is, the methods used to contain the roots and the type of system used to grow or manage the roots of the plant. It is critical that the specifications herein be amended to reflect allowable root ball packages. All projects do not have to accept all types of root ball packages. Since this can have a huge impact on the ultimate success of the plant, careful consideration must be made in selecting the type of packages permitted. Do not leave in references to root ball packages you do not want to use on the project in the specification (i.e. B&B, container, bare root, etc.).*

Warranty: *This specification assumes or implies a 1-year warranty. Modify the warranty to meet the project requirements.*

Maintenance: *This specification includes an option for no maintenance during the warranty period and optional language for maintenance during the warranty period.*

SECTION 32 9300 PLANTING

PART 1 – GENERAL

1.1 SUMMARY

Note to specifier: Remove parts of this work description that do not apply. This specification section is only for the planting and maintenance of trees, shrubs and ground covers. If construction and maintenance of lawn areas are included in the project, the provisions for construction and maintenance of lawns must be covered under a separate specification section.

- A. The scope of work includes all labor, materials, appliances, tools, equipment, facilities, transportation and services necessary for, and incidental to performing all operations in connection with furnishing, delivery, and installation of plant (also known as "landscaping") complete as shown on the drawings and as specified herein.
- B. The scope of work in this section includes, but is not limited to, the following:
 - 1. Locate, purchase, deliver and install all specified plants.
 - 2. Water all specified plants.
 - 3. Mulch, fertilize, stake, and prune all specified plants.
 - 4. Maintenance of all specified plants until the beginning of the warranty period.
 - 5. Plant warranty.
 - 6. Clean up and disposal of all excess and surplus material.
 - 7. Maintenance of all specified plants during the warranty period.

1.2 CONTRACT DOCUMENTS

- A. Shall consist of specifications and general conditions and the construction drawings. The intent of these documents is to include all labor, materials, and services necessary for the proper execution of the work. The documents are to be considered as one. Whatever is called for by any parts shall be as binding as if called for in all parts.

1.3 RELATED DOCUMENTS AND REFERENCES

- A. Related Documents:

Note to specifier: Coordinate this list with the other related specification sections. Add, delete or modify sections as appropriate.

- 1. Drawings and general provisions of contract including general and supplementary conditions and Division I specifications apply to work of this section
- 2. Related Specification Sections
 - a. Section - Planting Soil
 - b. Section - Irrigation
 - c. Section - Lawn
 - d. Section - Tree Protection and Plant Protection
- B. References: The following specifications and standards of the organizations and documents listed in this paragraph form a part of the specification to the extent required by the references thereto. In the event that the requirements of the following referenced standards and specification conflict with this specification section the requirements of this specification shall prevail. In the event that the requirements of any of the following referenced standards and specifications conflict with each other the more stringent requirement shall prevail or as determined by the Owners Representative.

Note to specifier: Remove any references that do not apply in the project region.

- 1. State of California, Department of Food and Agriculture, Regulations for Nursery Inspections, Rules and Grading.

2. ANSI Z60.1 American Standard for Nursery Stock, most current edition.
3. ANSI A 300 – Standard Practices for Tree, Shrub and other Woody Plant Maintenance, most current edition and parts.
4. Florida Grades and Standards for Nursery Stock, current edition (Florida Department of Agriculture, Tallahassee FL).
5. Interpretation of plant names and descriptions shall reference the following documents. Where the names or plant descriptions disagree between the several documents, the most current document shall prevail.
 - a. USDA - The Germplasm Resources Information Network (GRIN) <http://www.ars-grin.gov/npgs/searchgrin.html>
 - b. Manual of Woody Landscape Plants; Michael Dirr; Stipes Publishing, Champaign, Illinois; Most Current Edition.
 - c. The New Sunset Western Garden Book, Oxmoor House, most current edition.
6. Pruning practices shall conform to recommendations “Structural Pruning: A Guide For The Green Industry” most current edition; published by Urban Tree Foundation, Visalia, California.
7. Glossary of Arboricultural Terms, International Society of Arboriculture, Champaign IL, most current edition.

1.4 VERIFICATION

- A. All scaled dimensions on the drawings are approximate. Before proceeding with any work, the Contractor shall carefully check and verify all dimensions and quantities, and shall immediately inform the Owner’s Representative of any discrepancies between the information on the drawings and the actual conditions, refraining from doing any work in said areas until given approval to do so by the Owner’s Representative.
- B. In the case of a discrepancy in the plant quantities between the plan drawings and the plant call outs, list or plant schedule, the number of plants or square footage of the planting bed actually drawn on the plan drawings shall be deemed correct and prevail.

1.5 PERMITS AND REGULATIONS

- A. The Contractor shall obtain and pay for all permits related to this section of the work unless previously excluded under provision of the contract or general conditions. The Contractor shall comply with all laws and ordinances bearing on the operation or conduct of the work as drawn and specified. If the Contractor observes that a conflict exists between permit requirements and the work outlined in the contract documents, the Contractor shall promptly notify the Owner’s Representative in writing including a description of any necessary changes and changes to the contract price resulting from changes in the work.
- B. Wherever references are made to standards or codes in accordance with which work is to be performed or tested, the edition or revision of the standards and codes current on the effective date of this contract shall apply, unless otherwise expressly set forth.
- C. In case of conflict among any referenced standards or codes or between any referenced standards and codes and the specifications, the more restrictive standard shall apply or Owner’s Representative shall determine which shall govern.

1.6 PROTECTION OF WORK, PROPERTY AND PERSON

- A. The Contractor shall adequately protect the work, adjacent property, and the public, and shall be responsible for any damages or injury due to his/her actions.

1.7 CHANGES IN THE WORK

- A. The Owner’s Representative may order changes in the work, and the contract sum should be adjusted accordingly. All such orders and adjustments plus claims by the Contractor for extra compensation must be made and approved in writing before executing the work involved.

- B. All changes in the work, notifications and contractor's request for information (RFI) shall conform to the contract general condition requirements.

1.8 CORRECTION OF WORK

- A. The Contractor, at their own cost, shall re-execute any work that fails to conform to the requirements of the contract and shall remedy defects due to faulty materials or workmanship upon written notice from the Owner's Representative, at the soonest as possible time that can be coordinated with other work and seasonal weather demands.

1.9 DEFINITIONS

Note to specifier: *Delete any words below that are not used in the final specification.*

All terms in this specification shall be as defined in the "Glossary of Arboricultural Terms" or as modified below.

- A. Boxed trees: A container root ball package made of wood in the shape of a four-sided box.
- B. Container plant: Plants that are grown in and/or are currently in a container including boxed trees.
- C. Defective plant: Any plant that fails to meet the plant quality requirement of this specification.
- D. End of Warranty Final Acceptance: The date when the Owner's Representative accepts that the plants and work in this section meet all the requirements of the warranty. It is intended that the materials and workmanship warranty for Planting, Planting Soil, and Irrigation work run concurrent with each other.
- E. Field grown trees (B&B): Trees growing in field soil for at least 12 months prior to harvest.
- F. Healthy: Plants that are growing in a condition that expresses leaf size, crown density, color; and with annual growth rates typical of the species and cultivar's horticultural description, adjusted for the planting site soil, drainage and weather conditions.
- G. Kinked root: A root within the root package that bends more than 90 degrees.
- H. Maintenance: Actions that preserve the health of plants after installation and as defined in this specification.
- I. Maintenance period: The time period, as defined in this specification, which the Contractor is to provide maintenance.
- J. Normal: the prevailing protocol of industry standard(s).
- K. Owner's Representative: The person appointed by the Owner to represent their interest in the review and approval of the work and to serve as the contracting authority with the Contractor. The Owner's Representative may appoint other persons to review and approve any aspects of the work.
- L. Reasonable and reasonably: When used in this specification relative to plant quality, it is intended to mean that the conditions cited will not affect the establishment or long term stability, health or growth of the plant. This specification recognizes that it is not possible to produce plants free of all defects, but that some accepted industry protocols and standards result in plants unacceptable to this project.

When reasonable or reasonably is used in relation to other issues such as weeds, diseased, insects, it shall mean at levels low enough that no treatment would be required when applying recognized Integrated Plant Management practices.

This specification recognizes that some decisions cannot be totally based on measured findings and that professional judgment is required. In cases of differing opinion, the Owner's Representative's expert shall determine when conditions are judged as reasonable.
- M. Root ball: The mass of roots including any soil or substrate that is shipped with the tree within the root ball package.
- N. Root ball package. The material that surrounds the root ball during shipping. The root package may include the material in which the plant was grown, or new packaging placed around the root ball for

shipping.

- O. Root collar (root crown, root flare, trunk flare, flare): The region at the base of the trunk where the majority of the structural roots join the plant stem, usually at or near ground level.
- P. Shrub: Woody plants with mature height approximately less than 15 feet.
- Q. Spade harvested and transplanted: Field grown trees that are mechanically harvested and immediately transplanted to the final growing site without being removed from the digging machine.
- R. Stem: The trunk of the tree.
- S. Substantial Completion Acceptance: The date at the end of the Planting, Planting Soil, and Irrigation installation where the Owner's Representative accepts that all work in these sections is complete and the Warranty period has begun. This date may be different than the date of substantial completion for the other sections of the project.
- T. Stem girdling root: Any root more than ¼ inch diameter currently touching the trunk, or with the potential to touch the trunk, above the root collar approximately tangent to the trunk circumference or circling the trunk. Roots shall be considered as Stem Girdling that have, or are likely to have in the future, root to trunk bark contact.
Note to specifier regarding the Stem Girdling Root specification: 1/4 inch min. root diameter is in debate. Check most recent opinions from trusted researchers and practitioners. Insert the diameter standard that may be attainable from regional or selected growers.
- U. Structural root: One of the largest roots emerging from the root collar.
- V. Tree: Single and multi-stemmed plants with mature height approximately greater than 15 feet.

1.10 SUBMITTALS

- A. See contract general conditions for policy and procedure related to submittals.
- B. Submit all product submittals 8 weeks prior to installation of plantings.
Note to specifier: Confirm submittal time above is appropriate for project schedule.
- C. Product data: Submit manufacturer product data and literature describing all products required by this section to the Owner's Representative for approval. Provide submittal eight weeks before the installation of plants.
- D. Plant growers' certificates: Submit plant growers' certificates for all plants indicating that each meets the requirements of the specification, including the requirements of tree quality, to the Owner's Representative for approval. Provide submittal eight weeks before the installation of plants.
- E. Samples: Submit samples of each product and material where required by the specification to the Owner's Representative for approval. Label samples to indicate product, characteristics, and locations in the work. Samples will be reviewed for appearance only. Compliance with all other requirements is the exclusive responsibility of the Contractor.
- F. Plant sources: Submit sources of all plants as required by Article – "Selection of Plants" to the Owner's Representative for approval.
- G. Close out submittals: Submit to the Owner's Representative for approval.
 - 1. Plant maintenance data and requirements.
- H. Warranty period site visit record: If there is no maintenance during the warranty period, after each site visit during the warranty period, by the Contractor, as required by this specification, submit a written record of the visit, including any problems, potential problems, and any recommended corrective action to the Owner's Representative for approval.

Note to specifier: The paragraph above is only required if maintenance during the warranty period is not required.

- I. Installation plan submitted a minimum of 14 days prior to the scheduled installation. Plan should describe the methods, activities, materials and schedule to achieve installation of plants.

Note to specifier: *The paragraph above is only required if a contractor submitted Plant Installation Plan is required.*

1.11 OBSERVATION OF THE WORK

- A. The Owner's Representative may observe the work at any time. They may remove samples of materials for conformity to specifications. Rejected materials shall be immediately removed from the site and replaced at the Contractor's expense. The cost of testing materials not meeting specifications shall be paid by the Contractor.
- B. The Owner's Representative shall be informed of the progress of the work so the work may be observed at the following key times in the construction process. The Owner's Representative shall be afforded sufficient time to schedule visit to the site. Failure of the Owner's Representative to make field observations shall not relieve the Contractor from meeting all the requirements of this specification.
 1. SITE CONDITIONS PRIOR TO THE START OF PLANTING: review the soil and drainage conditions.
 2. COMPLETION OF THE PLANT LAYOUT STAKING: Review of the plant layout.
 3. PLANT QUALITY: Review of plant quality at the time of delivery and prior to installation. Review tree quality prior to unloading where possible, but in all cases prior to planting.
 4. COMPLETION OF THE PLANTING: Review the completed planting.

1.12 PRE-CONSTRUCTION CONFERENCE

- A. Schedule a pre-construction meeting with the Owner's Representative at least seven (7) days before beginning work to review any questions the Contractor may have regarding the work, administrative procedures during construction and project work schedule.

Note to specifier: *Confirm time frame above is appropriate for project schedule.*

1.13 QUALITY ASSURANCE

- A. Substantial Completion Acceptance - Acceptance of the work prior to the start of the warranty period:
 1. Once the Contractor completes the installation of all items in this section, the Owner's Representative will observe all work for Substantial Completion Acceptance upon written request of the Contractor. The request shall be received at least ten calendar days before the anticipated date of the observation.
 2. Substantial Completion Acceptance by the Owner's Representative shall be for general conformance to specified size, character and quality and not relieve the Contractor of responsibility for full conformance to the contract documents, including correct species.
 3. Any plants that are deemed defective as defined under the provisions below shall not be accepted.
- B. The Owner's Representative will provide the Contractor with written acknowledgment of the date of Substantial Completion Acceptance and the beginning of the warranty period and plant maintenance period (if plant maintenance is included).
- C. Contractor's Quality Assurance Responsibilities: The Contractor is solely responsible for quality control of the work.
- D. Installer Qualifications: The installer shall be a firm having at least 5 years of successful experience of a scope similar to that required for the work, including the handling and planting of large specimen trees in urban areas. The same firm shall install planting soil (where applicable) and plant material.

