City of Doral
RFP No. 2021-09
Construction of Pedestrian Bridge – Design Build
Addendum No. 3

Financial Projects Number(s): 441642-1-58-01
Contract Number: RFP No. 2021-09

Below are changes/ updates regarding this project. This Addendum is and does become a part of the above-mentioned solicitation. This addendum is issued to modify the subject solicitation as follows:

1. We are unable to locate attachments A-2 thru A-17 within the RFP information provided by the City. Please provide.
   - Please see attached.

2. Please provide any available electronic or CADD files including existing topography, right of way, surveys, utility designations, concept drawings etc. so that the Design-Build Teams may proceed with refining the design.
   - Attached the CADD files used to develop the Pedestrian Bridge Concept design layout, plan and elevation. The CADD files (topo, survey, etc.) provided in the "Reference Files" directory are for reference purposes only. Also a KMZ file is provided for your use. (Note the CADD reference files [topo, survey, etc.) were provided by the City's Consultant and were not developed by PHD).

     https://cityofdoral.files.com/f/f275687905c4be01

3. With respect to Section VI.D. of the RFP, please identify Utilities that are in conflict with the City's Concept Plan. Please provide any utility relocation work plans and schedules that have been developed and confirm that such utility work will be considered reimbursable.
   - A utility relocation work plan and schedule has not been developed. Preliminary utility coordination was performed to identify utility owners with utilities within the vicinity of the Project limits and are listed in the RFP. Attached for your use are utility information and/or responses from the following utility owners.
     - AT&T Florida
     - CenturyLink
     - Florida City Gas
     - FPL Distribution
     - FPL Transmission
     - Miami-Dade Water and Sewer

City of Doral

DESIGN-BUILD PROJECT FOR PEDESTRIAN BRIDGE OVER NW 41ST STREET AT HEFT
FINANCIAL PROJECT ID: 441642-1-58-01

ATTACHMENT A-2
Legal Requirements and Responsibility to the Public – Laws to be Observed – Compliance with Federal Endangered Species Act and Other Wildlife Regulations
(Manatee - SP0070104-4)

LEGAL REQUIREMENTS AND RESPONSIBILITY TO THE PUBLIC – LAWS TO BE OBSERVED - COMPLIANCE WITH FEDERAL ENDANGERED SPECIES ACT AND OTHER WILDLIFE REGULATIONS (MANATEE).

(City of Doral Revision 01-16-2020)

SUBARTICLE 7-1.4.1 revision (REV 6-15-17) (FA 6-20-17) (1-20) is replaced with the following:

7-1.4.1 Additional Requirements for Manatees *(Trichechus manatus*): The City of Doral has determined that the project occurs within the known habitat of manatees.

The City of Doral will provide instruction at a preconstruction meeting regarding:

1. The presence of the species and manatee speed zones.
2. The appearance, habits and biology of the species.
3. Their protected status.
4. The need to avoid collisions with and injury to the species.
5. The need to avoid any actions that would jeopardize the existence of these species.
6. The civil and criminal penalties for harming, harassing, or killing these species.

Advise all work crews of this information (as applicable).

Operate all vessels at "Idle Speed/No Wake" at all times while in the construction area and while in water where the draft of the vessel provides less than a four-foot clearance from the bottom. Follow routes of deep water whenever possible.

Do not dredge river bottom for barge access.

Lower all equipment or material to the mudline in a controlled descent. Do not allow freefall of any equipment or material below the water surface.

Advise all on-site project personnel they are responsible for observing water-related activities for the presence of manatees. Follow the requirements posted in the URL address in Spec 7-1.4 when manatees are observed.

Except for projects in Bay, Escambia, Franklin, Gilchrist, Gulf, Jefferson, Lafayette, Okaloosa, Santa Rosa, Suwannee and Walton:

1. Sediment or turbidity barriers shall be made of material which manatees cannot become entangled, shall be secured, and shall be monitored to avoid manatee entanglement or entrapment. Barriers must not impede manatee movement.
2. Temporary signs concerning manatees shall be posted prior to and during all in-water project activities. All signs are to be removed by the Contractor upon completion of the project. Temporary signs that have already been approved for this use by the FWC must be used. One sign which reads "Caution: Boaters", must be posted in a location conspicuous to boating traffic. A second sign measuring at least 8-1/2 inches by 11 inches, explaining the requirements for "Idle Speed/No Wake" and the shutdown of in-water operations, must be posted in at least one location prominently visible to all onsite project personnel engaged in water-related activities. These signs can be viewed at: https://myfwc.com/wildlifehabitats/wildlife/manatee/education-for-marinas/

City of Doral

DESIGN-BUILD PROJECT FOR PEDESTRIAN BRIDGE OVER NW 41ST STREET AT HEFT
FINANCIAL PROJECT ID: 441642-1-58-01

ATTACHMENT A-3
Legal Requirements and Responsibility to the Public – Laws to be Observed – Compliance with Federal Endangered Species Act and Other Wildlife Regulations
(Bats - SP0070104-10)

LEGAL REQUIREMENTS AND RESPONSIBILITY TO THE PUBLIC – LAWS TO BE OBSERVED – COMPLIANCE WITH FEDERAL ENDANGERED SPECIES ACT AND OTHER WILDLIFE REGULATIONS (BATS).

(City of Doral Revision 01-16-2020)

SUBARTICLE 7-1.4.1 revision (REV 12-7-18) (FA 1-4-19) (1-20) is replaced with the following.

7-1.4.1 Additional Requirements for Bats:

The proposed Pedestrian Bridge over NW 41st Street at HEFT is a new facility therefore there are no previously installed bat exclusion devices to maintain.

City of Doral

DESIGN-BUILD PROJECT FOR PEDESTRIAN BRIDGE OVER NW 41ST STREET AT HEFT
FINANCIAL PROJECT ID: 441642-1-58-01

ATTACHMENT A-4
Legal Requirements and Responsibility to the Public – Laws to be Observed – Compliance with Federal Endangered Species Act and Other Wildlife Regulations
(Bats in Bridges - SP0070104-11)

LEGAL REQUIREMENTS AND RESPONSIBILITY TO THE PUBLIX – LAWS TO BE OBSERVED – COMPLIANCE WITH FEDERAL ENDANGERED SPECIES ACT AND OTHER WILDLIFE REGULATIONS (BATS IN BRIDGES).

(City of Doral Revision 01-16-2020)

SUBARTICLE 7-1.4.1 revision (REV 12-7-18) (FA 1-4-19) (1-20) is replaced with the following.

7-1.4.1 Additional Requirements for Bats in Bridges: The proposed Pedestrian Bridge over NW 41st Street at HEFT is a new facility therefore there are no previously installed bat exclusion devices to maintain.

City of Doral

DESIGN-BUILD PROJECT FOR PEDESTRIAN BRIDGE OVER NW 41ST STREET AT HEFT
FINANCIAL PROJECT ID: 441642-1-58-01

ATTACHMENT A-5
Legal Requirements and Responsibility to the Public – E-Verify

LEGAL REQUIREMENTS AND RESPONSIBILITY TO THE PUBLIC – E-VERIFY. (REV 6-13-11) (FA 6-16-11) (1-20)

SECTION 7 is expanded by the following new Article:

7-29 E-Verify.

The Contractor shall utilize the U.S. Department of Homeland Security's E-Verify system to verify the employment eligibility of all new employees hired by the Contractor during the term of the Contract and shall expressly require any subcontractors performing work or providing services pursuant to the Contract to likewise utilize the U.S. Department of Homeland Security's E-Verify system to verify the employment eligibility of all new employees hired by the subcontractor during the Contract term.