1. The bidders list for work under this section shall be approved by the Owner's Representative.
2. Installer Field Supervision: When any planting work is in progress, installer shall maintain, on site, a full-time supervisor who can communicate in English with the Owner's Representative.
3. Installer's field supervisor shall have a minimum of five years experience as a field supervisor installing plants and trees of the quality and scale of the proposed project, and can communicate in English with the Owner's Representative.
4. The installer's crew shall have a minimum of 3 years experienced in the installation of Planting Soil, Plantings, and Irrigation (where applicable) and interpretation of soil plans, planting plans and irrigation plans.
5. Submit references of past projects, employee training certifications that support that the Contractors meets all of the above installer qualifications and applicable licensures.

1.14 PLANT WARRANTY

A. Plant Warranty:

1. The Contractor agrees to replace defective work and defective plants. The Owner's Representative shall make the final determination if plants meet these specifications or that plants are defective.

Plants warranty shall begin on the date of Substantial Completion Acceptance and continue for the following periods, classed by plant type:

Note to specifier: Modify below to state the number of years of the warranty.

- a. Trees – XX Year(s).
 - b. Shrubs – XX Year(s).
 - c. Ground cover and perennial flower plants – XX Year(s).
 - d. Bulbs, annual flower and seasonal color plants – for the period of expected bloom or primary display.
2. When the work is accepted in parts, the warranty periods shall extend from each of the partial Substantial Completion Acceptances to the terminal date of the last warranty period. Thus, all warranty periods for each class of plant warranty, shall terminate at one time.
 3. All plants shall be warranted to meet all the requirements for plant quality at installation in this specification. Defective plants shall be defined as plants not meeting these requirements. The Owner's representative shall make the final determination that plants are defective.
 4. Plants determined to be defective shall be removed immediately upon notification by the Owner's Representative and replaced without cost to the Owner, as soon as weather conditions permit and within the specified planting period.
 5. Any work required by this specification or the Owner's Representative during the progress of the work, to correct plant defects including the removal of roots or branches, or planting plants that have been bare rooted during installation to observe for or correct root defects shall not be considered as grounds to void any conditions of the warranty. In the event that the Contractor decides that such remediation work may compromise the future health of the plant, the plant or plants in question shall be rejected and replaced with plants that do not contain defects that require remediation or correction.
 6. The Contractor is exempt from replacing plants, after Substantial Completion Acceptance and during the warranty period, that are removed by others, lost or damaged due to occupancy of project, lost or damaged by a third party, vandalism, or any natural disaster.
 7. Replacements shall closely match adjacent specimens of the same species. Replacements shall be subject to all requirements stated in this specification. Make all necessary repairs due to plant replacements. Such repairs shall be done at no extra cost to the Owner.
 8. The warranty of all replacement plants shall extend for an additional one-year period from the

date of their acceptance after replacement. In the event that a replacement plant is not acceptable during or at the end of the said extended warranty period, the Owner's Representative may elect one more replacement items or credit for each item. These tertiary replacement items are not protected under a warranty period.

9. During and by the end of the warranty period, remove all tree wrap, ties, and guying unless agreed to by the Owner's Representative to remain in place. All trees that do not have sufficient caliper to remain upright, or those requiring additional anchorage in windy locations, shall be staked or remain staked, if required by the Owner's Representative.
- B. End of Warranty Final Acceptance - Acceptance of plants at the end of the warranty period.
1. At the end of the warranty period, the Owner's Representative shall observe all warranted work, upon written request of the Contractor. The request shall be received at least ten calendar days before the anticipated date for final observation.
 2. End of Warranty Final Acceptance will be given only when all the requirements of the work under this specification and in specification sections Planting Soil and Irrigation have been met.

1.15 SELECTION AND OBSERVATION OF PLANTS

- A. The Owner's Representative may review all plants subject to approval of size, health, quality, character, etc. Review or approval of any plant during the process of selection, delivery, installation and establishment period shall not prevent that plant from later rejection in the event that the plant quality changes or previously existing defects become apparent that were not observed.
- B. Plant Selection: The Owner's Representative reserves the right to select and observe all plants at the nursery prior to delivery and to reject plants that do not meet specifications as set forth in this specification. If a particular defect or substandard element can be corrected at the nursery, as determined by the Owner's Representative, the agreed upon remedy may be applied by the nursery or the Contractor provided that the correction allows the plant to meet the requirements set forth in this specification. Any work to correct plant defects shall be at the contractor's expense.
1. The Owner's Representative may make invasive observation of the plant's root system in the area of the root collar and the top of the root ball in general in order to determine that the plant meets the quality requirements for depth of the root collar and presence of roots above the root collar. Such observations will not harm the plant.
 2. Corrections are to be undertaken at the nursery prior to shipping.
- C. The Contractor shall bear all cost related to plant corrections.
- D. All plants that are rejected shall be immediately removed from the site and acceptable replacement plants provided at no cost to the Owner.
- E. Submit to the Owner's Representative, for approval, plant sources including the names and locations of nurseries proposed as sources of acceptable plants, and a list of the plants they will provide. The plant list shall include the botanical and common name and the size at the time of selection. Observe all nursery materials to determine that the materials meet the requirements of this section.
1. The following nurseries are pre-approved to supply plants for this project:
XXXXXX
- Note to specifier: Insert pre-approved growers. If pre-approved growers are not to be required, eliminate the above paragraph. If specific nurseries are going to be REQUIRED for specific plants this is the place to insert that language.***
- F. Trees shall be purchased from the growing nursery. Re-wholesale plant suppliers shall not be used as sources unless the Contractor can certify that the required trees are not directly available from a growing nursery. When Re-wholesale suppliers are utilized, the Contractor shall submit the name and location of the growing nursery from where the trees were obtained by the re-wholesale seller. The re-wholesale nursery shall be responsible for any required plant quality certifications.

- G. The Contractor shall require the grower or re-wholesale supplier to permit the Owner's Representative to observe the root system of all plants at the nursery or job site prior to planting including random removal of soil or substrate around the base of the plant. Observation may be as frequent and as extensive as needed to verify that the plants meet the requirements of the specifications and conform to requirements.
- H. Each tree shall have a numbered seal applied by the Contractor. The seal shall be placed on a lateral branch on the north side of the tree. The seal shall be a tamper proof plastic seal bearing the Contractor's name and a unique seven-digit number embossed on the seal.
 - 1. Do not place seals on branches that are so large that there is not sufficient room for the branch growth over the period of the warranty.
- I. The Owner's Representative may choose to attach their seal to each plant, or a representative sample. Viewing and/or sealing of plants by the Owner's Representative at the nursery does not preclude the Owner's Representative's right to reject material while on site. The Contractor is responsible for paying any up charge for the Owner's Representative to attach their seal to specific plants.
- J. Where requested by the Owner's Representative, submit photographs of plants or representative samples of plants. Photographs shall be legible and clearly depict the plant specimen. Each submitted image shall contain a height reference, such as a measuring stick. The approval of plants by the Owner's Representative via photograph does not preclude the Owner's Representative's right to reject material while on site.

1.16 PLANT SUBSTITUTIONS FOR PLANTS NOT AVAILABLE

- A. Submit all requests for substitutions of plant species, or size to the Owner's Representative, for approval, prior to purchasing the proposed substitution. Request for substitution shall be accompanied with a list of nurseries contacted in the search for the required plant and a record of other attempts to locate the required material. Requests shall also include sources of plants found that may be of a smaller or larger size, or a different shape or habit than specified, or plants of the same genus and species but different cultivar origin, or which may otherwise not meet the requirements of the specifications, but which may be available for substitution.

1.17 SITE CONDITIONS

- A. It is the responsibility of the Contractor to be aware of all surface and sub-surface conditions, and to notify the Owner's Representative, in writing, of any circumstances that would negatively impact the health of plantings. Do not proceed with work until unsatisfactory conditions have been corrected.
 - 1. Should subsurface drainage or soil conditions be encountered which would be detrimental to growth or survival of plant material, the Contractor shall notify the Owner's Representative in writing, stating the conditions and submit a proposal covering cost of corrections. If the Contractor fails to notify the Owner's Representative of such conditions, he/she shall remain responsible for plant material under the warranty clause of the specifications.
- B. It is the responsibility of the Contractor to be familiar with the local growing conditions, and if any specified plants will be in conflict with these conditions. Report any potential conflicts, in writing, to the Owner's Representative.
- C. This specification requires that all Planting Soil and Irrigation (if applicable) work be completed and accepted prior to the installation of any plants.
 - 1. Planting operations shall not begin until such time that the irrigation system is completely operational for the area(s) to be planted, and the irrigation system for that area has been preliminarily observed and approved by the Owner's Representative.
- D. Actual planting shall be performed during those periods when weather and soil conditions are suitable in accordance with locally accepted horticultural practices.

1. Do not install plants into saturated or frozen soils. Do not install plants during inclement weather, such as rain or snow or during extremely hot, cold or windy conditions.

1.18 PLANTING AROUND UTILITIES

- A. Contractor shall carefully examine the civil, record, and survey drawings to become familiar with the existing underground conditions before digging.
- B. Determine location of underground utilities and perform work in a manner that will avoid possible damage. Hand excavate, as required. Maintain grade stakes set by others until parties concerned mutually agree upon removal.
- C. Notification of *Local Utility Locator Service*, Insert *PHONE NUMBER*, is required for all planting areas: The Contractor is responsible for knowing the location and avoiding utilities that are not covered by the *Local Utility Locator Service*.

Note to specifier: *Insert the telephone number and correct name of the Local Utility Locator Service if available.*

PART 2 – PRODUCTS

2.1 PLANTS: GENERAL

- A. Standards and measurement: Provide plants of quantity, size, genus, species, and variety or cultivars as shown and scheduled in contract documents.
 1. All plants including the root ball dimensions or container size to trunk caliper ratio shall conform to ANSI Z60.1 “American Standard for Nursery Stock” latest edition, unless modified by provisions in this specification. When there is a conflict between this specification and ANSI Z60.1, this specification section shall be considered correct.
 2. Plants larger than specified may be used if acceptable to the Owner’s Representative. Use of such plants shall not increase the contract price. If larger plants are accepted the root ball size shall be in accordance with ANSI Z-60.1. Larger plants may not be acceptable if the resulting root ball cannot be fit into the required planting space.
 3. If a range of size is given, no plant shall be less than the minimum size and not less than 50 percent of the plants shall be as large as the maximum size specified. The measurements specified are the minimum and maximum size acceptable and are the measurements after pruning, where pruning is required.
- B. Proper Identification: All trees shall be true to name as ordered or shown on planting plans and shall be labeled individually or in groups by genus, species, variety and cultivar.
- C. Compliance: All trees shall comply with federal and state laws and regulations requiring observation for plant disease, pests, and weeds. Observation certificates required by law shall accompany each shipment of plants.
 1. Clearance from the local county agricultural commissioner, if required, shall be obtained before planting trees originating outside the county in which they are to be planted.

Note to specifier: *Confirm that the above sentence is applicable to the region of the project.*
- D. Plant Quality:

Note to specifier: *The following paragraphs are necessary to assure that quality plant material is installed. With a few exceptions such as the Florida Grades and Standards for Nursery Plants and the Guideline Specifications for Nursery Tree Quality, current nursery standards for root systems do not exist. It is critical that the purchaser of plants have sufficient resources to enforce these quality standards through observations and well-conceived plans, details, specifications, and contracts.*

 1. **General:** Provide healthy stock, grown in a nursery and reasonably free of die-back, disease, insects, eggs, bores, and larvae. At the time of planting all plants shall have a root system, stem, and branch form that will not restrict normal growth, stability and health for the expected life of the plant

2. **Plant quality above the soil line:** *Note to specifier: Determining acceptability of crown quality is subjective. These specifications are designed to have the Crown Acceptance details included with the other planting details. An alternative is to use the Florida Grades and Standards for Nursery Plants and specify tree grades as either Florida #1 or Florida Fancy Grades. If the project does not want to use the Florida Grades and Standards or does not include the Crown Acceptance details on the drawings delete these references in the following paragraph.*

- a. Plants shall be healthy with the color, shape, size and distribution of trunk, stems, branches, buds and leaves normal to the plant type specified. Tree quality above the soil line shall comply with the project Crown Acceptance details (or Florida Grades and Standards, tree grade Florida Fancy or Florida #1) and the following:
 - 1.) Crown: The form and density of the crown shall be typical for a young specimen of the species or cultivar pruned to a central and dominant leader.
 - a.) Crown specifications do not apply to plants that have been specifically trained in the nursery as topiary, espalier, multi-stem, clump, or unique selections such as contorted or weeping cultivars.
 - 2.) Leaves: The size, color, and appearance of leaves shall be typical for the time of year and stage of growth of the species or cultivar. Trees shall not show signs of prolonged moisture stress or over watering as indicated by wilted, shriveled, or dead leaves.
 - 3.) Branches: Shoot growth (length and diameter) throughout the crown should be appropriate for the age and size of the species or cultivar. Trees shall not have dead, diseased, broken, distorted, or otherwise injured branches.
 - a.) Main branches shall be distributed along the central leader not clustered together. They shall form a balanced crown appropriate for the cultivar/species.
 - b.) Branch diameter shall be no larger than two-thirds (one-half is preferred) the diameter of the central leader measured 1 inch above the branch union.
 - c.) The attachment of the largest branches (scaffold branches) shall be free of included bark.
 - 4.) Trunk: The tree trunk shall be relatively straight, vertical, and free of wounds that penetrate to the wood (properly made pruning cuts, closed or not, are acceptable and are not considered wounds), sunburned areas, conks (fungal fruiting bodies), wood cracks, sap leakage, signs of boring insects, galls, cankers, girdling ties, or lesions (mechanical injury).
 - 5.) Temporary branches, unless otherwise specified, can be present along the lower trunk below the lowest main (scaffold) branch, particularly for trees less than 1 inch in caliper. These branches should be no greater than 3/8-inch diameter. Clear trunk should be no more than 40% of the total height of the tree.

Note to specifier: Delete the last sentence above if more clearance is needed.