City of Doral

DESIGN-BUILD PROJECT FOR PEDESTRIAN BRIDGE OVER NW 41ST STREET AT HEFT
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ATTACHMENT A-6
Legal Requirements and Responsibility to the Public
(Scrutinized Companies - SP0073900)

LEGAL REQUIREMENTS AND RESPONSIBILITY TO THE PUBLIC – SCRUTINIZED COMPANIES.
(City of Doral Revision – 01-16-2020)

SECTION 7 revision (REV 3-22-18) (1-20)) is replaced with the following:

7-30 Scrutinized Companies.

For Contracts of any amount, if the City of Doral determines the Contractor submitted a false certification under Section 287.135(5) of the Florida Statutes, or if the Contractor has been placed on the Scrutinized Companies that Boycott Israel List, or is engaged in a boycott of Israel, the City of Doral shall either terminate the Contract after it has given the Contractor notice and an opportunity to demonstrate the City of Doral's determination of false certification was in error pursuant to Section 287.135(5)(a) of the Florida Statutes, or maintain the Contract if the conditions of Section 287.135(4) of the Florida Statutes are met.

For Contracts $1,000,000 and greater, if the City of Doral determines the Contractor submitted a false certification under Section 287.135(5) of the Florida Statutes, or if the Contractor has been placed on the Scrutinized Companies with Activities in the Sudan List, or the Scrutinized Companies with Activities in the Iran Petroleum Energy Sector List, the City of Doral shall either terminate the Contract after it has given the Contractor notice and an opportunity to demonstrate the City of Doral's determination of false certification was in error pursuant to Section 287.135(5)(a) of the Florida Statutes, or maintain the Contract if the conditions of Section 287.135(4) of the Florida Statutes are met.

City of Doral

DESIGN-BUILD PROJECT FOR PEDESTRIAN BRIDGE OVER NW 41ST STREET AT HEFT
FINANCIAL PROJECT ID: 441642-1-58-01

ATTACHMENT A-7
Legal Requirements and Responsibility to the Public
(Title VI Assurance - DOT 1050.2A, Appendix A and Appendix E SP0073100)

LEGAL REQUIREMENTS AND RESPONSIBILITY TO THE PUBLIC – TITLE VI ASSURANCE – DOT 1050.2A, APPENDIX A AND APPENDIX E.
(REV 5-27-16) (FA 6-2-16) (7-20)

SECTION 7 is expanded by the following new Article:

7-31 Title VI Assurance – DOT 1050.2A, Appendix A and Appendix E.

7-31.1 Appendix A: During the performance of this Contract, the Contractor, for itself, its assignees and successors in interest (hereinafter referred to as the "Contractor") agrees as follows:

1. Compliance with Regulations: The Contractor shall comply with the Regulations relative to nondiscrimination in Federally-assisted programs of the US Department of Transportation (hereinafter, "USDOT") Title 49, Code of Federal Regulations, Part 21, as they may be amended from time to time, (hereinafter referred to as the Regulations), which are herein incorporated by reference and made a part of this Contract.

2. Nondiscrimination: The Contractor, with regard to the work performed by it during the Contract, shall not discriminate on the basis of race, color, national origin or sex in the selection and retention of sub-contractors, including procurements of materials and leases of equipment. The Contractor shall not participate either directly or indirectly in the discrimination prohibited by Section 21.5 of the Regulations, including employment practices when the Contract covers a program set forth in Appendix B of the Regulations.

3. Solicitations for subcontractors, including procurements of materials and equipment: In all solicitations either by competitive bidding or negotiation made by the Contractor for work to be performed under subcontract, including procurements of materials or leases of equipment, each potential subcontractor or supplier shall be notified by the Contractor of the Contractor's obligations under this contract and the Regulations relative to nondiscrimination on the basis of race, color, national origin, or sex.

4. Information and Reports: The Contractor shall provide all information and reports required by the Regulations or directives issued pursuant thereto, and shall permit access to its books, records, accounts, other sources of information and its facilities as may be determined by the City of Doral, the Florida Department of Transportation or the Federal Highway Administration, Federal Transit Administration, Federal Aviation Administration, and Federal Motor Carrier Safety Administration to be pertinent to ascertain compliance with such Regulations, order and instructions. Where any information required of a Contractor is in the exclusive possession of another who fails or refuses to furnish this information the Contractor shall so certify to the City of Doral, Florida Department of Transportation, or the Federal Highway Administration, Federal Transit Administration, Federal Aviation Administration, or Federal Motor Carrier Safety Administration as appropriate, and shall set forth what efforts it has made to obtain the information.

5. Sanctions for Noncompliance: In the event of the Contractor's noncompliance with the nondiscrimination provisions of this Contract, the City of Doral and the Florida Department of Transportation shall impose such Contract sanctions as it or the Federal Highway Administration, Federal Transit Administration, Federal Aviation Administration, or Federal Motor Carrier Safety Administration may determine to be appropriate, including, but not limited to:

a. withholding of payments to the Contractor under the Contract until the Contractor complies, or

b. cancellation, termination or suspension of the Contract, in whole or in part.

6. Incorporation of Provisions: The Contractor shall include the provisions of this Appendix in every subcontract, including procurements of materials and leases of equipment, unless exempt by the Regulations, or directives issued pursuant thereto. The Contractor shall take such action with respect to any subcontract or procurement as the City of Doral, Florida Department of Transportation or the Federal Highway Administration, Federal Transit Administration, Federal Aviation Administration, or Federal Motor Carrier Safety Administration may direct as a means of enforcing such provisions including sanctions for noncompliance, provided, however, that, in the event a Contractor becomes involved in, or is threatened with, litigation with a subcontractor or supplier as a result of such direction, the Contractor may request the City of Doral and the Florida Department of Transportation to enter into such litigation to protect the interests of the City of Doral, Florida Department of Transportation, and, in addition, the Contractor may request the United States to enter into such litigation to protect the interests of the United States.

7-31.2 Appendix E: During the performance of this Contract, the Contractor, for itself, its assignees, and successors in interest (hereinafter referred to as the "Contractor" agrees to comply with the following non-discrimination statutes and authorities; including but not limited to:

1. Title VI of the Civil Rights Act of 1964 (42 U.S.C. § 2000d et seq., 78 stat. 252), (prohibits discrimination on the basis of race, color, national origin); and 49 CFR Part 21;

2. The Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, (42 U.S.C. § 4601), (prohibits unfair treatment of persons displaced or whose property has been acquired of Federal or Federal-aid programs and projects);

3. Federal-Aid Highway Act of 1973, (23 U.S.C § 324 et seq.), (prohibits discrimination on the basis of sex);

4. Section 504 of the Rehabilitation Act of 1973 (29 U.S.C. § 794 et seq.), as amended, (prohibits discrimination on the basis of disability); and 49 CFR Part 27;

5. The Age Discrimination Act of 1975, as amended, (42 U.S.C. § 6101 et seq.), (prohibits discrimination on the basis of age);

6. Airport and Airway Improvement Act of 1982, (49 U.S.C. 471, Section 47123), as amended, (prohibits discrimination based on race, creed, color national origins or sex);

7. The Civil Rights Restoration Act of 1987 (PL 100-209), (Broadened the scope, coverage and applicability of Title VI of the Civil Rights Act of 1964, The Age Discrimination Act of 1975 and Section 504 of the Rehabilitation Act of 1973, by expanding the definition of the terms "programs or activities" to include all of the programs or activities of the Federal-aid recipients, sub-recipients and contractors, whether such programs or activities are Federally funded or not);

8. Titles II and III of the Americans with Disabilities Act, which prohibits discrimination on the basis of disability in the operation of public entities, public and private transportation systems, places of public accommodation, and certain testing entities (42 U.S.C. §§ 12131 – 12189) as implemented by the City of Doral or the Department of Transportation regulations at 49 C.F.R. parts 37 and 38;

9. The Federal Aviation Administration's Non-discrimination statute (49 U.S.C. § 47123) (prohibits discrimination on the basis of race, color, national origin, and sex);

10. Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, which ensures non-discrimination against minority populations by discouraging programs, policies, and activities with disproportionately high and adverse human health or environmental effects on minority and low-income populations;

11. Executive Order 13166, Improving Access to Services for Persons with Limited English Proficiency, and resulting agency guidance, national origin discrimination includes discrimination because of limited English proficiency (LEP). To ensure compliance with Title VI, you must take reasonable steps to ensure that LEP persons have meaningful access to your programs (70 Fed. Reg. at 74087 to 74100);

12. Title IX of the Education Amendments of 1972, as amended, which prohibits discrimination based on sex in education programs, or activities (20 U.S.C. 1681 et seq.).

City of Doral

DESIGN-BUILD PROJECT FOR PEDESTRIAN BRIDGE OVER NW 41ST STREET AT HEFT
FINANCIAL PROJECT ID: 441642-1-58-01

ATTACHMENT A-8
Contaminated Materials
(Mercury - SP0080409)

PROSECUTION AND PROGRESS – LIMITATIONS OF OPERATIONS - CONTAMINATED MATERIAL (MERCURY-CONTAINING DEVICES AND LAMPS). (REV 11-6-95) (FA 12-27-95) (1-20)

SUBARTICLE 8-4.9 is expanded by the following:

This Contract may require the removal and special disposal of mercury-containing devices.

Contact City of Doral , at (305) 593-6740 for information relating to the identification and proper disposal of these hazardous waste materials.

Include payment for the removal and disposal of mercury-containing devices in the payment for the related Contract items.

City of Doral

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ATTACHMENT A-9
Environmental Valuation
(Pending – To be obtained by Design-Build Firm)

City of Doral

DESIGN-BUILD PROJECT FOR PEDESTRIAN BRIDGE OVER NW 41ST STREET AT HEFT
FINANCIAL PROJECT ID: 441642-1-58-01

ATTACHMENT A-10
Mobilization
(SP1010000DB)

MOBILIZATION.
(REV 2-17-14) (FA 7-2-14) (1-20)

SECTION 101 is deleted and the following substituted:

SECTION 101
MOBILIZATION

101-1 Description.

Perform preparatory work and operations in mobilizing for beginning work on the project, including, but not limited to, those operations necessary for the movement of personnel, equipment, supplies, and incidentals to the project site and for the establishment of temporary offices, buildings, safety equipment and first aid supplies, and sanitary and other facilities.

Include the costs of bonds and any required insurance and any other preconstruction expense necessary for the start of the work, excluding the cost of construction materials.

101-2 Basis of Payment.

101-2.1 General: The work and incidental costs specified as being covered under this Section will be paid for at the lump sum prices for the items of Mobilization included in the Schedule of Values.

101-2.2 Partial Payments: When the Notice to Proceed has been issued, partial payments will be made in accordance with the following:

Partial payment will be made at 25% of the Mobilization amount shown in the Schedule of Values per month for the first four months until 100% of the Mobilization amount shown in the Schedule of Values is paid. In no event shall more than 50% of the Mobilization amount shown in the Schedule of Values be paid prior to commencing construction on the project site.

Total partial payments for Mobilization on any project, including when more than one project or job is included in the Contract, will be limited to 10% of the original Contract amount for that project. Any remaining amount will be paid upon completion of all work on the Contract.

Retainage, as specified in 9-5, will be applied to all partial payments.

Partial payments made on this item will in no way act to preclude or limit any of the provisions for partial payments otherwise provided for by the Contract.

City of Doral

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ATTACHMENT A-11
Contractor Quality Control General Requirements (SP1050813DB)

CONTRACTOR QUALITY CONTROL GENERAL REQUIREMENTS.
(City of Doral Revision 01-16-2020)

ARTICLE 105-8 revision (REV 5-15-17) (FA 8-1-17) (1-20) is replaced with the following.

105-8.13 Geotechnical Foundation Services Personnel For Design Build Projects:

105-8.13.1 General: Provide qualified personnel to design foundations and provide geotechnical analyses and recommendations for the design of roadways and structures for the project. Provide qualified and trained personnel to perform foundation testing, inspection of the construction activities and oversight of the foundation construction operations. Ensure the personnel provided meet the registration and qualification requirements specified herein and these requirements are maintained throughout the duration of the design and construction of the project elements where these personnel are required to work.

Submit qualification statements for the geotechnical, dynamic testing, load testing and non-destructive testing personnel to be used on the project for acceptance by the Engineer. The City of Doral will review these qualification statements, provide comments or request additional information within 15 working days, excluding weekends and City of Doral observed holidays. Do not begin Design or Construction until the qualifications of supervisory personnel have been accepted by the Engineer. Acceptance of the Design-Build Firm's personnel does not relieve the Design-Build Firm of the responsibility for obtaining the required results in the completed work.

105-8.13.2 Geotechnical Foundation Design Engineer of Record (GFDEOR): Provide a Geotechnical Foundation Design Engineer of Record in responsible charge of the geotechnical exploration, analysis, design and recommendations for the roadways and structures on the project. The GFDEOR shall also supervise and certify the constructed foundations. The GFDEOR must be a Professional Engineer registered in the state of Florida and must have a minimum of five years of design experience with the type of foundation proposed for the project. For bridges founded on piles and drilled shafts, the GFDEOR must possess verifiable responsible charge experience in the interpretation and utilization of data from the types of load tests (dynamic, static, Osterberg Cell and/or Statnamic load tests) used on the project on at least three Florida Department of Transportation bridge projects.

105-8.13.3 Dynamic Testing Engineer (DTE): Provide a Dynamic Testing Engineer in responsible charge of the performance of the dynamic load testing of driven piles, evaluation, signal matching and analysis of the dynamic load test data, the establishment of the production pile lengths (when these are to be determined based on test pile information) and driving criteria. Production pile lengths and driving criteria shall be developed by the same engineering firm, and under the same DTE analyzing the dynamic pile testing data in conjunction with the GFDEOR. The DTE must be a Professional Engineer registered in the state of Florida with responsible charge experience of geotechnical foundation construction engineering and dynamic testing of driven piles for a period of not less than three years including at least three Florida Department of Transportation bridge projects. This "responsible charge" experience shall include verifiable experience using the test methods that will be utilized on the project. The DTE must have a rank of Intermediate or higher in the PDCA/PDI Dynamic Measurement and Analysis Proficiency Test.

105-8.13.4 Dynamic Testing Operator: Provide a Dynamic Testing Operator

(DTO) to perform the dynamic load testing of instrumented piles and test piles in the field. The DTO must have a rank of Intermediate or higher in the PDCA/PDI Dynamic Measurement and Analysis Proficiency Test. When EDCs will be used to monitor piles and/or test piles, EDC monitoring shall be performed by an operator who has passed EDC Monitoring Certification as evidenced by a Smart Structures valid Certification Card and ID. The operator must have experience in geotechnical foundation construction and dynamic testing of driven piles for a period of not less than two years including at least three Florida Department of Transportation bridge projects. The experience may have been obtained while working under the supervision of another qualified operator. The Dynamic Testing Operator shall work under the supervision of the DTE.