- b. Trees shall have one central leader. If the leader was headed, a new leader (with a live terminal bud) at least one-half the diameter of the pruning cut shall be present.
 - 1.) All trees are assumed to have one central leader trees unless a different form is specified in the plant list or drawings.
- c. All graft unions, where applicable, shall be completely closed without visible sign of graft rejection. All grafts shall be visible above the soil line.
- d. Trunk caliper and taper shall be sufficient so that the lower five feet of the trunk remains vertical without a stake. Auxiliary stake may be used to maintain a straight leader in the upper half of the tree.

3. **Plant quality at or below the soil line:**

- a. Plant roots shall be normal to the plant type specified. Root observations shall take place without impacting tree health. Root quality at or below the soil line shall comply with the project Root Acceptance details and the following:
 - 1.) The roots shall be reasonably free of scrapes, broken or split wood.
 - 2.) The root system shall be reasonably free of injury from biotic (e.g., insects and

- pathogens) and abiotic (e.g., herbicide toxicity and salt injury) agents. Wounds resulting from root pruning used to produce a high quality root system are not considered injuries.
- 3.) A minimum of three structural roots reasonably distributed around the trunk (not clustered on one side) shall be found in each plant. Root distribution shall be uniform throughout the root ball, and growth shall be appropriate for the species.
 - a.) Plants with structural roots on only one side of the trunk (J roots) shall be rejected.
 - 4.) The root collar shall be within the upper 2 inches of the substrate/soil. Two structural roots shall reach the side of the root ball near the top surface of the root ball. The grower may request a modification to this requirement for species with roots that rapidly descend, provided that the grower removes all stem girdling roots above the structural roots across the top of the root ball.
 - 5.) The root system shall be reasonably free of stem girdling roots over the root collar or kinked roots from nursery production practices.
 - a.) Plant Grower Certification: The final plant grower shall be responsible to have determined that the plants have been root pruned at each step in the plant production process to remove stem girdling roots and kinked roots, or that the previous production system used practices that produce a root system throughout the root ball that meets these specifications. Regardless of the work of previous growers, the plant's root system shall be modified at the final production stage, if needed, to produce the required plant root quality. The final grower shall certify in writing that all plants are reasonably free of stem girdling and kinked roots as defined in this specification, and that the tree has been grown and harvested to produce a plant that meets these specifications.

Note to specifier: *The above certification requirement is not an industry standard and will require that the project team is willing to enforce the process.*

- 6.) At time of observations and delivery, the root ball shall be moist throughout. Roots shall not show signs of excess soil moisture conditions as indicated by stunted, discolored, distorted, or dead roots.
- E. Submittals: Submit for approval the required plant quality certifications from the grower where plants are to be purchased, for each plant type. The certification must state that each plant meets all the above plant quality requirements.
1. The grower's certification of plant quality does not prohibit the Owner's Representative from observing any plant or rejecting the plant if it is found to not meet the specification requirements.
- 2.2 ROOT BALL PACKAGE OPTIONS: The following root ball packages are permitted. Specific root ball packages shall be required where indicated on the plant list or in this specification. Any type of root ball packages that is not specifically defined in this specification shall not be permitted.

Note to specifier: *It is critical to remove any of the following root ball package descriptions and requirement paragraphs that are not to be permitted for the project. Assure that the plants and root ball packages specified are available from regional growers as not all plant types are available in all root ball package types. Consider specifying preapproved growers to obtain higher quality root ball package types and overall tree quality.*

Each of these final root ball package types has advantages and disadvantages. Not all root ball package types are available in every market region and for every tree species. Some species may only be available in a few root ball package types. To complicate the decision of which to specify, trees may be grown in more than one type of root ball system during the production phase and normally the final grower may have purchased seedlings or liners from another nursery. The methods used at the different stages in the nursery production process can affect the root system of a plant, leaving root problems and difficult root architecture that the plant may struggle with for many years after planting. These root system problems may cause premature decline and even kill the tree well after the end of the warranty period.

The quality control and root ball package type in the initial production nursery may not be known or

apparent to the final grower. It can be quite difficult for the purchaser to determine the quality of the trees root system. The current American Nursery and Landscape Association (ANLA) "American Standards for Nursery Stock (ANSI Z60.1)" does not adequately address these issues, set acceptable standards for root architecture, or offer solutions to the problems. It is up to the purchaser to set their own quality standards, recommend solutions, and to enforce those standards with appropriate observations. Simply stating "Trees shall meet the ANSI Z60.1 standard" does NOT address nor guarantee quality.

It is NEVER REQUIRED for any specification to accept all products available from an industry or to use the ANLA "American Standards for Nursery Stock" as the only requirement that a grower must comply with. The specifier has a choice of what to accept as long as they can verify that the products that meet the specification are available. Until significant changes are made in the nursery industry, it may be difficult, in many regions and for many species, to specify large numbers of trees with an optimum root system. Check your local suppliers to specify the best quality root ball package prior to making specification edits in this section.

It is critical that the specifications be amended to reflect the root ball packages that will be allowable on the project. Since this has a huge impact on the ultimate success of the tree, careful consideration must be made in selecting the type of packages permitted. It is not required that a project accept all types of root ball packages. Some root ball package types can be strictly prohibited in the specification. Do not leave references to any of the root ball packages you do not want to permit for the project in the specification. Remove the paragraphs related to both the package option descriptions in Part 2 and the special planting requirements in Part 3 of all root ball packages that will not be permitted.

A. BALLED AND BURLAPPED PLANTS

Note to specifier: *Remove this paragraph if Balled and Burlapped plants are not to be permitted.*

1. All Balled and Burlapped Plants shall be field grown, and the root ball packaged in a burlap and twine and/or burlap and wire basket package.
2. Plants shall be harvested with the following modifications to standard nursery practices.
 - a. Prior to digging any tree that fails to meet the requirement for maximum soil and roots above the root collar, carefully removed the soil from the top of the root ball of each plant, using hand tools, water or an air spade, to locate the root collar and attain the soil depth over the structural roots requirements. Remove all stem girdling roots above the root collar. Care must be exercised not to damage the surface of the root collar and the top of the structural roots.

Note to specifier: *Modify paragraph below to reflect climatic differences.*

- b. Trees shall be dug for a minimum of 4 weeks and a maximum of 52 weeks prior to shipping. Trees dug 4 to 52 weeks prior to shipping are defined as hardened-off. Digging is defined as cutting all roots and lifting the tree out of the ground and either moving it to a new location in the nursery or placing it back into the same hole. Trees that are stored out of the ground shall be placed in a holding area protected from extremes of wind and sun with the root ball protected by covering with mulch or straw and irrigated sufficiently to keep moisture in the root ball above wilt point and below saturation
 - c. If wire baskets are used to support the root ball, a "low profile" basket shall be used. A low profile basket is defined as having the top of the highest loops on the basket no less than 4 inches and no greater than 8 inches below the shoulder of the root ball package.
 - 1.) At nurseries where sandy soils prevent the use of "low profile baskets", baskets that support the entire root ball, including the top, are allowable.

Note to specifier: *Where removal of all or a portion of the wire basket is desirable, insert language to that effect in the above paragraph.*

- d. Twine and burlap used for wrapping the root ball package shall be natural, biodegradable material. If the burlap decomposes after digging the tree then the root ball shall be re-wrapped prior to shipping if roots have not yet grown to keep root ball intact during shipping.

3. The following tree species when harvested at a size greater than X inches in caliper shall be root-pruned a minimum of XX months before digging in the nursery. All root pruning and hardening off procedures shall be accomplished utilizing accepted horticultural practices.

Note to specifier: Remove the paragraph above if root pruning is not required. Add the minimum caliper size and time needed for root pruning and/or hardening off. Add required species as considered by local knowledge as benefitting from hardening off and/or root pruning.

B. SPADE HARVESTED AND TRANSPLANTED

Note to specifier: Remove the paragraph below if Spade Harvested and Transplanted plants are not to be permitted.

1. Spade Harvested and Transplanted Plants shall meet all the requirements for field grown trees. Root ball diameters shall be of similar size as the ANSI Z60.1 requirements for Balled and Burlapped plants.
2. Trees shall be harvested prior to leafing out (bud break) in the spring or during the fall planting period except for plants know to be considered as fall planting hazards. Plants that are fall planting hazards shall only be harvested prior to leafing out in the spring.
3. Trees shall be moved and planted within 48 hours of the initial harvesting and shall remain in the spade machine until planted.

C. CONTAINER (INCLUDING ABOVE-GROUND FABRIC CONTAINERS AND BOXES) PLANTS

Note to specifier: Remove the paragraph below if Container plants are not to be permitted.

1. Container plants may be permitted only when indicated on the drawing, in this specification, or approved by the Owner's Representative.
2. Provide plants shall be established and well rooted in removable containers.
3. Container class size shall conform to ANSI Z60.1 for container plants for each size and type of plant.

D. BARE ROOT PLANTS

Note to specifier: Remove the paragraph below if Bare Root plants are not to be permitted.

1. Harvest bare root plants while the plant is dormant and a minimum of 4 weeks prior to leaf out (bud break).
2. The root spread dimensions of the harvested plants shall conform to ANSI Z60.1 for nursery grown bare root plants for each size and type of plant. Just prior to shipping to the job site, dip the root system into a slurry of hydrogel (cross linked polyacrylamide) and water mixed at a rate of 15 oz. of hydrogel in 25 gallons of water. Do not shake off the excess hydrogel. Place the root system in a pleated black plastic bag and tie the bag snugly around the trunk. Bundle and tie the upper branches together.
3. Keep the trees in a cool dark space for storage and delivery. If daytime outside temperatures exceeds 70 degrees F, utilize a refrigerated storage area with temperature between 35 and 50 degrees.
4. Where possible, plan time of planting to be before bud break. For trees to be planted after bud break, place the trees before bud break in an irrigated bed of pea gravel.
 - a. The pea gravel bed shall be 18 inches deep over a sheet of plastic.
 - b. Space trees to allow the unbundled branches to grow without shading each other.
 - c. Once stored in pea gravel, allow the trees sufficient time for the new root system to flush and spring growth of leaves to fully develop before planting.
 - d. Pea gravel stored trees may be kept for up to one growing season.
 - e. Pea gravel stored trees shall be dipped, packaged and shipped similar to the requirements for freshly dug bare root trees above.

E. IN-GROUND FABRIC BAG-GROWN

Note to specifier: *Remove this paragraph if trees grown in In-ground fabric containers are not to be permitted.*

1. In-ground fabric container plants may be permitted only when indicated on the drawing, in this specification, or approved by the Owner's Representative.
2. Provide plants established and well rooted.

2.3 ANNUAL FLOWERING AND SEASONAL COLOR PLANTS

Note to specifier: *Annual and Seasonal color plants may require project specific requirements. Add special plant requirements here as needed.*

- A. Container or flat-grown plants should be sized as noted in the planting plan. Plants shall be well-rooted and healthy.

2.4 PALMS

Note to specifier: *If palms are included in this planting add any special requirements for this classification of plant here. The following is a general product specification. If Palms are not to be included, delete this section.*

- A. Except as modified below or where the requirements are not appropriate to the specification of palms, palms shall meet all the requirements of the plant quality section above.
- B. Defronding, tying, and hedging:
 1. In preparing palm trees for relocation, all dead fronds shall be removed.
 2. All remaining fronds above horizontal shall be lifted up and tied together around the crown in an upright position. Up to 2/3 of the oldest live fronds can be removed; all fronds can be removed on Sabal palms. Do not tie too tightly, bind or injure the bud. Jute binder twine shall be used in tying up the fronds; wire will not be permitted. Fronds shall be untied immediately after planting.
- C. Digging the root ball:
 1. When digging out the root ball, no excavation shall be done closer than **XX** Inches to the trunk at ground level and the excavation shall extend below the major root system to a minimum depth of 3.5 feet. The bottom of the root ball shall be cut off square and perpendicular to the trunk below the major root system.
- D. The Contractor shall not free-fall, drag, roll or abuse the tree or put a strain on the crown (bud area) at any time. A protective device shall be used around the trunk of the tree while lifting and relocating so as not to injure the bud, or scar or skin the trunk in any way.

2.5 PLANTING SOIL

Note to specifier: *It is critical to this planting specification that a separate specification section Planting Soil be included. If no such section is included the specifier MUST add in any needed soil requirements to the Planting specification; however, this alternative is NOT recommended.*

- A. Planting Soil as used in this specification means the soil at the planting site, or imported as modified and defined in specification Section Planting Soil. If there is no Planting Soil specification, the term Planting Soil shall mean the soil at the planting site within the planting hole.

2.6 MULCH

Note to specifier: *Revise this paragraph to reflect regionally available mulch materials or project specific mulch quality or type requirements where appropriate. The coarse grade mulch specified here is considered superior for its water retention and soil building properties in areas of tree and shrub roots when irrigation is drip, bubblers or flood methods. The term "Walk on Mulch" is a California regional term. Use regional terminology.*

Add additional requirements as needed to more tightly define tree species source, % bark if desired

and size.

- A. Mulch shall be "Walk on" grade, coarse, ground, from tree and woody brush sources. The size range shall be a minimum (less than 25% or less of volume) fine particles 3/8 inch or less in size, and a maximum size of individual pieces (largest 20% or less of volume) shall be approximately 1 to 1-1/2 inch in diameter and maximum length approximately 4 to 8". Pieces larger than 8 inch long that are visible on the surface of the mulch after installation shall be removed.
 - 1. It is understood that mulch quality will vary significantly from supplier to supplier and region to region. The above requirements may be modified to conform to the source material from locally reliable suppliers as approved by the Owner's Representative.
- B. Submit supplier's product specification data sheet and a one gallon sample for approval.

2.7 TREE STAKING AND GUYING MATERIAL

Note to specifier: *Do not leave references to any of the staking and guying types you do not want to permit for the project in the specification. Remove the paragraphs below of the types that will not be permitted. Add specifications for other types of staking and guying.*

- A. Tree guying to be flat woven polypropylene material, 3/4 inch wide, and 900 lb. break strength. Color to be Green. Product to be ArborTie manufactured by Deep Root Partners, L.P. or approved equal.
- B. Stakes shall be lodge pole stakes free of knots and of diameters and lengths appropriate to the size of plant as required to adequately support the plant.
- C. Below ground anchorage systems to be constructed of 2 x 2 dimensional untreated wood securing (using 3 inch long screws) horizontal portions to 4 feet long vertical stakes driven straight into the ground outside the root ball.
- D. Submit manufacturer's product data for approval.