105-8.13.5 Foundation Inspectors: Provide qualified foundation inspectors, working under the supervision of the GFDEOR, to monitor and record the construction of foundations. Pile Driving inspectors must possess CTQP Pile Driving Inspector qualification. Drilled Shaft inspectors must possess CTQP Drilled Shaft Inspector qualification. Auger Cast Pile inspectors must have completed and passed the CTQP based training class for auger cast piles.

105-8.13.6 Pile Driving Superintendents: Use pile driving superintendents or foremen in responsible charge of pile driving operations, with experience in installing driven piles of the type, size and depth proposed for the project and for a period of not less than two years.

105-8.13.7 Drilled Shaft Superintendents: Use drilled shaft superintendents or foremen in responsible charge of drilling operations with experience in installing drilled shafts of the size and depth proposed and for the project for a period of not less than three years.

105-8.13.8 Auger Cast Pile Superintendents: Use auger cast pile superintendents or foremen in responsible charge of auger cast pile installation operations with experience in installing auger cast piles of the size and depth proposed for the project and for a period of not less than one year.

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ATTACHMENT A-12
Structures Foundations
(SP4550000DB)

STRUCTURES FOUNDATIONS (DESIGN BUILD).
(City of Doral Revision 01-16-2020)

SECTION 455 revision (REV 6-17-19) (FA 7-9-19) (1-20) is replaced with the following:

SECTION 455
STRUCTURES FOUNDATIONS

Index

A. GENERAL

455-1 General Requirement.

The Contractor may examine available soil samples and/or rock cores obtained during the preliminary soil boring operations at the appropriate District Materials Office or designated storage location.

455-1.1 Monitor Existing Structures: Monitor existing structures in accordance with Section 108.

455-1.2 Excavation: Complete all excavation of the foundations prior to installing piles or shafts unless otherwise authorized by the Engineer. After completing pile/shaft installation, remove all loose and displaced materials from around the piles/shafts, leaving a clean, solid surface. Compact the soil surface on which concrete is to be placed or which will support the forming system for the concrete to support the load of the plastic concrete without settling or causing the concrete to crack, or as shown in the Contract Documents.

455-1.2.1 Abutment (End Bent) Fill: Place and compact the fill before installing end-bent piling/shafts, except when driving specified test piling in end bents or when the Plans show uncased piles through proprietary retaining wall fills.

When installing piles/shafts or casing prior to placing fill, take necessary precautions to prevent displacement of piles/shafts during placing and compacting fill materials within 15 feet of the piles/shafts or casing. Reference and check the position of the piles/shafts or casing at three approximately equal intervals during construction of the embankment.

Place embankment material in 6 inch compacted lifts in the 15 foot area around the piles/shafts or casing. Compact embankment material within the 15 foot area adjacent to the piles/shafts or casing to the required density with compaction equipment weighing less than 1,000 pounds. When installing piles/shafts prior to the completion of the surrounding fills, do not cap them until placing the fills as near to final grade as possible, leaving only the necessary working room for construction of the caps.

When shown in the Plans, provide permanent casings installed prior to placement of the fill, for all drilled shafts through mechanically stabilized fills (for example, behind proprietary retaining walls) for shafts installed after fill placement. Install temporary casings through the completed conventional fill when permanent casings are not required.

Provide permanent casings, if required, before the fill is placed extending a sufficient distance into the existing ground to provide stability to the casings during construction of the abutment fill.

455-1.3 Cofferdams: Construct cofferdams as detailed in the Plans. When cofferdams are not detailed in the Plans, employ a qualified Specialty Engineer to design cofferdams, and to sign and seal the plans and specification requirements. Send the designs to the Engineer for his records before beginning construction.

Provide a qualified diver and a safety diver to inspect the conditions of the foundation enclosure or cofferdam when the Contract Documents require a seal for construction. Equip these divers with suitable voice communications, and have them inspect the foundation enclosure and cofferdam periphery including each sheeting indentation and around each piling or drilled shaft to ensure that no layers of mud or other undesirable materials were left above the bottom of seal elevation during the excavation process. Also have the divers check to make sure the surfaces of the piles or drilled shafts are sufficiently clean to allow bond of the concrete down to the minimum bottom of seal elevation. Ensure that there are no mounds of stone, shell, or unapproved backfill material left after placement and grading. Ensure that the seal is placed as specified and evaluate the adequacy of the foundation soils or rock. Correct any deficiencies found by the divers. Upon completion of inspection by the divers, the City of Doral may also elect to inspect the work before authorizing the Contractor to proceed with subsequent construction operations. Submit a written report by the divers to the Engineer indicating the results of their underwater inspection before requesting authorization to place the seal concrete.

455-1.4 Vibrations on Freshly Placed Concrete (Drilled Shafts and Piers): Ensure that freshly placed concrete is not subjected to peak particle velocities greater than 1.5 inches per second from vibration sources located within 30 feet (from the nearest outside edge of freshly placed concrete to the vibration source) until that concrete has attained its final set as defined by ASTM C403 except as required to remove temporary casings before the drilled shaft elapsed time has expired.

455-2 Static Compression Load Tests.

455-2.1 General: Employ a professional testing laboratory, or Specialty Engineer with prior load test experience on at least three projects, to conduct the load test in compliance with these Specifications, to record all data, and to submit signed and sealed reports of the test results to the Engineer.

Perform the load test by applying a load up to the load required in the Contract Documents or to the failure load, whichever occurs first.

Do not apply test loads to piles sooner than 48 hours (or the time interval shown in the Plans) after driving of the test pile or reaction piles, whichever occurs last.

Do not begin static load testing of drilled shafts until the concrete has attained a compressive strength of 3,400 psi. The Contractor may use high early strength concrete to obtain this strength at an earlier time to prevent testing delays.

Provide all equipment, materials, labor, and personnel required to conduct the load tests, including determination of anchor reaction member depths. In this case, provide a loading apparatus designed to accommodate the maximum load plus an adequate safety factor.

While performing the load test, provide safety equipment, and employ safety procedures consistent with the latest approved practices for this work. Include with these safety procedures, adequate support for the load test plates and jack to prevent them from falling in the event of a release of load due to hydraulic failure, test pile/shaft failure, or any other cause.

455-2.2 Loading Apparatus: Provide an apparatus for applying the vertical loads as described in one of the following:

1. As shown and described in the Contract Documents.

2. As supplied by the Contractor, one of the following devices designed to accommodate a load at least 20% higher than the test load shown in the Plans or described herein for test loads:

a. Load Applied by Hydraulic Jack Acting Against Weighted Box or Platform: Construct a test box or test platform, resting on a suitable support, over the pile, and load it with material with a total weight greater than the anticipated maximum test load. Locate supports for the weighted box or platform at least 6 feet or three pile/shaft diameters, whichever is greater, measured from the edge of the pile or shaft to the edge of the supports. Insert a hydraulic jack with pressure gauge between the test pile or shaft and the underside of the reaction beam, and apply the load to the pile or shaft by operating the jack between the reaction beam and the top of the pile or shaft.

b. Load Applied to the Test Pile or Shaft by Hydraulic Jack Acting Against Anchored Reaction Member: Construct reaction member anchorages in accordance with article 6.3 of ASTM D1143. Attach a girder(s) of sufficient strength to act as a reaction beam to the upper ends of the anchor piles or shafts. Insert a hydraulic jack with pressure gauges between the head of the test pile/shaft and the underside of the reaction beam, and apply the test load to the pile/shaft by operating the jack between the reaction beam and the pile/shaft head.

If using drilled shafts with bells as reaction member anchorages, locate the top of the bell of any reaction shaft anchorage at least three shaft diameters below the bottom of the test shaft.

c. Combination Devices: The Contractor may use a combination of devices (a) and (b), as described above, to apply the test load to the pile or shaft.

d. Other systems proposed by the Contractor and accepted by the Engineer: When necessary, provide horizontal supports for loading the pile/shaft, and space them so that the ratio of the unsupported length to the minimum radius of gyration of the pile does not exceed 120 for steel piles, and the unsupported length to the least cross-section dimension does not exceed 20 for concrete piles or drilled shafts. Ensure that horizontal supports provide full support without restraining the vertical movement of the pile/shaft in any way.

When required by the Contract Documents, apply a horizontal load to the pile/shaft either separately or in conjunction with the vertical load. Apply the load to the test pile/shaft by hydraulic jacks, jacking against Contractor provided reaction devices. After receiving the Engineer's acceptance of the proposed method of load application, apply the horizontal load in increments, and relieve it in decrements as required by the Contract Documents.

455-2.2.1 Modified Quick Test:

1. Loading Procedure: Apply vertical loads concentric with the longitudinal axis of the tested pile/shaft to accurately determine and control the load acting on the pile/shaft at any time. Place the load on the pile/shaft continuously, in increments equal to approximately 5% of the maximum test load specified until approaching the failure load, as indicated by the measuring

apparatus and/or instruments. Then, apply increments of approximately 2.5% until the pile/shaft "plunges" or attains the limiting load. The Specialty Engineer may elect to stop the loading increments when the pile/shaft has met the failure criteria or when a settlement equal to 10% of the pile/shaft width or diameter is reached. Apply each load increment immediately after taking and verifying the complete set of readings from all gauges and instruments. Apply each increment of load within the minimum length of time practical, and immediately take the readings. Complete the addition of a load increment and the completion of the readings within 5 to 15 minutes. Hold the maximum applied load for one hour.

Remove the load in decrements of about 10% of the maximum test load. Remove each decrement of load within the minimum length of time practical, and immediately take the readings. Complete the removal of a load decrement and the taking of the readings within 5 to 15 minutes. The Engineer may also require up to two reloading cycles with five loading increments and three unloading decrements. Record the final recovery of the pile/shaft until movement is essentially complete for a period of one hour after the last unload interval.

2. Failure Criteria and Nominal Resistance: Use the criteria described herein to establish the failure load. The failure load is defined as the load that causes a pile/shaft top deflection equal to the calculated elastic compression plus 0.15 inches plus 1/120 of the pile/shaft minimum width or the diameter in inches for piles/shafts 24 inches or less in width, and equal to the calculated elastic compression plus 1/30 of the pile/shaft minimum width or diameter for piles/shafts greater than 24 inches in width. Consider the nominal resistance of any pile/shaft so tested as either the maximum applied load or the failure load, whichever is smaller.

455-2.3 Measuring Apparatus: Provide an apparatus for measuring movement of the test piles/shafts that consists of all of the following devices:

1. Wire Line and Scale: Stretch a wire between two secure supports located at a distance at least:

a. 10 feet from the center of the test pile but not less than 3.5 times the pile diameter or width.

b. 12 feet from the centerline of the shaft to be tested but not less than three shaft diameters.

Locate the wire supports as far as practical from reaction beam anchorages. At over-water test sites, the Contractor may attach the wire line to the sides of the service platform. Mount the wire with a pulley on one support and a weight at the end of the wire to provide constant tension on the wire. Ensure that the wire passes across the face of a scale mounted on a mirror attached to the test pile/shaft so that readings can be made directly from the scale. Use the scale readings as a check on an average of the dial readings. When measuring both horizontal and vertical movement, mount separate wires to indicate each movement, horizontal or vertical. Measure horizontal movements from two reference wires set normal to each other in a horizontal.

2. Wooden Reference Beams and Dial Gauges: Attach wooden reference beams as detailed in the Plans and accepted by the Engineer to independent supports. For piles, install the independent supports at the greater of 3.5 times the pile diameter or width or 10 feet from the centerline of the test pile. For drilled shafts, install independent supports at the greater of three shaft diameters or 12 feet from the centerline of the shaft to be tested. Locate the reference beam supports as far as practical from reaction beam anchorages. For over-water test sites, the Contractor may attach the reference beams between two diagonal platform supports. Attach dial gauges, with their stems resting either on the top of the pile/shaft or on lugs or similar reference

points on the pile/shaft, to the fixed beams to record the movement of the pile/shaft head. Ensure that the area on the pile/shaft or lug on which the stem bears is a smooth surface which will not cause irregularities in the dial readings.

Provide a minimum of four dial gauges, each with 0.001 inch divisions and with 2 inch minimum travel, placed at 90 degree intervals for measuring vertical or horizontal movement.

3. Survey Level: As a check on the dial gauges, determine the elevation of a point near the top of the test pile/shaft (on plan datum) by survey level at each load and unload interval during the load test. Unless accepted otherwise by the Engineer, level survey precision is 0.001 foot. Alternately, the surveyor may read an engineer's 50 scale attached near the pile/shaft head. Determine the first elevation before applying the first load increment; make intermediate readings immediately before a load increment or an unload decrement, and after the final unload decrement that completely removes the load. Make a final reading at the time of the last recovery reading.

For over-water test sites, when shown in the Plans or directed by the Engineer, the Contractor shall, drive an H pile through a 36 inch casing to provide a stable support for the level and to protect it against wave action interfering with level measurements. Provide a suitable movable jig for the surveyor to stand. Use a jig that has a minimum of three legs, has a work platform providing at least 4 feet width of work area around the casing, and is accepted by the Engineer before use. The described work platform may be supported by the protective casing when accepted by the Engineer.

455-2.4 Load Test Instrumentation:

1. General: The intent of the load test instrumentation is to measure the test load on top of the pile/shaft and its distribution between side friction and end bearing to provide evaluation of the preliminary design calculations and settlement estimates and to provide information for final pile/shaft length design. Ensure that the instrumentation is as described in the Contract Documents.

Supply 110 V, 60 Hz, 30 A of AC electric power in accordance with the National Electric Code (NEC) to each test pile/shaft site during the installation of the instrumentation, during the load testing, and during any instrumented set-checks/redrives.

Place all of the internal instrumentation on the rebar cage before installation in the test shaft. Construct the rebar cage at least two days before it is required for construction of the test shaft. Successfully demonstrate the lifting and handling procedures before installing the instrumentation. Place the instrumented rebar cage in one segment without causing damage to the instrumentation.

2. Hydraulic Jack and Load Cell: Provide hydraulic jack(s) of adequate size to deliver the required test load to the pile/shaft unless shown otherwise in the Plans. Before load testing begins, submit a certificate from a reputable testing laboratory showing a calibration of gauge readings for all stages of jack loading and unloading for jacks provided. Ensure that the jack has been calibrated within the preceding six months. Ensure that the accuracy of the gauge is within 5% of the true load.

Provide an adequate load cell accepted by the Engineer that has been calibrated within the preceding six months. Provide an approved electrical readout device for the load cell. Submit a certificate from an independent laboratory showing a calibration of readings for all stages of loading and unloading for load cells furnished by the Contractor and obtain the

approval of the Engineer before beginning load testing. Ensure that the accuracy of the load cell is within 1% of the true load.