2.8 TREE BARK PROTECTOR

Note to specifier: *This is a specialty application generally only used in locations such as streetscapes and parks where tree trunks may be subject to mechanical abuse. Remove these paragraphs if this is not applicable.*

- A. Tree Bark Protectors shall be black extruded resin mesh, 4 inches in diameter, 5 feet long. As manufactured by Industrial Netting, Minneapolis, MN, USA or approved equal.
- B. Fasten the split side of the Tree Bark Protector together in three places with black plastic tape.
- C. Submit manufacturers' product data for approval.

2.9 WATERING BAGS

Note to specifier: *Remove this paragraph if this is not applicable.*

- A. Plastic tree watering bags holding a minimum of 15 gallons of water and with a slow drip hole(s) water release system, specifically designed to water establishing trees. Water should release over a several day period, not within a few hours
- B. Watering bags shall be:
 - 1. Treegator Irrigation Bags sized to the appropriate model for the requirements of the plant, manufactured by Spectrum Products, Inc., Youngsville, NC 27596.
 - 2. Ooze Tube sized to the appropriate model for the requirements of the plant, manufactured by Engineered Water Solutions, Atlanta, GA.
 - 3. Or approved equal.
- C. Submit manufacturer's product data for approval.

2.10 CHEMICAL OR BIOLOGICAL ADDITIVES

Note to specifier: *Insert additives, as desired for the specific project requirements.*

PART 3 – EXECUTION

3.1 SITE EXAMINATION

- A. Examine the surface grades and soil conditions to confirm that the requirements of the Specification Section – Planting Soil - and the soil and drainage modifications indicated on the Planting Soil Plan and Details (if applicable) have been completed. Notify the Owner's Representative in writing of any unsatisfactory conditions.

3.2 DELIVERY, STORAGE AND HANDLING

- A. Protect materials from deterioration during delivery and storage. Adequately protect plants from drying out, exposure of roots to sun, wind or extremes of heat and cold temperatures. If planting is delayed more than 24 hours after delivery, set plants in a location protected from sun and wind. Provide adequate water to the root ball package during the shipping and storage period.
 - 1. All plant materials must be available for observation prior to planting.
 - 2. Using a soil moisture meter, periodically check the soil moisture in the root balls of all plants to assure that the plants are being adequately watered. Volumetric soil moisture shall be maintained above wilting point and below field capacity for the root ball substrate or soil.
- B. Do not deliver more plants to the site than there is space with adequate storage conditions. Provide a suitable remote staging area for plants and other supplies.
 - 1. The Owner's Representative or Contractor shall approve the duration, method and location of storage of plants.
- C. Provide protective covering over all plants during transporting.

3.3 PLANTING SEASON

- A. Planting shall only be performed when weather and soil conditions are suitable for planting the materials specified in accordance with locally accepted practice. Install plants during the planting time as described below unless otherwise approved in writing by the Owner's Representative. In the event that the Contractor request planting outside the dates of the planting season, approval of the request does not change the requirements of the warranty.

Note to specifier: *Insert required regional appropriate planting date limitations including limitations if any for fall planting hazard plants.*

- 1. **Deciduous trees and shrubs** XXX to XXX and YYY to YYY
- 2. **Evergreen trees and shrubs** XXX to XXX and YYY to YYY

3.4 ADVERSE WEATHER CONDITIONS

- A. No planting shall take place during extremely hot, dry, windy or freezing weather.

3.5 COORDINATION WITH PROJECT WORK

- A. The Contractor shall coordinate with all other work that may impact the completion of the work.
- B. Prior to the start of work, prepare a detailed schedule of the work for coordination with other trades.
- C. Coordinate the relocation of any irrigation lines, heads or the conduits of other utility lines that are in conflict with tree locations. Root balls shall not be altered to fit around lines. Notify the Owner's Representative of any conflicts encountered.

3.6 LAYOUT AND PLANTING SEQUENCE

- A. Relative positions of all plants and trees are subject to approval of the Owner's Representative.
- B. Notify the Owner's Representative, one (1) week prior to layout. Layout all individual tree and shrub locations. Place plants above surface at planting location or place a labeled stake at planting location. Layout bed lines with paint for the Owner's Representative's approval. Secure the Owner's Representative's acceptance before digging and start of planting work.

- C. When applicable, plant trees before other plants are installed.
- D. It is understood that plants are not precise objects and that minor adjustments in the layout will be required as the planting plan is constructed. These adjustments may not be apparent until some or all of the plants are installed. Make adjustments as required by the Owner's Representative including relocating previously installed plants.

3.7 SOIL PROTECTION DURING PLANT DELIVERY AND INSTALLATION

- A. Protect soil from compaction during the delivery of plants to the planting locations, digging of planting holes and installing plants.
 - 1. Where possible deliver and plant trees that require the use of heavy mechanized equipment prior to final soil preparation and tilling. Where possible, restrict the driving lanes to one area instead of driving over and compacting a large area of soil.
 - 2. Till to a depth of 6 inches, all soil that has been driven over during the installation of plants.

3.8 SOIL MOISTURE

- A. Volumetric soil moisture level, in both the planting soil and the root balls of all plants, prior to, during and after planting shall be above permanent wilting point and below field capacity for each type of soil texture within the following ranges.

Soil type	Permanent wilting point	Field capacity
Sand, Loamy sand, Sandy loam	5-8%	12-18%
Loam, Sandy clay, Sandy clay loam	14-25%	27-36%
Clay loam, Silt loam	11-22%	31-36%
Silty clay, Silty clay loam	22-27%	38-41%

- 1. Volumetric soil moisture shall be measured with a digital moisture meter. The meter shall be the Digital Soil Moisture Meter, DSMM500 by General Specialty Tools and Instruments, or approved equivalent.
- B. The Contractor shall confirm the soil moisture levels with a moisture meter. If the moisture is too high, suspend planting operations until the soil moisture drains to below field capacity.

3.9 INSTALLATION OF PLANTS: GENERAL

- A. Installation plan shall be submitted a minimum of 14 days prior to the scheduled installation. Plan should describe the methods, activities, materials and schedule to achieve installation of plants.

Note to specifier: Remove the above paragraph if no Installation Plan is required. Also remove the submittal requirement in Part One – Submittals.

- B. Observe each plant after delivery and prior to installation for damage of other characteristics that may cause rejection of the plant. Notify the Owner's Representative of any condition observed.
- C. No more plants shall be distributed about the planting bed area than can be planted and watered on the same day.
- D. The root system of each plant, regardless of root ball package type, shall be observed by the Contractor, at the time of planting to confirm that the roots meet the requirements for plant root quality in Part 2 Products: Plants General: Plant Quality. The Contractor shall undertake at the time of planting, all modifications to the root system required by the Owner's Representative to meet these quality standards.
 - 1. Modifications, at the time of planting, to meet the specifications for the depth of the root collar and removal of stem girdling roots and circling roots may make the plant unstable or stress the plant to the point that the Owner's Representative may choose to reject the plant rather than permitting

the modification.

2. Any modifications required by the Owner's Representative to make the root system conform to the plant quality standards outlined in Part 2 Products: Plants General: Quality, or other requirements related to the permitted root ball package, shall not be considered as grounds to modify or void the plant warranty.
 3. The resulting root ball may need additional staking and water after planting. The Owner's Representative may reject the plant if the root modification process makes the tree unstable or if the tree is not healthy at the end of the warranty period. Such plants shall still be covered under the warranty
 4. The Contractor remains responsible to confirm that the grower has made all required root modifications noted during any nursery observations.
- E. Container and Boxed Root Ball Shaving: The outer surfaces of ALL plants in containers and boxes, including the top, sides and bottom of the root ball shall be shaved to remove all circling, descending, and matted roots. Shaving shall be performed using saws, knives, sharp shovels or other suitable equipment that is capable of making clean cuts on the roots. Shaving shall remove a minimum of one inch of root mat or up to 2 inches as required to remove all root segments that are not growing reasonably radial to the trunk.
- F. Exposed Stem Tissue after Modification: The required root ball modifications may result in stem tissue that has not formed trunk bark being exposed above the soil line. If such condition occurs, wrap the exposed portion of the stem in a protective wrapping with a white filter fabric. Secure the fabric with biodegradable masking tape. DO NOT USE string, twine, green nursery ties or any other material that may girdle the trunk if not removed.
- G. Excavation of the Planting Space: Using hand tools or tracked mini-excavator, excavate the planting hole into the Planting Soil to the depth of the root ball measured after any root ball modification to correct root problems, and wide enough for working room around the root ball or to the size indicated on the drawing or as noted below.
1. For trees and shrubs planted in soil areas that are NOT tilled or otherwise modified to a depth of at least 12 inches over a distance of more than 10 feet radius from each tree, or 5 feet radius from each shrub, the soil around the root ball shall be loosened as defined below or as indicated on the drawings.
 - a. The area of loosening shall be a minimum of 3 times the diameter of the root ball at the surface sloping to 2 times the diameter of the root ball at the depth of the root ball.
 - b. Loosening is defined as digging into the soil and turning the soil to reduce the compaction. The soil does not have to be removed from the hole, just dug, lifted and turned. Lifting and turning may be accomplished with a tracked mini excavator, or hand shovels.
 2. If an auger is used to dig the initial planting hole, the soil around the auger hole shall be loosened as defined above for trees and shrubs planted in soil areas that are NOT tilled or otherwise modified.
 3. The measuring point for root ball depth shall be the average height of the outer edge of the root ball after any required root ball modification.
 4. If motorized equipment is used to deliver plants to the planting area over exposed planting beds, or used to loosen the soil or dig the planting holes, all soil that has been driven over shall be tilled to a depth of 6 inches.

Note to specifier: Most other planting specifications set a minimum planting hole size, often 2 or 3 times the root ball diameter. This specification assumes that all soil preparation and the preparation of the planting hole is specified in the specification section Planting Soil and the Contractor needs to dig the hole in the already prepared soil only as large as is required to accomplish the planting process; the smaller the planting hole the better. Revise the paragraph Installation of Plants, above to reflect other project requirements if needed.

In some circumstance (soil type or budget) it may be reasonable or necessary to allow the use of an auger to dig planting holes. While augers are not recommended, if they are allowed, the soil around the top and sides of the holes must be loosened as defined for holes that are dug with other equipment.

Motorized equipment used to dig planting holes or deliver plants to the planting location will compact the soil surface. Tilling of the surface soil that has been compacted, as noted in this specification, is critical to the health of the soil after planting.

- H. For trees to be planted in prepared Planting Soil that is deeper than the root ball depth, compact the soil under the root ball using a mechanical tamper to assure a firm bedding for the root ball. If there is more than 12 inches of planting soil under the root ball excavate and tamp the planting soil in lifts not to exceed 12 inches.
- I. Set top outer edge of the root ball at the average elevation of the proposed finish. Set the plant plumb and upright in the center of the planting hole. The tree graft, if applicable, shall be visible above the grade. Do not place soil on top of the root ball.
- J. The Owner's Representative may request that plants orientation be rotated when planted based on the form of the plant.
- K. Backfill the space around the root ball with the same planting soil or existing soil that was excavated for the planting space. See Specification Section Planting Soil, for requirements to modify the soil within the planting bed.
- L. Brace root ball by tamping Planting Soil around the lower portion of the root ball. Place additional Planting Soil around base and sides of ball in six-inch (6") lifts. Lightly tamp each lift using foot pressure or hand tools to settle backfill, support the tree and eliminate voids. DO NOT over compact the backfill or use mechanical or pneumatic tamping equipment. Over compaction shall be defined as greater than 85% of maximum dry density, standard proctor or greater than 250 psi as measured by a cone penetrometer when the volumetric soil moisture is lower than field capacity.
 - 1. When the planting hole has been backfilled to three quarters of its depth, water shall be poured around the root ball and allowed to soak into the soil to settle the soil. Do not flood the planting space. If the soil is above field capacity, allow the soil to drain to below field capacity before finishing the planting. Air pockets shall be eliminated and backfill continued until the planting soil is brought to grade level.
- M. Where indicated on the drawings, build a 4 inch high, level berm of Planting Soil around the outside of the root ball to retain water. Tamp the berm to reduce leaking and erosion of the saucer.
- N. Thoroughly water the Planting Soil and root ball immediately after planting.
- O. Remove all nursery plant identification tags and ribbons as per Owner's Representative instructions. The Owner's Representative's seals are to remain on plants until the end of the warranty period.
- P. Remove corrugated cardboard trunk protection after planting.
- Q. Follow additional requirements for the permitted root ball packages.