3. Telltales: When shown in the Contract Documents, install telltales that consist of an unstressed steel rod, greased for reducing friction and corrosion, with appropriate clearance inside a constant-diameter pipe that rests on a flat plate attached to the end of the pipe at the point of interest shown in the Plans. Construct telltales in accordance with the Contract Documents. Install dial gauges reading to 0.001 inch with 1 inch minimum travel as directed by the Specialty Engineer to measure the movement of the telltale with respect to the top of the pile/shaft.

4. Embedded Strain Gauges: Install strain gauges in the test shaft to measure the distribution of the load. Ensure that the type, number, and location of the strain gauges are as shown in the Plans or as directed by the Geotechnical Foundation Design Engineer of Record (GFDEOR). Use strain gauges that are waterproof and have suitable shielded cable that is unspliced within the shaft. In drilled shafts provide sufficient instrumentation to determine side friction components in segments no longer than 5 feet and the end bearing component.

5. Caliper: Provide a caliper tool or system to measure accurately and continuously the shape of test shafts prior to placing concrete.

455-2.5 Support Facilities: Furnish adequate facilities for making load and settlement readings 24 hours per day. Provide such facilities for the instrumented area, and include lighting and shelter from rain, wind, and direct sunlight.

455-2.6 Load Test Personnel Furnished by the Contractor: Provide a certified welder, together with necessary cutting and welding equipment, to assist with the load test setup and to make any necessary adjustments during the load test. Provide personnel to operate the jack, generators, and lighting equipment, and also provide one person with transportation to assist as required during load test setup and conducting of the load tests. Provide qualified personnel, to read the dial gauges, take level measurements, and conduct the load test under the direct supervision of the Specialty Engineer.

455-2.7 Cooperation by the Contractor: Cooperate with the City of Doral, and ensure that the City of Doral has access to all facilities necessary for observation of the conduct and the results of the test.

455-2.8 Required Reports: Submit a static load test report signed and sealed by the Specialty Engineer to the Engineer for review and acceptance, at least three working days, excluding weekends and City of Doral observed holidays, prior to beginning production pile/shaft construction. Include in the report of the load test the following information:

1. A tabulation of the time of, and the amount of, the load and settlement readings, and the load and recovery readings taken during the loading and unloading of the pile/shaft.

2. A graphic representation of the test results, during loading and unloading of pile/shaft top movement as measured by the average of the dial gauge readings, from wireline readings and from level readings.

3. A graphic representation of the test results, when using telltales, showing pile/shaft compression and pile/shaft tip movement.

4. The estimated failure and safe loads according to the criteria described herein.

5. The derived side friction component for each pile/shaft segment, and end bearing component. Include all pertinent test data, analysis and charts used to determine these values.

6. Remarks concerning any unusual occurrences during the loading of the pile/shaft.

7. The names of those making the required observations of the results of the load test, the weather conditions prevailing during the load test, and the effect of weather conditions on the load test.

8. All supporting data including jack and load cell calibrations and certificates and other equipment requiring calibration.

9. All data taken during the load test together with instrument calibration certifications. In addition, submit a report showing an analysis of the results of axial load and lateral load tests in which soil resistance along and against the pile/shaft is reported as a function of deflection.

10. For drilled shafts, include all cross-hole sonic logging results, gamma-gamma density logging results, the results of other integrity tests, caliper measurements data and the pilot holes reports of core borings. Attach this report to the final authorized tip elevations letter in accordance with 455-15.6.

11. For piles, include pile driving records, and dynamic testing data and analysis.

12. Submit a signed & sealed letter to the City of Doral confirming the design assumptions were verified by the load tests before proceeding with production foundation construction.

455-2.9 Disposition of Loading Material: Remove all equipment and materials, which remains the Contractor's property, from the site. Clean up and restore the site to the satisfaction of the Engineer.

455-2.10 Disposition of Tested Piles/Shafts: After completing testing, cut off the tested piles/shafts, which are not to be incorporated into the final structure, and any reaction piles/shafts at an elevation 24 inches below the finished ground surface. Take ownership of the cut-offs and provide areas for their disposal.

B. PILING

455-3 General.

Furnish and install concrete, steel, or wood piling including driving, jetting, preformed pile holes, cutting off, splicing, dynamic load testing, and static load testing of piling.

In the event a pile is broken or otherwise damaged by the Contractor to the extent that the damage is irreparable, in the opinion of the Engineer, the Contractor shall extract and replace the pile at no additional expense to the City of Doral. In the event that a pile is mislocated by the Contractor, the Contractor shall extract and replace the pile, at no expense to the City of Doral, except when a design change proposed by the Contractor is approved by the City of Doral as provided in 455-5.16.5.

455-4 Classification.

The Florida Department of Transportation classifies piling as follows:

1. Treated timber piling.
2. Prestressed concrete piling.
3. Steel piling.
4. Test piling.

5. Sheet piling.
    a. Concrete sheet piling.
    b. Steel sheet piling.
6. Polymeric Piles (see Section 471 for requirements).

455-5 General Construction Requirements.

455-5.1 Predrilling of Pile Holes: Predrilled pile holes are either starter holes to the depth described in this Subarticle or holes drilled through embankment/fill material down to the natural ground surface at no additional cost to the City of Doral. When using low displacement steel piling such as structural shapes, drive them through the compacted fill without the necessity of drilling holes through the fill except when the requirements for predrilling are shown in the Plans. When using concrete or other high displacement piles, drill pile holes through fill, new or existing, to at least the elevation of the natural ground surface. Use the range of drill diameters listed below for square concrete piles.

12 inch square piles	15 to 17 inches
14 inch square piles	18 to 20 inches
18 inch square piles	22 to 26 inches
20 inch square piles	24 to 29 inches
24 inch square piles	30 to 34 inches
30 inch square piles	36 to 43 inches

For other pile sizes, use the diameter of the drills shown in the Plans or accepted by the Engineer. Accurately drill the pile holes with the hole centered over the Plan location of the piling. Maintain the location and vertical alignment within the tolerances allowed for the piling.

For predrilled holes required through rock or other hard (i.e. debris, obstructions, etc.) materials that may damage the pile during installation, predrill hole diameters approximately 2 inches larger than the largest dimension across the pile cross-section. Fill the annular space around the piles as described in 455-5.10.1 with clean A-3 sand or sand meeting the requirements of 902-3.3.

In the setting of permanent and test piling, the Contractor may initially predrill holes to a depth up to 10 feet or 20% of the pile length whichever is greater, unless otherwise shown in the plans. When installing piles in compacted fill, predrill the holes to the elevation of the natural ground surface. With prior written authorization from the Engineer, the Contractor may predrill holes to greater depths to minimize the effects of vibrations on existing structures adjacent to the work or for other reasons the Contractor proposes.

455-5.2 Underwater Driving: Underwater driving is defined as any driving through water which is above the pile head at the time of driving.

When conducting underwater driving, provide a diver equipped with voice communications to aid in placing the hammer back on the pile for required cushion changes or for subsequent redriving, to attach or recover instrumentation, to inspect the condition of the pile, or for other assistance as required.

Select one of the following methods for underwater driving:

1. Accomplish underwater driving using conventional driving equipment and piling longer than authorized so that the piling will extend above the water surface during

final driving. When choosing this option, furnish a pile hammer that satisfies the requirements of this Section for use with the longer pile.