3.10 PERMITTED ROOT BALL PACKAGES AND SPECIAL PLANTING REQUIREMENTS

- A. The following are permitted root ball packages and special planting requirements that shall be followed during the planting process in addition to the above General planting requirements.
- B. BALLED AND BURLAPPED PLANTS

***Note to specifier:** Remove this paragraph if BALLED AND BURLAPPED PLANTS are not permitted. Removing some or all of the wire of a wire basket after the plant is positioned in the planting hole is controversial. Despite the scientific evidence showing that roots grow to engulf the wire, and lack of documented cases of wire impacting tree health, some professionals insist that some or all wire be removed. Delete, accept, or modify sections B.1 and 2 below as you feel necessary.*

1. After the root ball has been backfilled, remove all twine and burlap from the top of the root ball. Cut the burlap away; do not fold down onto the Planting Soil.
 2. If the plant is shipped with a wire basket that does not meet the requirements of a "Low Rise" basket, remove the top 6 - 8 inches of the basket wires just before the final backfilling of the tree.
 3. Earth root balls shall be kept intact except for any modifications required by the Owner's Representative to make root package comply with the requirement in Part 2 Products.
- C. SPADE HARVESTED AND TRANSPLANTED PLANTS
- Note to specifier: Remove this paragraph if Tree Spade Harvested and Transplanted Plants are not to be permitted.*
1. After installing the tree, loosen the soil along the seam between the root ball and the surrounding soil out to a radius from the root ball edge equal to the diameter of the root ball to a depth of 8 - 10 inches by hand digging to disturb the soil interface.
 2. Fill any gaps below this level with loose soil.
- D. CONTAINER (INCLUDES BOXED AND ABOVE-GROUND FABRIC CONTAINERS) PLANTS
- Note to specifier: Remove this paragraph if CONTAINER PLANTS are not permitted. All of the items below can be included if the following details are included in the contract: 1) root ball shaving, 2) root observations, 3) root correction. Remove sections below that will not be required.*
1. This specification assumes that most container plants have significant stem girdling and circling roots, and that the root collar is too low in the root ball.
 2. Remove the container.
 3. Perform root ball shaving as defined in Installation of Plants: General above.
 4. Remove all roots and substrate above the root collar and the main structural roots according to root correction details so root system conforms to root observations detail.
 5. Remove all substrate at the bottom of the root ball that does not contain roots.
 6. Using a hose, power washer or air excavation device, wash out the substrate from around the trunk and top of the remaining root ball and find and remove all stem girdling roots within the root ball above the top of the structural roots.
- E. BARE ROOT PLANTS
- Note to specifier: Remove this paragraph if BARE ROOT PLANTS are not permitted.*
1. Dig the planting hole to the diameter of the spread of the roots to a depth in the center that maintains the root collar at the elevation of the surrounding finished grade and slightly deeper along the edges of the hole.
 2. Spread all roots out radial to the trunk in the prepared hole making the hole wider where needed to accommodate long roots. Root tips shall be directed away from the trunk. Prune any broken roots removing the least amount of tissue possible.
 3. Maintain the trunk plumb while backfilling soil around the roots.
 4. Lightly tamp the soil around the roots to eliminate voids and reduce settlement.
- F. IN-GROUND FABRIC CONTAINERS
- Note to specifier: Remove this paragraph if FABRIC CONTAINERS are not permitted.*
1. Remove the fabric container from the root ball. Cut roots at the edge of the container as needed to extract the fabric from the roots. Make clean cuts with sharp tools; do not tear roots away from the fabric.
 2. Observe the root system after the container is removed to confirm that the root system meets the quality standards.

3.11 GROUND COVER, PERENNIAL AND ANNUAL PLANTS

- A. Assure that soil moisture is within the required levels prior to planting. Irrigation, if required, shall be applied at least 12 hours prior to planting to avoid planting in muddy soils.
- B. Assure that soil grades in the beds are smooth and as shown on the plans.
- C. Plants shall be planted in even, triangularly spaced rows, at the intervals called out for on the drawings, unless otherwise noted. The first row of Annual flower plants shall be 6 inches from the bed edge unless otherwise directed.
- D. Dig planting holes sufficiently large enough to insert the root system without deforming the roots. Set the top of the root system at the grade of the soil.
- E. Schedule the planting to occur prior to application of the mulch. If the bed is already mulched, pull the mulch from around the hole and plant into the soil. Do not plant the root system in the mulch. Pull mulch back so it is not on the root ball surface.
- F. Press soil to bring the root system in contact with the soil.
- G. Spread any excess soil around in the spaces between plants.
- H. Apply mulch to the bed being sure not to cover the tops of the plants with or the tops of the root ball with mulch.
- I. Water each planting area as soon as the planting is completed. Apply additional water to keep the soil moisture at the required levels. Do not over water.

3.12 PALM PLANTING

- A. Palm trees shall be placed at grade making sure not to plant the tree any deeper in the ground than the palm trees originally stood.
- B. The trees shall be placed with their vertical axis in a plumb position.
- C. All backfill shall be native soil except in cases where planting in rock. Water-settle the back fill.
- D. Do not cover root ball with mulch or topsoil.
- E. Provide a watering berm at each palm. Berms shall extend a minimum of 18 inches out from the trunk all around and shall be a minimum of (6) inches high.
- F. Remove twine which ties fronds together after placing palm in planting hole and securing it in the upright position.

3.13 STAKING AND GUYING

Note to specifier: There are many staking systems available in the market. Special project requirements and regional or designer preferences may indicate different approach. Modify the following paragraphs to reflect project requirements.

If palms are include then add palm bracing detail.

- A. Do not stake or guy trees unless specifically required by the Contract Documents, or in the event that the Contractor feels that staking is the only alternative way to keep particular trees plumb.
 - 1. The Owner's Representative shall have the authority to require that trees are staked or to reject staking as an alternative way to stabilize the tree.
 - 2. Trees that required heavily modified root balls to meet the root quality standards may become unstable. The Owner's Representative may choose to reject these trees rather than utilize staking to temporarily support the tree.
- B. Trees that are guyed shall have their guys and stakes removed after one full growing season or at other times as required by the Owner's Representative.
- C. Tree guying shall utilize the tree staking and guying materials specified. Guying to be tied in such a

manner as to create a minimum 12-inch loop to prevent girdling. Refer to manufacturer's recommendations and the planting detail for installation.

1. Plants shall stand plumb after staking or guying.
2. Stakes shall be driven to sufficient depth to hold the tree rigid.

- D. For trees planted in planting mix over waterproofed membrane, use dead men buried 24 inches to the top of the dead man, in the soil. Tie the guy to the dead man with a double wrap of line around the dead man followed by a double half hitch. When guys are removed, leave the dead men in place and cut the guy tape 12 inches above the ground, leaving the tape end covered in mulch.

3.14 TREE BARK PROTECTION

Note to specifier: *This is a specialty application generally only used in location such as streetscapes where tree trunks may be subject to mechanical abuse. Remove this paragraph if this is not applicable.*

- A. For all street trees in commercial areas where indicated on the drawings, apply a Tree Bark Protector to each tree.

3.15 STRAIGHTENING PLANTS

- A. Maintain all plants in a plumb position throughout the warranty period. Straighten all trees that move out of plumb including those not staked. Plants to be straightened shall be excavated and the root ball moved to a plumb position, and then re-backfilled.
- B. Do not straighten plants by pulling the trunk with guys.

3.16 INSTALLATION OF FERTILIZER AND OTHER CHEMICAL ADDITIVES

- A. Do not apply any soluble fertilizer to plantings during the first year after transplanting unless soil test determines that fertilizer or other chemical additives is required. Apply chemical additives only upon the approval of the Owner's Representative.
- B. Controlled release fertilizers shall be applied according to the manufacturer's instructions and standard horticultural practices.

3.17 PRUNING OF TREES AND SHRUBS

- A. Prune plants as directed by the Owner's Representative. Pruning trees shall be limited to addressing structural defects as shown in details; follow recommendations in "Structural Pruning: A Guide For The Green Industry" published by Urban Tree Foundation, Visalia CA.
- B. All pruning shall be performed by a person experienced in structural tree pruning.
- C. Except for plants specified as multi-stemmed or as otherwise instructed by the Owner's Representative, preserve or create a central leader.
- D. Pruning of large trees shall be done using pole pruners or if needed, from a ladder or hydraulic lift to gain access to the top of the tree. Do not climb in newly planted trees. Small trees can be structurally pruned by laying them over before planting. Pruning may also be performed at the nursery prior to shipping.
- E. Remove and replace excessively pruned or malformed stock resulting from improper pruning that occurred in the nursery or after.
- F. Pruning shall be done with clean, sharp tools.
- G. No tree paint or sealants shall be used.

3.18 MULCHING OF PLANTS

- A. Apply 4 inches of mulch before settlement, covering the entire planting bed area. Install no more than 1 inch of mulch over the top of the root balls of all plants. Taper to 2 inches when abutting pavement.
- Note to specifier:** *Mulch thickness varies by mulch type, project location, and project requirements. Four inches of coarse mulch is for dry climates. In wet climates 4 inches of shredded bark mulch would be far too much mulch and have detrimental effect to the plants. Adjust the mulch thickness in*

both the specifications and details.

- B. For trees planted in lawn areas the mulch shall extend to a 5 foot radius around the tree or to the extent indicated on the plans.
- C. Lift all leaves, low hanging stems and other green portions of small plants out of the mulch if covered.

3.19 PLANTING BED FINISHING

- A. After planting, smooth out all grades between plants before mulching.
- B. Separate the edges of planting beds and lawn areas with a smooth, formed edge cut into the turf with the bed mulch level slightly lower, 1 and 2 inches, than the adjacent turf sod or as directed by the Owner's Representative. Bed edge lines shall be as depicted on the drawings.

3.20 WATERING

- A. The Contractor shall be fully responsible to ensure that adequate water is provided to all plants from the point of installation until the date of Substantial Completion Acceptance. The Contractor shall adjust the automatic irrigation system, if available, and apply additional or adjust for less water using hoses as required.
- B. Hand water root balls of all plants to assure that the root balls have moisture above wilt point and below field capacity. Test the moisture content in each root ball and the soil outside the root ball to determine the water content.
- C. The Contractor shall install 25 gallon watering bag for each tree to be maintained and used for tree watering during the warranty period.

Note to specifier: Watering bags come in various sizes from 15 to 25 gallons. Confirm bag size needed and adjust the above paragraph. Confirm if the watering bags are to be given to the Owner or remain the property of the Contractor. Adjust the below paragraph as required.

- 1. The watering bags shall remain the property of the Owner at the completion of the work.

3.21 CLEAN-UP

- A. During installation, keep the site free of trash, pavements reasonably clean and work area in an orderly condition at the end of each day. Remove trash and debris in containers from the site no less than once a week.
 - 1. Immediately clean up any spilled or tracked soil, fuel, oil, trash or debris deposited by the Contractor from all surfaces within the project or on public right of ways and neighboring property.
- B. Once installation is complete, wash all soil from pavements and other structures. Ensure that mulch is confined to planting beds and that all tags and flagging tape are removed from the site. The Owner's Representative's seals are to remain on the trees and removed at the end of the warranty period.
- C. Make all repairs to grades, ruts, and damage by the plant installer to the work or other work at the site.
- D. Remove and dispose of all excess planting soil, subsoil, mulch, plants, packaging, and other material brought to the site by the Contractor.

3.22 PROTECTION DURING CONSTRUCTION

- A. The Contractor shall protect planting and related work and other site work from damage due to planting operations, operations by other Contractors or trespassers. Maintain protection during installation until Substantial Completion Acceptance. Treat, repair or replace damaged work immediately.
- B. Damage done by the Contractor, or any of their sub-contractors to existing or installed plants, or any other parts of the work or existing features to remain, including roots, trunk or branches of large existing trees, soil, paving, utilities, lighting, irrigation, other finished work and surfaces including those on adjacent property, shall be cleaned, repaired or replaced by the Contractor at no expense to

the Owner. The Owner's Representative shall determine when such cleaning, replacement or repair is satisfactory.

3.23 PLANT MAINTENANCE PRIOR TO SUBSTANTIAL COMPLETION ACCEPTANCE

- A. During the project work period and prior to Substantial Completion Acceptance, the Contractor shall maintain all plants.
- B. Maintenance during the period prior to Substantial Completion Acceptance shall consist of pruning, watering, cultivating, weeding, mulching, removal of dead material, repairing and replacing of tree stakes, tightening and repairing of guys, repairing and replacing of damaged tree wrap material, resetting plants to proper grades and upright position, and furnishing and applying such sprays as are necessary to keep plantings reasonably free of damaging insects and disease, and in healthy condition. The threshold for applying insecticides and herbicide shall follow established Integrated Pest Management (IPM) procedures. Mulch areas shall be kept reasonably free of weeds, grass.

3.24 SUBSTANTIAL COMPLETION ACCEPTANCE

- A. Upon written notice from the Contractor, the Owners Representative shall review the work and make a determination if the work is substantially complete.
 - 1. Notification shall be at least 7 days prior to the date the contractor is requesting the review.
- B. The date of substantial completion of the planting shall be the date when the Owner's Representative accepts that all work in Planting, Planting Soil, and Irrigation installation sections is complete.
- C. The Plant Warranty period begins at date of written notification of substantial completion from the Owner's Representative. The date of substantial completion may be different than the date of substantial completion for the other sections of the project.

Note to specifier: *The following two sections are options for maintenance during the warranty period: "Maintenance During the Warranty Period by Others" and "Maintenance During the Warranty Period by the Plant Installer". Confirm the approach that is appropriate to the project and delete the other option. These options may also need to be modified to meet the project requirements.*

Confirm that the lengths and timing of beginning and end of maintenance periods are suitable to the project owner's requirements. If the owner does not want to purchase plant maintenance during warranty period, use option one below. If plant maintenance is to be included the extent of the maintenance must be defined.

The maintenance specification assumes that maintenance of lawn grass areas, if required, would be covered under a separate specification for lawn installation.

3.25 MAINTENANCE DURING THE WARRANTY PERIOD BY OTHERS

- A. After Substantial Completion Acceptance, the Contractor shall make sufficient site visits to observe the Owner's maintenance and become aware of problems with the maintenance in time to request changes, until the date of End of Warranty Final Acceptance.
 - 1. Notify the Owner's Representative in writing if maintenance, including watering, is not sufficient to maintain plants in a healthy condition. Such notification must be made in a timely period so that the Owner's Representative may take corrective action.
 - a. Notification must define the maintenance needs and describe any corrective action required.
 - 2. In the event that the Contractor fails to visit the site and or notify, in writing, the Owner's Representative of maintenance needs, lack of maintenance shall not be used as grounds for voiding or modifying the provisions of the warranty.

3.26 MAINTENANCE DURING THE WARRANTY PERIOD BY THE PLANT INSTALLER

- A. During the warranty period, provide all maintenance for all plantings to keep the plants in a healthy state and the planting areas clean and neat.