2. Accomplish underwater driving using an underwater hammer that meets the requirements of this Section and is accepted by the Engineer. When choosing this option, provide at least one pile longer than authorized at each pile group, extending above the water surface at final driving. At each group location, drive the longer pile first. Evaluate the adequacy of the underwater driving system. Use the pile tip elevation of the longer pile to evaluate the acceptability of the piles driven with the underwater hammer.

3. Accomplish underwater driving using conventional driving equipment with a suitable pile follower. When choosing this option, provide at least one pile longer than required at each pile group, extending above the water surface at final driving. At each group location, drive the full length pile first without using the follower. Perform a dynamic load test on the first pile driven with the follower in each group. Use the pile tip elevation of the longer pile to evaluate the acceptability of the piles driven with the follower.

Prior to use, submit details of the follower to the Engineer along with the information required in 455-10. Include the weight, cross-section details, stiffness, type of materials, and dimensions of the follower.

455-5.3 Pile Hammers: All equipment is subject to satisfactory field performance during and without dynamic testing. Use a variable energy hammer to drive concrete piles. Hammers will be rated based on the theoretical energy of the ram at impact. Supply driving equipment which provides the required resistance at a blow count ranging from 3 blows per inch (36 blows per foot) to 10 blows per inch (120 blows per foot) at the end of initial drive. When the stroke height or bounce chamber pressure readings do not adequately determine the energy of the hammer, provide and maintain a device to measure the velocity of the ram at impact. Determine the actual hammer energy in the field so that it is consistent with the hammer energy used for each bearing capacity determination. When requested, submit to the Engineer all technical specifications and operating instructions related to hammer equipment.

455-5.3.1 Air/steam: Variable energy air/steam hammers shall be capable of providing at least two ram stroke lengths. The short ram stroke length shall be approximately half of the full stroke for hammers with strokes up to 4 feet and no more than 2 feet for hammers with maximum strokes lengths over 4 feet. Operate and maintain air/steam hammers within the manufacturer's specified ranges. Use a plant and equipment for steam and air hammers with sufficient capacity to maintain, under working conditions, the hammer, volume and pressure specified by the manufacturer. Equip the plant and equipment with accurate pressure gauges which are easily accessible. Drive piles with air/steam hammers operating within 10% of the manufacturer's rated speed in blows per minute. Provide and maintain in working order for the Engineer's use an approved device to automatically determine and display the blows per minute of the hammer.

455-5.3.2 Diesel: Variable energy diesel hammers shall have at least three fuel settings that will produce reduced strokes. Operate and maintain diesel hammers within the manufacturer's specified ranges. Determine the rated energy of diesel hammers using measured ram stroke length multiplied by the weight of the ram for open end hammers and by methods recommended by the manufacturer for closed end hammers.

Provide and maintain in working order an approved device to automatically determine and display ram stroke for open-end diesel hammers.

Equip closed-end (double acting) diesel hammers with a bounce chamber pressure gauge, in good working order, mounted near ground level so it can be easily read. Also, submit to the Engineer a chart, calibrated to actual hammer performance within 30 days prior to initial use, equating bounce chamber pressure to either equivalent energy or stroke for the closed-end diesel hammer to be used.

455-5.3.3 Hydraulic: Variable energy hydraulic hammers shall have at least three hydraulic control settings that provide for predictable energy or equivalent ram stroke. The shortest stroke shall be a maximum of 2 feet for the driving of concrete piles. The remaining strokes shall include full stroke and approximately halfway between minimum and maximum stroke.

Supply hammer instrumentation with electronic read out, and control unit that allows the inspector and Engineer to monitor, and the operator to read and adjust the hammer energy or equivalent ram stroke. When pressure measuring equipment is required to determine hammer energy, calibrate the pressure measuring equipment before use.

455-5.3.4 Vibratory: Vibratory hammers of sufficient capacity (force and amplitude) may be used to drive steel sheet piles and, with acceptance of the Engineer, to drive steel bearing piles a sufficient distance to get the impact hammer on the pile (to stick the pile). The Geotechnical Foundation Design Engineer of Record will determine the allowable depth of driving using the vibratory hammer based on site conditions. However, in all cases, use a power impact hammer for the last 15 feet or more of the final driving of steel bearing piles for bearing determinations after all piles in the bent/pier have been driven with a vibratory hammer. Do not use vibratory hammers to install concrete piles, or to install support or reaction piles for a load test.

455-5.4 Cushions and Pile Helmet:

455-5.4.1 Capblock: Provide a capblock (also called the hammer cushion) as recommended by the hammer manufacturer. Use commercially manufactured capblocks constructed of durable manmade materials with uniform known properties. Do not use wood chips, wood blocks, rope, or other material which permit excessive loss of hammer energy. Do not use capblocks constructed of asbestos materials. Obtain the Engineer's acceptance for all proposed capblock materials and proposed thickness for use. Maintain capblocks in good condition, and replace them when charred, melted, or otherwise significantly deteriorated. Inspect the capblock before driving begins and weekly or at appropriate intervals based on field trial. Replace or repair any capblock which loses more than 25% of its original thickness, in accordance with the manufacturer's instructions, before permitting further driving.

455-5.4.2 Pile Cushion: Provide a pile cushion that is adequate to protect the pile from being overstressed in compression and tension during driving. Use a pile cushion sized so that it will fully fill the lateral dimensions of the pile helmet minus one inch but does not cover any void or hole extending through the top of the pile. Determine the thickness based upon the hammer-pile-soil system. For driving concrete piles, use a pile cushion made from pine plywood or oak lumber. Do not use materials previously soaked, saturated or treated with oil. Maintain pile cushions in good condition and replace them when charred, splintered, excessively compressed, or otherwise deteriorated to the point it will not protect the pile against overstressing in tension or compression. Protect cushions from the weather, and keep them dry. Do not soak the cushions in any liquid. Provide a new cushion for each pile unless approved otherwise by the Engineer after satisfactory field trial during dynamic testing.

During dynamic load tests, replace the pile cushion when any of the pile stress measurements exceed the maximum allowed pile stress determined by 455-5.12.2. When driving a pile without dynamic testing, replace the pile cushion when the cushion is either compressed more than one-half the original thickness, begins to burn, or as directed by the Engineer after field performance.

Reuse pile cushions in good condition to perform all set-checks and redrives. Use the same cushion to perform the set-check or redrive as was used during the initial driving, unless this cushion is unacceptable due to deterioration, in which case use a similar cushion.

455-5.4.3 Pile Helmet: Provide a pile helmet suitable for the type and size of piling being driven. Use a pile helmet deep enough to adequately contain the required thickness of pile cushion and to assist in maintaining pile-hammer alignment. Use a pile helmet that fits loosely over the pile head and is at least 1 inch larger than the pile dimensions. Use a pile helmet designed so that it will not restrain the pile from rotating.

455-5.5 Leads: Provide pile leads constructed in a manner which offers freedom of movement to the hammer and that have the strength and rigidity to hold the hammer and pile in the correct position and alignment during driving. When using followers, use leads that are long enough and suitable to maintain position and alignment of the hammer, follower, and pile throughout driving.

455-5.6 Followers: When driving using followers, perform dynamic load testing as per 455-5.14. Obtain the Engineer's acceptance for the type of follower, when used, and the method of connection to the leads and pile. Use followers constructed of steel with an adequate cross-section to withstand driving stresses. When driving concrete piles, ensure that the cross-sectional area of the follower is at least 18% of the cross-sectional area of the pile. When driving steel piles, ensure that the cross-sectional area of the follower is greater than or equal to the cross-sectional area of the pile. Provide a pile helmet at the lower end of the follower sized according to the requirements of 455-5.4.3. Use followers constructed that maintain the alignment of the pile, follower, and hammer and still allow the pile to be driven within the allowable tolerances. Use followers designed with guides adapted to the leads that maintain the hammer, follower, and the piles in alignment.