- B. General requirements:
1. All work shall be undertaken by trained planting crews under the supervision of a foreman with a minimum of 5 years experience supervising commercial plant maintenance crews.
 2. All chemical and fertilizer applications shall be made by licensed applicators for the type of chemicals to be used. All work and chemical use shall comply with all applicable local, provincial and federal requirements.
 3. Assure that hoses and watering equipment and other maintenance equipment does not block paths or be placed in a manner that may create tripping hazards. Use standard safety warning barriers and other procedures to maintain the site in a safe manner for visitors at all times.
 4. All workers shall wear required safety equipment and apparel appropriate for the tasks being undertaken.
 5. The Contractor shall not store maintenance equipment at the site at times when they are not in use unless authorized in writing by the Owner's Representative.
 6. Maintenance vehicles shall not park on the site including walks and lawn areas at any time without the Owner's Representative's written permission.
 7. Maintain a detailed log of all maintenance activities including types of tasks, date of task, types and quantities of materials and products used, watering times and amounts, and number of each crew. Periodically review the logs with the Owner's Representative, and submit a copy of the logs at the end of each year of the maintenance agreement.
 8. Meet with the Owner's Representative a minimum of three times a year to review the progress and discuss any changes that are needed in the maintenance program. At the end of the warranty period attend a hand over meeting to formally transfer the responsibilities of maintenance to the Owner's Representative. Provide all information on past maintenance activities and provide a list of critical tasks that will be needed over the next 12 months. Provide all maintenance logs and soil test data. Make the Contractor's supervisor available for a minimum of one year after the end of the warranty period to answer questions about past maintenance.
- C. Provide the following maintenance tasks:
1. Watering; Provide all water required to keep soil within and around the root balls at optimum moisture content for plant growth.
 - a. Maintain all watering systems and equipment and keep them operational.
 - b. Monitor soil moisture to provide sufficient water. Check soil moisture and root ball moisture with a soil moisture meter on a regular basis and record moisture readings. Do not over water.
 2. Soil nutrient levels: Take a minimum of 4 soil samples from around the site in the spring and fall and have them tested by an accredited agricultural soil testing lab for chemical composition of plant required nutrients, pH, salt and % organic matter. Test results shall include laboratory recommendations for nutrient applications. Apply fertilizers at rates recommended by the soil test.
 - a. Make any other soil test and/or plant tissue test that may be indicated by plant conditions that may not be related to soil nutrient levels such as soil contaminated by other chemicals or lack of chemical uptake by the plant.
 3. Plant pruning: Remove cross over branching, shorten or remove developing co dominant leaders, dead wood and winter-damaged branches. Unless directed by the Owner's Representative, do not shear plants or make heading cuts.
 4. Restore plants: Reset any plants that have settled or are leaning as soon as the condition is noticed.
 5. Guying and staking: Maintain plant guys in a taught position. Remove tree guys and staking after the first full growing season unless directed by Owner's Representative.
 6. Weed control: Keep all beds free of weeds. Hand-remove all weeds and any plants that do not appear on the planting plan. Chemical weed control is permitted only with the approval of the Owner's Representative. Schedule weeding as needed but not less *12 times per year*.
Note to specifier: Insert the frequency of weed control above based on the project budget and need to keep the plantings weed free.
 7. Trash removal: Remove all trash and debris from all planting beds and maintain the beds in a neat and tidy appearance. The number of trash and debris removal visits shall be no less than 12 times per year and may coincide with other maintenance visits.

Note to specifier: Insert the frequency of trash removal based on the project budget and need to keep the site trash free.

8. Plant pest control: Maintain disease, insects and other pests at manageable levels. Manageable levels shall be defined as damage to plants that may be noticeable to a professional but not to the average person. Use least invasive methods to control plant disease and insect outbreaks.
 - a. The Owner's Representative must approve in advance the use of all chemical pesticide applications.
9. Plant replacement: Replace all plants that are defective as defined in the warranty provisions, as soon as the plant decline is obvious and in suitable weather and season for planting as outlined in above sections. Plants that become defective during the maintenance period shall be covered and replaced under the warranty provisions.
10. Mulch: Refresh mulch once a year to maintain complete coverage but do not over mulch. At no time shall the overall mulch thickness be greater than 4 inches. Do not apply mulch within 6 inches of the trunks or stems of any plants. Replacement mulch shall meet the requirements of the original approved material. Mulch shall be no more than one inch on top of the root ball surface.

Note to specifier: Insert the maximum depth of mulch based on the project budget and need to keep the mulch in the beds. Often after bed foliage completely fills in, no or little additional mulch is needed.

11. Bed edging: Check and maintain edges between mulch and lawn areas in smooth neat lines as originally shown on the drawings.
12. Leaf, fruit and other plant debris removal: Remove fall leaf, spent flowers, fruit and plant part accumulations from beds and paved surfaces. Maintain all surface water drains free of debris. Debris removal shall be undertaken at each visit to weed or pick up trash in beds.
13. Damage from site use: Repair of damage by site visitors and events, beyond normal wear, are not part of this maintenance. The Owner's Representative may request that the Contractor repair damage beds or plantings for an additional cost. All additional work shall be approved in advance by the Owner's Representative.

3.27 END OF WARRANTY FINAL ACCEPTANCE / MAINTENANCE OBSERVATION

- A. At the end of the Warranty and Maintenance period the Owner's Representative shall observe the work and establish that all provisions of the contract are complete and the work is satisfactory.
 1. If the work is satisfactory, the maintenance period will end on the date of the final observation.
 2. If the work is deemed unsatisfactory, the maintenance period will continue at no additional expense to the Owner until the work has been completed, observed, and approved by the Owner's Representative.
- B. FAILURE TO PASS OBSERVATION: If the work fails to pass final observation, any subsequent observations must be rescheduled as per above. The cost to the Owner for additional observations will be charged to the Contractor at the prevailing hourly rate of the Owners Representative.

END OF SECTION 32 9300

015639 Tree and Plant Protection

DISCLAIMER AND RESPONSIBILITY OF THE USER

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INSTRUCTIONS TO THE SPECIFICATION WRITER:

The following document is intended as a general specification to guide the writing of a project-specific specification. Each project is unique and it is required that the specification be developed accordingly. DO NOT USE THE FOLLOWING SPECIFICATION WITHOUT MAKING IMPORTANT ADJUSTMENTS to reflect local conditions, regulations, market standards, project schedules and local and regional practices. The following are specific items that need to be addressed.

1. General instructions for using this specification: *These instructions are intended to guide the specification writer (the specifier) through the process of editing this document into a Tree and Plant Protection specification. Be sure to delete these instructions (i.e. all the text in red displayed above the paragraph) before issuing the specifications.*

2. General Requirements - Division 01 (Construction Specification Institute) specifications and other contract elements: *This specification is designed to be used in conjunction with standard Division 01 specifications, which cover project general conditions and project wide contract elements. THIS IS NOT A STAND-ALONE SPECIFICATION and should not be used as a contract for the protection of plants. Important issue of project ownership, liability, insurance, contract language, project controls, Instructions to bidders, change orders and review and approval of the work are normally in the Division 01 specifications.*

3. The construction team: *A construction project is a team effort where the Owner, in effect, creates an agreement with all the Contractors to build a project. As with any good contract there are protections for both sides; that the Owner will get the quality of project that they desire within the time limits and budget available; and the Contractor will be paid for the work satisfactorily completed. In between the initial bidding and the final completion there will be many places where parts of the construction do not work out as originally intended. This is normal and a good contract should allow for these changes in a manner that is equitable to both the Owner and the Contractor. To get there, a team approach and spirit must prevail. Both sides must assume that each is operating in the best interest of the project goals. The clearer the goals and description of the project, the smoother the flow of a successful project. **The more each of the team members can trust the other members, the better the project.** This should be a critical principle in approaching interpretation of the specification.*

4. Unique aspects of Tree and Plant Protection: *Most specification sections describe how a particular trade or sub contractor should proceed to accomplish certain tasks to construct a specific part of the project. There is an assumption in almost all specifications that if the subcontractor damages the work of another they must provide a remedy to fix the damage. With plants, particularly large trees, there is not effective remedy if significant damage occurs to the plant. Often the damage particularly to the root system of a tree may not be readily apparent and may not express itself as decline in the tree till after the construction project is finished. For this reason Tree and Plant Protection specification is as much about preventing damage as it is instructions to the subcontractor related to what to build. It is also unique specification section in that it applies to all Contractors working on the site effecting where they can park, store equipment and perform excavations by making certain areas off limits except for the activities permitted by the specification. Conflicts between this specification and other requirements must be resolved prior to the start of work. The Tree and Plant Protection requirements begin at the very beginning of construction and are enforce for the entire construction contract period.*

5. Other project documents: *This specification is intended to be used in conjunction with other project documents including the bid forms, the construction contract, Division 1 specifications, other specifications directly related to this section; other specifications that are not directly related to this work and most critically the Project*

construction drawings. It is very critical that all these documents be prepared with consistent terminology and that they be coordinated. The terms used for the parts of trees and other plants, different soil types, drainage features, irrigation features and structures such as paving, walls and planters must be consistent across disciplines.

6. Related specification sections: This specification requires additional specification sections to describe several important related parts of the Tree and Plant Protection process.

Planting: This specification assumes that there is a separate specification section and separate plans and details for installation of plants.

Planting Soil: This specification assumes that there is a separate specification section and separate plans and details for installation of planting soils.

Irrigation: This specification assumes that there is a separate specification section for Irrigation that might be associated with the project planting.

Other sections: such as plumbing, electric, excavation, paving site structures.

7. Reviewing and approval authority: Each specification identifies a certain entity as responsible for the review and approval of the work, project submittals, changes to the work and acceptance of the work. The entity with this authority is normally identified in Division 1. For the purposes of this specification, the term the "Owner's Representative" has been used as a placeholder for this entity. Once the proper term is defined for example another term such as; Contracting Officer, The Architect, The Landscape Architect, The Engineer etc.; this term should replace the words "Owner's Representative" wherever it appears in this specification.

8. Header and footer requirements: Change the header/footer language to meet the project requirements.

9. Notes to specifier: Before issuing the document, be sure to remove all "Notes to specifier" incorporated into this document after you have read them and responded to the recommendations.

10. Submittals: Submittals are a critical part of any construction contract. This is where all products and materials are reviewed and approved in advance of the work. Tree and Plant Protection quality control is in this section. Including very specific requirements for approval of submittals while a good practice assumes that the reviewing authority has the skills needed to make these reviews and interpret the results. A common practice is to make very specific requirements but not have the time or expertise to enforce them. Lack of review of submittals does not automatically transfer quality control to the Contractor. In fact, lack of review or inappropriate review can make the reviewing authority responsible for having accepted the submittal even if it was not acceptable. Take great care in putting into the specification submittal requirements that you do not have the time or knowledge to enforce.

11. Specification modifications: There are locations in this specification where additional information is required to reflect project region or contract conditions. Please insert the requested information.

015639
TREE AND PLANT PROTECTION

PART 1 – GENERAL

1.1 SUMMARY

Note to specifier: Remove parts of this work description that do not apply.

- A. The scope of work includes all labor, materials, tools, equipment, facilities, transportation and services necessary for, and incidental to performing all operations in connection with protection of existing trees and other plants as shown on the drawings and as specified herein.
 - 1. Provide preconstruction evaluations
 - 2. Provide tree and plant protection fencing.
 - 3. Provide protection of root zones and above ground tree and plants
 - 4. Provide pruning of existing trees and plants.
 - 5. Coordinate with the requirements of Section Planting Soil for modifications to the soil within the root zone of existing trees and plants.
 - 6. Provide all insect and disease control.
 - 7. Provide maintenance of existing trees and plants including irrigation during the construction period as recommended by the arborist report.
 - 8. Provide maintenance of existing trees and plants including irrigation during the post construction plant maintenance period.
 - 9. Remove tree protection fencing and other protection from around and under trees and plants.
 - 10. Clean up and disposal of all excess and surplus material.

1.2 CONTRACT DOCUMENTS

- A. Shall consist of specifications and general conditions and the drawings. The intent of these documents is to include all labor, materials, and services necessary for the proper execution of the work. The documents are to be considered as one. Whatever is called for by any parts shall be as binding as if called for in all parts.
- B. It is the intent of this section that the requirements apply to all sections of the project specification such that any subcontractor must comply with the restrictions on work within designated Tree and Plant Protection Areas.

1.3 RELATED DOCUMENTS AND REFERENCES

- A. Related Documents:

Note to specifier: Coordinate this list with the other related specification sections. Add or delete sections as appropriate.

- 1. Drawings and general provisions of contract including general and supplementary conditions and Division I specifications apply to work of this section.
 - 2. Section - Planting Soil
 - 3. Section - Irrigation
 - 4. Section - Planting
 - 5. Section - Lawn
- B. References: The following specifications and standards of the organizations and documents listed in this paragraph form a part of the specification to the extent required by the references thereto. In the event that the requirements of the following referenced standards and specification conflict with this specification section the requirements of this specification shall prevail. In the event that the

requirements of any of the following referenced standards and specifications conflict with each other the more stringent requirement shall prevail.

1. ANSI A 300 (Part 5) – Standard Practices for Tree, Shrub and other Woody Plant Maintenance, most current editions.
2. Pruning practices shall conform with recommendations “Structural Pruning: A Guide For The Green Industry”; Published by Urban Tree Foundation, Visalia, California; most current edition.
3. Glossary of Arboricultural Terms, International Society of Arboriculture, Champaign Il, most current edition.

1.4 VERIFICATION

- A. All scaled dimensions on the drawings are approximate. Before proceeding with any work, the Contractor shall carefully check and verify all dimensions and quantities, and shall immediately inform the Owner’s Representative of any discrepancies between the information on the drawings and the actual conditions, refraining from doing any work in said areas until given approval to do so by the Owner’s Representative.

1.5 PERMITS AND REGULATIONS

- A. The Contractor shall obtain and pay for all permits related to this section of the work unless previously excluded under provision of the contract or general conditions. The Contractor shall comply with all laws and ordinances bearing on the operation or conduct of the work as drawn and specified. If the Contractor observes that a conflict exists between permit requirements and the work outlined in the contract documents, the Contractor shall promptly notify the Owner’s Representative in writing including a description of any necessary changes and changes to the contract price resulting from changes in the work.
- B. Wherever references are made to standards or codes in accordance with which work is to be performed or tested, the edition or revision of the standards and codes current on the effective date of this contract shall apply, unless otherwise expressly set forth.
- C. In case of conflict among any referenced standards or codes or between any referenced standards and codes and the specifications, the more restrictive standard shall apply or Owner’s Representative shall determine which shall govern.

1.6 PROTECTION OF WORK, PROPERTY AND PERSON

- A. The Contractor shall protect the work, adjacent property, and the public, and shall be responsible for any damages or injury due to his/her actions.

1.7 CHANGES IN THE WORK

- A. The Owner’s Representative may order changes in the work, and the contract sum should be adjusted accordingly. All such orders and adjustments plus claims by the Contractor for extra compensation must be made and approved in writing before executing the work involved.

1.8 CORRECTION OF WORK

- A. The Contractor shall re-execute any work that fails to conform to the requirements of the contract and shall remedy defects due to faulty materials or workmanship upon written notice from the Owner’s Representative, at the soonest possible time that can be coordinated with other work and seasonal weather demands.

1.9 DEFINITIONS

Note to specifier: Delete any words below that are not used in the final specification.

All terms in this specification shall be as defined in the “Glossary of Arboricultural Terms” or as modified below.

- A. Owner’s Representative: The person appointed by the Owner to represent their interest in the review

and approval of the work and to serve as the contracting authority with the Contractor. The Owner's Representative may appoint other persons to review and approve any aspects of the work.

- B. Reasonable and reasonably: When used in this specification is intended to mean that the conditions cited will not affect the establishment or long term stability, health or growth of the plant. This specification recognizes that plants are not free of defects, and that plant conditions change with time. This specification also recognizes that some decisions cannot be totally based on measured findings and that profession judgment is required. In cases of differing opinion, the Owner's Representative expert shall determine when conditions within the plant are judged as reasonable.
- C. Shrub: Woody plants with mature height approximately less than 25 feet.
- D. Tree and Plant Protection Area: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and defined by a circle centered on the trunk with each tree with a radius equal to the crown dripline unless otherwise indicated by the owner's representative.
- E. Tree: Single and multi-stemmed plants, including palms with anticipated mature height approximately greater than 25 feet or any plant identified on the plans as a tree.

1.10 SUBMITTALS

Note to specifier: *The arborist report, described below is to provide a current assessment of all trees to remain and serve as the basis for determining if trees are damaged. The Contractor is made responsible for the preparation of this report with the Owner's Representative responsible for approval of the report so that both sides of the contract are satisfied that the condition of these trees is accurately reported before any work has started. Add or delete any portions that do not apply.*

- A. ARBORIST REPORT: Prior to the start of construction, submit, for approval by the Owner's Representative, the report of a consulting arborist who is a registered Consulting Arborist® (RCA) with American Society of Consulting Arborists or an ISA Board Certified Master Arborist, which details the following information for all trees to remain within the area designated on the drawings as the Tree and Plant Protection Area. The report shall include the following:
 - 1. A description of each tree to remain indicating its genus and species, condition including any visible damage to the root system or soil within the root zone, tree diameter at breast height (dbh) and approximate height, size and any visible disease, insect infestations and or branch and trunk structural deficiencies.
 - 2. The report shall note all trees or parts of trees, which are considered a hazard or significant or extreme risk level. Include the International Society of Arboriculture hazard evaluation sheet for each tree, which may reasonably be identified as a potential hazard tree.
 - 3. Recommendations as to treatment of all insect, disease and structural problems encountered.
 - 4. Recommendations for fertilizer treatments, if any.
 - 5. A plan of the site showing the location of all trees included in the report.
- B. PRODUCT DATA: Submit manufacturer product data and literature describing all products required by this section to the Owner's Representative for approval. Provide submittal four weeks before the start of any work at the site.

Note to specifier: *Confirm submittal time is appropriate for project schedule.*

- C. QUALIFICATIONS SUBMITTAL: For each applicable person expected to work on the project, provide copies of the qualifications and experience of the Consulting arborist, proof of either the registered Consulting Arborist® (RCA) with American Society of Consulting Arborists or an ISA Board Certified Master Arborist and any required Herbicide/Pesticide license to the Owner's Representative, for review prior to the start of work.

1.11 OBSERVATION OF THE WORK

- A. The Owner's Representative may inspect the work at any time.

1.12 PRE-CONSTRUCTION CONFERENCE

- A. Schedule a pre - construction meeting with the Owner's Representative at least seven (7) days before beginning work to review any questions the Contractor may have regarding the work, administrative procedures during construction and project work schedule.
 1. The following Contractors shall attend the preconstruction conference:
 - a. General Contractor.
 - b. Consulting Arborist.
 - c. Subcontractor assigned to install Tree and Plant Protection measures.
 - d. Earthwork Contractor.
 - e. All site utility Contractors that may be required to dig or trench into the soil.
 - f. Landscape subcontractor.
 - g. Irrigation subcontractor
- B. Prior to this meeting, mark all trees and plants to remain and or be removed as described in this specification for review and approval by the Owner's Representative.

1.13 QUALITY ASSURANCE

- A. Contractor qualifications:
 1. All pruning, branch tie back, tree removal, root pruning, and fertilizing required by this section shall be performed by or under the direct supervision of ISA Certified Arborist Submit aforementioned individual's qualifications for approval by the Owner's Representative.
 2. All applications of pesticide or herbicide shall be performed by a person maintaining a current state license to apply chemical pesticides valid in the jurisdiction of the project. Submit copies of all required state licensing certificates including applicable chemical applicator licenses.

PART 2 – PRODUCTS

2.1 MULCH

Note to specifier: *Revise this paragraph to reflect regionally available mulch materials or project specific mulch quality or type requirements where appropriate. The coarse grade Mulch specified here is considered superior for its water retention and soil building properties in areas of tree and shrub roots when irrigation is drip, bubblers or flood methods.*

- A. Mulch shall be coarse, ground, from tree and woody brush sources. The minimum range of fine particles shall be 3/8 inch or less in size and a maximum size of individual pieces shall be approximately 1 to 1-1/2 inch in diameter and maximum length of approximately 4 to 8 inches. No more that 25% of the total volume shall be fine particles and no more than 20% of total volume be large pieces.
 1. It is understood that Mulch quality will vary significantly from supplier to supplier and region to region. The above requirements may be modified to conform to the source material from locally reliable suppliers as approved by the Owner's Representative.
- B. Submit suppliers product data that product meets the requirements and two gallon sample for approval.

2.2 WOOD CHIPS:

Note to specifier: *Woodchips if available may be a suitable and more sustainable alternative to other types of Mulch. Consider permitting Mulch or Wood Chips; however be sure to coordinate requirements with the drawings. Remove this paragraph if Wood Chips are not to be permitted.*

- A. Wood Chips from an arborist chipping operation with less than 20% by volume green leaves. Chips stockpiled from the tree removal process may be used.

2.3 TREE PROTECTION FENCING:

Note to specifier: *Two fencing options are provided. The more robust chain link fencing is often*

required at urban sites where there are significant conflicts between tree preservation and other work tasks. Amend this specification and the tree protection details to be clear as to the required fencing. Remove the paragraph of the fence type that is not to be used. If both types are to be permitted coordinate with the drawings so that use is correctly identified.

- A. PLASTIC MESH FENCE: Heavy - duty orange plastic mesh fencing fabric 48 inches wide. Fencing shall be attached to metal “U” or “T” post driven into the ground of sufficient depth to hold the fabric solidly in place with out sagging. The fabric shall be attached to the post using attachment ties of sufficient number and strength to hold up the fabric without sagging. The Owner’s Representative may request, at any time, additional post, deeper post depths and or additional fabric attachments if the fabric begins to sag, lean or otherwise not present a sufficient barrier to access.
 - B. CHAIN LINK FENCE: 6 feet tall metal chain link fence set in metal frame panels on movable core drilled concrete blocks of sufficient size to hold the fence erect in areas of existing paving to remain.
 - C. GATES: For each fence type and in each separate fenced area, provide a minimum of one 3 foot wide gate. Gates shall be lockable. The location of the gates shall be approved by the Owner's Representative.
 - D. Submit suppliers product data that product meets the requirements for approval.
- 2.4 TREE PROTECTION SIGN:
- A. Heavy-duty cardboard signs, 8.5 inches x 11 inches, white colored background with black 2 inch high or larger letters block letters. The signs shall be attached to the tree protection fence every 50 feet o.c. The tree protection sign shall read “Tree and Plant Protection Area- Keep Out”.
- 2.5 TREE GROWTH REGULATOR (TGR)
- A. Cambistat 25C.
 - B. Submit suppliers product data that product meets the requirements for approval.
- 2.6 MATTING
- A. Matting for vehicle and work protection shall be heavy duty matting designed for vehicle loading over tree roots, Alturnamats as manufactured by Alturnamats, Inc. Franklin, PA 16323 or approved equal.
 - B. Submit suppliers product data that product meets the requirements for approval.
- 2.7 GEOGRID
- A. Geogrid shall be woven polyester fabric with PVC coating, Uni-axial or biaxial geogrid, inert to biological degradation, resistant to naturally occurring chemicals, alkalis, acids.
 - 1. Geogrid shall be Miragrid 2XT as manufactured by Ten Cate Nicolon, Norcross, GA. <http://www.tencate.com> or approved equal.
 - B. Submit suppliers product data that product meets the requirements for approval.
- 2.8 FILTER FABRIC
- A. Filter Fabric shall be nonwoven polypropylene fibers, inert to biological degradation and resistant of naturally occurring chemicals, alkalis and acids.
 - 1. Mirafi 135 N as manufactured by Ten Cate Nicolon, Norcross, GA. <http://www.tencate.com> or approved equal.
 - B. Submit suppliers product data that product meets the requirements for approval.

PART 3 – EXECUTION

3.1 SITE EXAMINATION

- A. Examine the site, tree, plant and soil conditions. Notify the Owner’s Representative in writing of any conditions that may impact the successful Tree and Plant Protections that is the intent of this section.

3.2 COORDINATION WITH PROJECT WORK

- A. The Contractor shall coordinate with all other work that may impact the completion of the work.
- B. Prior to the start of Work, prepare a detailed schedule of the work for coordination with other trades.
- C. Coordinate the relocation of any irrigation lines currently present on the irrigation plan, heads or the conduits of other utility lines or structures that are in conflict with tree locations. Root balls shall not be altered to fit around lines. Notify the Owner’s Representative of any conflicts encountered.

3.3 TREE AND PLANT PROTECTION AREA: The Tree and Plant Protection Area is defined as all areas indicated on the tree protection plan. Where no limit of the Tree and Plant Protection area is defined on the drawings, the limit shall be the drip line (outer edge of the branch crown) of each tree.

3.4 PREPARATION:

- A. Prior to the preconstruction meeting, layout the limits of the Tree and Plant Protection Area and then alignments of required Tree and Plant Protection Fencing and root pruning. Obtain the Owner’s Representative’s approval of the limits of the protection area and the alignment of all fencing and root pruning.
- B. Flag all trees and shrubs to be removed by wrapping orange plastic ribbon around the trunk and obtain the Owner’s Representative’s approval of all trees and shrubs to be removed prior to the start of tree and shrub removal. After approval, mark all trees and shrubs to be removed with orange paint in a band completely around the base of the tree or shrub 4.5 feet above the ground.
- C. Flag all trees and shrubs to remain with white plastic ribbon tied completely around the trunk or each tree and on a prominent branch for each shrub. Obtain the Owner’s Representative’s approval of all trees and shrubs to be remain prior to the start of tree and shrub removal.
- D. Prior to any construction activity at the site including utility work, grading, storage of materials, or installation of temporary construction facilities, install all tree protection fencing, Filter Fabric, silt fence, tree protection signs, Geogrid, Mulch and or Wood Chips as shown on the drawings.

3.5 SOIL MOISTURE

A. Volumetric soil moisture level, in all soils within the Tree and Plant Protection Area shall be maintained above permanent wilt point to a depth of at least 8 inches. No soil work or other activity shall be permitted within the Tree and Plant Protection Area when the volumetric soil moisture is above field capacity. The permanent wilt point and field capacity for each type of soil texture shall be defined as follows (numbers indicate percentage volumetric soil moisture).

Soil type	Permanent wilt point v/v	Field capacity v/v
Sand, Loamy sand, Sandy loam	5-8%	12-18%
Loam, Sandy clay, Sandy clay loam	14-25%	27-36%
Clay loam, Silt loam	11-22%	31-36%
Silty clay, Silty clay loam	22-27%	38-41%

- 1. Volumetric soil moisture shall be measured with a digital, electric conductivity meter. The meter shall be the Digital Soil Moisture Meter, DSMM500 by General Specialty Tools and Instruments, or approved equivalent meter.
- B. The Contractor shall confirm the soil moisture levels with a moisture meter. If the moisture is too high, suspend operations until the soil moisture drains to below field capacity.

3.6 ROOT PRUNING:

A. Prior to any excavating into the existing soil grade within 25 feet of the limit of the Tree and Plant Protection Area or trees to remain, root prune all existing trees to a depth of 24 inches below existing grade in alignments following the edges of the Tree and Plant Protection Area or as directed by the

Owner's Representative. Root pruning shall be in conformance with ANSI A300 (part 8) latest edition.

1. Using a rock saw, chain trencher or similar trenching device, make a vertical cut within 2 feet of the limit of grading.
2. After completion of the cut, make clean cuts with a lopper, saw or pruner to remove all torn root ends on the tree side of the excavation, and backfill the trench immediately with existing soil, filling all voids.

3.7 INSTALLATION OF GEOGRIDS, FILTER FABRIC, MATTING, WOOD CHIPS AND OR MULCH

- A. Install Geogrids, Filter Fabric, matting, Wood Chips and or Mulch in areas and depths shown on the plans and details or as directed by the Owner's representative. In general it is the intent of this specification to provide the following levels of protection:
 1. All areas within the Tree and Plant Protection area provide a minimum of 5 inches of Wood Chips or Mulch.
 2. Areas where foot traffic or storage of lightweight materials is anticipated to be unavoidable provide a layer of Filter Fabric under the 5 inches of Wood Chips or Mulch.
 3. Areas where occasional light vehicle traffic is anticipated to be unavoidable provide a layer of Geogrids under 8 inches of Wood Chips or Mulch.
 4. Areas where heavy vehicle traffic is unavoidable provide a layer of Geogrids under 8 - 12 inches of Wood Chips or Mulch and a layer of matting over the Wood Chips or Mulch.
- B. The Owner's Representative shall approve the appropriate level of protection.
- C. In the above requirements, light vehicle is defined as a track skid steer with a ground pressure of 4 psi or lighter. A heavy vehicle is any vehicle with a tire or track pressure of greater than 4 psi. Lightweight materials are any packaged materials that can be physically moved by hand into the location. Bulk materials such as soil, or aggregate shall never be stored within the Tree and Plant Protection Area.

3.8 PROTECTION:

- A. Protect the Tree and Plant Protection Area at all times from compaction of the soil; damage of any kind to trunks, bark, branches, leaves and roots of all plants; and contamination of the soil, bark or leaves with construction materials, debris, silt, fuels, oils, and any chemicals substance. Notify the Owner's Representative of any spills, compaction or damage and take corrective action immediately using methods approved by the Owner's Representative.

3.9 GENERAL REQUIREMENTS AND LIMITATIONS FOR OPERATIONS WITHIN THE TREE AND PLANT PROTECTION AREA:

- A. The Contractor shall not engage in any construction activity within the Tree and Plant Protection Area without the approval of the Owner's Representative including: operating, moving or storing equipment; storing supplies or materials; locating temporary facilities including trailers or portable toilets and shall not permit employees to traverse the area to access adjacent areas of the project or use the area for lunch or any other work breaks. Permitted activity, if any, within the Tree and Plant Protection Area maybe indicated on the drawings along with any required remedial activity as listed below.
- B. In the event that construction activity is unavoidable within the Tree and Plant Protection Area, notify the Owner's Representative and submit a detailed written plan of action for approval. The plan shall include: a statement detailing the reason for the activity including why other areas are not suited; a description of the proposed activity; the time period for the activity, and a list of remedial actions that will reduce the impact on the Tree and Plant Protection Area from the activity. Remedial actions shall include but shall not be limited to the following:
 1. In general, demolition and excavation within the drip line of trees and shrubs shall proceed with extreme care either by the use of hand tools, directional boring and or Air Knife excavation where indicated or with other low impact equipment that will not cause damage to the tree, roots or soil.
 2. When encountered, exposed roots, 1 inches and larger in diameter shall be worked around in a manner that does not break the outer layer of the root surface (bark). These roots shall be

covered in Wood Chips and shall be maintained above permanent wilt point at all times. Roots one inch and larger in diameter shall not be cut without the approval of the owners representative. Excavation shall be tunneled under these roots without cutting them. In the areas where roots are encountered, work shall be performed and scheduled to close excavations as quickly as possible over exposed roots.

3. Tree branches that interfere with the construction may be tied back or pruned to clear only to the point necessary to complete the work. Other branches shall only be removed when specifically indicated by the Owner's Representative. Tying back or trimming of all branches and the cutting of roots shall be in accordance with accepted arboricultural practices (ANSI A300, part 8) and be performed under supervision of the arborist.
4. Matting: Install temporary matting over the Wood Chips or Mulch to the extent indicated. Do not permit foot traffic, scaffolding or the storage of materials within the Tree and Plant Protection Area to occur off of the temporary matting.
5. Trunk Protection: Protect the trunk of each tree to remain by covering it with a ring of 8 foot long 2 inch x 6 - inch planks loosely banded onto the tree with 3 steel bands. Staple the bands to the planks as necessary to hold them securely in place. Trunk protection must be kept in place no longer than 12 months. If construction requires work near a particular tree to continue longer than 12 months, the steel bands shall be inspected every six months and loosened if they are found to have become tight.
6. Air Excavation Tool: If excavation for footings or utilities is required within the Tree and Plant Protection Area, air excavation tool techniques shall be used where practical or as designed on the drawings.
 - a. Remove the Wood Chips from an area approximately 18 inches beyond the limits of the hole or trench to be excavated. Cover the Wood Chips for a distance of not less than 15 feet around the limit of the excavation area with Filter Fabric or plastic sheeting to protect the Wood Chips from silt. Mound the Wood Chips so that the plastic slopes towards the excavation.
 - b. Using a sprinkler or soaker hose, apply water slowly to the area of the excavation for a period of at least 4 hours, approximately 12 hours prior to the work so that the ground water level is at or near field capacity at the beginning of the work. For excavations that go beyond the damp soil, rewet the soil as necessary to keep soil moisture near field capacity.
 - c. Using an air excavation tool specifically designed and manufactured for the intended purpose, and at pressures recommended by the manufacturer of the equipment, fracture the existing soil to the shape and the depths required. Work at rates and using techniques that do not harm tree roots. Air pressure shall be a maximum of 90-100 psi.
 - 1.) The air excavation tool shall be "Air-Spade" as manufactured by Concept Engineering Group, Inc., Verona, PA (412) 826-8800, or Air Knife as manufactured by Easy Use Air Tools, Inc. Allison Park, Pa (866) 328-5723 or approved equal.
 - d. Using a commercial, high-powered vacuum truck if required, remove the soil from the excavation produced by the Air Knife excavation. The vacuum truck should generally operate simultaneously with the hose operator, such that the soil produced is picked up from the excavation hole, and the exposed roots can be observed and not damaged by the ongoing operation. Do not drive the vacuum truck into the Tree and Plant Protection Area unless the area is protected from compaction as approved in advance by the Owner's Representative.
 - e. Remove all excavated soil and excavated Wood Chips, and contaminated soil at the end of the excavation.
 - f. Schedule the work so that foundations or utility work is completed immediately after the excavation. Do not let the roots dry out. Mist the roots several times during the day. If the excavated area must remain open over night, mist the roots and cover the excavation with black plastic.
 - g. Dispose of all soil in a manner that meets local laws and regulations.
 - h. Restore soil within the trench as soon as the work is completed. Utilize soil of similar texture to the removed soil and lightly compact with hand tools. Leave soil mounded over the trench to a height of approximately 10% of the trench depth to account for settlement.
 - i. Restore any Geogrids, Filter Fabric, Wood Chips or Mulch and or matting that was previously

required for the area.

3.10 TREE REMOVAL:

- A. Remove all trees indicated by the drawings and specifications, as requiring removal, in a manner that will not damage adjacent trees or structures or compacts the soil.
- B. Remove trees that are adjacent to trees or structures to remain, in sections, to limit the opportunity of damage to adjacent crowns, trunks, ground plane elements and structures.
- C. Do not drop trees with a single cut unless the tree will fall in an area not included in the Tree and Plant Protection Area. No tree to be removed within 50 feet of the Tree and Plant Protection Area shall be pushed over or up-rooted using a piece of grading equipment.
- D. Protect adjacent paving, soil, trees, shrubs, ground cover plantings and understory plants to remain from damage during all tree removal operations, and from construction operations. Protection shall include the root system, trunk, limbs, and crown from breakage or scarring, and the soil from compaction.
- E. Remove stumps and immediate root plate from existing trees to be removed. Grind trunk bases and large buttress roots to a depth of the largest buttress root or at least 18 inches below the top most roots which ever is less and over the area of three times the diameter of the trunk (DBH).
 - 1. For trees where the stump will fall under new paved areas, grind roots to a total depth of 18 inches below the existing grade. If the sides of the stump hole still have greater than approximately 20% wood visible, continue grinding operation deeper and or wider until the resulting hole has less than 20% wood. Remove all wood chips produced by the grinding operation and back fill in 8 inch layers with controlled fill of a quality acceptable to the site engineer for fill material under structures, compacted to 95% of the maximum dry density standard proctor. The Owner's Representative shall approve each hole at the end of the grinding operation.
 - 2. In areas where the tree location is to be a planting bed or lawn, remove all woodchips and backfill stump holes with planting soil as defined in Specification Section Planting Soil, in maximum of 12 inch layers and compact to 80 - 85% of the maximum dry density standard proctor.

3.11 PRUNING:

- A. Within six months of the estimated date of substantial completion, prune all dead or hazardous branches larger than 2 inch in diameter from all trees to remain.
- B. Implement all pruning recommendations found in the arborist report.
- C. Prune any low, hanging branches and vines from existing trees and shrubs that overhang walks, streets and drives, or parking areas as follows:
 - 1. Walks - within 8 feet vertically of the proposed walk elevation.
 - 2. Parking areas - within 12 feet vertically of the proposed parking surface elevation.
 - 3. Streets and drives - within 14 feet vertically of the proposed driving surface elevation.
- D. All pruning shall be done in accordance with ANSI A300 (part 1), ISA BMP Tree Pruning (latest edition, and the "Structural Pruning: A Guide for the Green Industry", Edward Gilman, Brian Kempf, Nelda Matheny and Jim Clark, 2013 Urban Tree Foundation, Visalia CA.
- E. Perform other pruning task as indicated on the drawings or requested by the Owner's Representative.
- F. Where tree specific disease vectors require, sterilize all pruning tools between the work in individual trees.

3.12 TREE GROWTH REGULATOR INJECTION (TGR)

Note to specifier: Confirm that Tree Growth Regulator is appropriate for the project. If not remove this paragraph and the TGR product in Part 2. If appropriate, be sure that the specific trees to be treated are labeled on the Tree and Plant Protection Plan. There is little data on the effectiveness of

TGR treatments. Use your own judgment on including it in the requirements.

- A. At the start of the construction contract period, treat all trees, indicated on the Plan, with Tree Growth Regulator at recommended rates, time of year and methods indicated by the product distributor.

3.13 WATERING

- A. The Contractor shall be fully responsible to ensure that adequate water is provided to all plants to be preserved during the entire construction period. Adequate water is defined to be maintaining soil moisture above the permanent wilt point to a depth of 8 inches or greater.
- B. The Contractor shall adjust the automatic irrigation system, if available, and apply additional water, using hoses or water tanks as required.
- C. Periodically test the moisture content in the soil within the root zone to determine the water content.

3.14 WEED REMOVAL

- A. During the construction period, control any plants that seed in and around the fenced Tree and Plant Protection area at least three times a year.
 - 1. All plants that are not shown on the planting plan or on the Tree and Plant Protection Plan to remain shall be considered as weeds.
- B. At the end of the construction period provide one final weeding of the Tree and Plant Protection Area.

3.15 INSECT AND DISEASE CONTROL

- A. Monitor all plants to remain for disease and insect infestations during the entire construction period. Provide all disease and insect control required to keep the plants in a healthy state using the principles of Integrated Plant Management (IPM). All pesticides shall be applied by a certified pesticide applicator.

3.16 CLEAN-UP

- A. During tree and plant protection work, keep the site free of trash, pavements reasonably clean and work area in an orderly condition at the end of each day. Remove trash and debris in containers from the site no less than once a week.
 - 1. Immediately clean up any spilled or tracked soil, fuel, oil, trash or debris deposited by the Contractor from all surfaces within the project or on public right of ways and neighboring property.
- B. Once tree protection work is complete, wash all soil from pavements and other structures. Ensure that Mulch is confined to planting beds.
- C. Make all repairs to grades, ruts, and damage to the work or other work at the site.
- D. Remove and dispose of all excess Mulch, Wood Chips, packaging, and other material brought to the site by the Contractor.

3.17 REMOVAL OF FENCING AND OTHER TREE AND PLANT PROTECTION

- A. At the end of the construction period or when requested by the Owner's Representative remove all fencing, Wood Chips or Mulch, Geogrids and Filter Fabric, trunk protection and or any other Tree and Plant Protection material.

3.18 DAMAGE OR LOSS TO EXISTING PLANTS TO REMAIN

Note to specifier: This clause is not written to cover high value heritage trees. A specification to address high value heritage trees should be added here if any exist on the project.

- A. Any trees or plants designated to remain and which are damaged by the Contractor shall be replaced in kind by the Contractor at their own expense. Trees shall be replaced with a tree of similar species and of equal size or 6 inch caliper which ever is less. Shrubs shall be replaced with a plant of similar species and equal size or the largest size plants reasonably available which ever is less. Where replacement plants are to be less than the size of the plant that is damaged, the Owner's

Representative shall approve the size and quality of the replacement plant.

1. All trees and plants shall be installed per the requirements of Specification Section Planting.
- B. Plants that are damaged shall be considered as requiring replacement or appraisal in the event that the damage affects more than 25 % of the crown, 25% of the trunk circumference, or root protection area, or the tree is damaged in such a manner that the tree could develop into a potential hazard. Trees and shrubs to be replaced shall be removed by the Contractor at his own expense.
1. The Owner's Representative may engage an independent arborist to assess any tree or plant that appears to have been damaged to determine their health or condition.
- C. Any tree that is determined to be dead, damaged or potentially hazardous by the Owner's arborist and upon the request of the Owner's Representative shall be immediately removed by the Contractor at no additional expense to the owner. Tree removal shall include all clean up of all wood parts and grinding of the stump to a depth sufficient to plant the replacement tree or plant, removal of all chips from the stump site and filling the resulting hole with topsoil.
- D. Any remedial work on damaged existing plants recommended by the consulting arborist shall be completed by the Contractor at no cost to the owner. Remedial work shall include but is not limited to: soil compaction remediation and vertical mulching, pruning and or cabling, insect and disease control including injections, compensatory watering, additional mulching, and could include application tree growth regulators (TGR).
- E. Remedial work may extend up to two years following the completion of construction to allow for any requirements of multiple applications or the need to undertake applications at required seasons of the year.

END OF SECTION 015639