Use information from dynamic load tests described in 455-5.14 to evaluate the adequacy of the follower and to determine pile capacity.

455-5.7 Templates and Ground Elevations: Provide a fixed template, adequate to maintain the pile in proper position and alignment during driving with swinging leads or with semi-fixed leads. Where practical, place the template so that the pile can be driven to cut-off elevation before removing the template. Ensure that templates do not restrict the vertical movement of the pile.

Supply a stable reference close to the pile, which is satisfactory in the opinion of the Engineer, for determination of the pile penetration. At the time of driving piles, obtain and record elevations of the original ground and template at each pile or pile group location. Note the highest and lowest elevation at each required location and the ground elevation at all piles.

455-5.8 Water Jets: Use jet pumps, supply lines, and jet pipes that provide adequate pressure and volume of water to freely erode the soil. Do not perform jetting without prior approval by the Engineer.

Do not perform jetting in the embankment or for end bents. Where conditions warrant, with approval by the GFDEOR, perform jetting on the holes first, place the pile therein,

then drive the pile to secure the last few feet of penetration. Only use one jet for prejetting or jetting through piles constructed with a center jet-hole. Use two jets when using external jets. When jetting and driving, position the jets slightly behind the advancing pile tip (approximately 3 feet or as approved by the GFDEOR. When using water jets in the driving, determine the pile bearing only from the results of driving after withdrawing the jets, except where using jets to continuously eliminate soil resistance through the scour zone, ensure that they remain in place as directed by the GFDEOR and operating during pile bearing determination. Where practical, perform jetting on all piles in a pile group before driving begins. When large pile groups or pile spacing and batter make this impractical, or when the Plans specify a jet-drive sequence, set check a sufficient number of previously driven piles in a pile group to confirm their capacity after completing all jetting.

455-5.9 Penetration Requirements: Measure the penetration of piles from the elevation of natural ground, the deepest scour elevation shown in the Pile Data Table, or the bottom of excavation, whichever is lower. When the Contract Documents show a minimum pile tip elevation, drive the tip of the pile to this minimum elevation. The Engineer will accept the bearing of a pile only if the Contractor achieves the required bearing when the tip of the pile is at or below the specified minimum tip elevation and below the bottom of the preformed or predrilled pile hole.

When the Plans do not show a minimum tip elevation, ensure that the penetration is at least 10 feet into firm bearing material or at least 20 feet into soft material unless otherwise permitted by the Engineer. The Engineer may accept a penetration between 15 feet and 20 feet when there is an accumulation of five consecutive feet or more of firm bearing material. Firm bearing material is any material offering a driving resistance greater than or equal to 30 tons per square foot of gross pile area as determined by the Dynamic Load Testing (455-5.12.4). Soft material is any material offering less than these resistances. The gross pile area is the actual pile tip cross-sectional area for solid concrete piles, the product of the width and depth for H piles, and the area within the outside perimeter for pipe piles and voided concrete piles.

Do not drive piles beyond practical refusal. To meet the requirements in this Subarticle, provide penetration aids, such as jetting or preformed pile holes, when piles cannot be driven to the required penetration without reaching practical refusal.

455-5.10 Preformed Pile Holes:

455-5.10.1 Description: Preformed pile holes serve as a penetration aid when all other pile installation methods fail to produce the desired penetration and when authorized by the GFDEOR to minimize the effects of vibrations on adjacent structures. Preformed pile holes are necessary when the presence of rock or strong strata of soils will not permit the installation of piles to the desired penetration by driving or a combination of jetting and driving, when determined necessary, and authorized by the GFDEOR to minimize the effects of vibrations on adjacent existing structures. Drive all piles installed in preformed pile holes to determine that the bearing requirements have been met.

For preformed holes which are required through material that caves during driving to the extent that the preformed hole does not serve its intended purpose, case the hole from the surface through caving material. After installing the pile to the bottom of the casing, remove the casings unless shown otherwise in the Plans. Determine bearing of the pile after removing the casing unless shown otherwise in the Plans. Fill all voids between the pile and soil remaining after driving through preformed holes with clean A-3 sand or sand meeting the requirements of 902-3.3, after the pile has achieved the required minimum tip elevation, unless

grouting of preformed pile holes is shown in the Plans. If pile driving is interrupted during sand placement, drive the pile at least 20 additional blows after filling all of the voids between the pile and soil with sand at no additional cost to the City of Doral.

455-5.10.2 Provisions for Use of Preformed Pile Holes: Preformed pile holes may be used when the Contractor establishes that the required results cannot be obtained when driving the load bearing piles with specified driving equipment, or if jetting is allowed, while jetting the piles and then driving or while jetting the piles during driving.

455-5.10.3 Reasons for Preformed Pile Holes: The Florida Department of Transportations considers, but does not limit to, the following conditions as reasons for preformed pile holes:

1. Inability to drive piles to the required penetration with driving and jetting equipment.
2. To penetrate a hard layer or layers of rock or strong stratum that the Engineer considers not sufficiently thick to support the structure.
3. To obtain greater penetration into dense (strong) material and into dense material containing holes, cavities or unstable soft layers.
4. To obtain penetration into a stratum in which it is desired to found the structure.
5. To minimize the effects of vibrations or heave on adjacent existing structures.
6. To minimize the effects of ground heave on adjacent piles.

455-5.10.4 Construction Methods: Construct preformed pile holes by drilling, or driving and withdrawing a suitable punch or chisel at the locations of the piles. Construct a hole that is equal to or slightly greater than the largest pile dimension for the entire length of the hole and of sufficient depth to obtain the required penetration. Carefully form the preformed hole by using a drill or punch guided by a template or other suitable device, and do not exceed the minimum dimensions necessary to achieve the required penetration of the pile. When the Plans call for grouting the preformed pile holes, provide a minimum pile hole dimension that is 2 inches larger than the largest pile dimension. Construct the holes at the Plan position of the pile and the tolerances in location, and ensure the hole is straight and that the batter is the same as specified for the pile. Loose material may remain in the preformed pile hole if the conditions in 455-5.10.1 are satisfied.

455-5.10.5 Grouting of Pile Holes: Clean and grout preformed pile holes for bearing piles, when the Plans require grouting after driving. Use grout that meets the requirements of 455-40 and 455-42 and has a minimum compressive strength of 3,000 psi at 28 days or as specified in the Plans. Prepare cylinders and perform QC testing in accordance with 455-43. LOT size and verification will be in accordance with 455-43. Pump the grout through three or more grout pipes initially placed at the bottom of the preformed hole. The Contractor may raise the grout pipes when necessary to prevent clogging and to complete the grouting operations. Maintain the grout pipes below the surface of the previously placed grout. Continue grouting until the grout reaches the ground surface all around the pile. Provide divers to monitor grouting operations when the water depth is such that it is impractical to monitor from the ground surface.

455-5.11 Bearing Requirements:

455-5.11.1 General: Drive piles to provide the bearing required for carrying the loads shown in the Plans. For all types of bearing piles, consider the driving resistance as

determined by the methods described herein sufficient for carrying the specified loads as the minimum bearing which is accepted for any type of piles. Determine pile bearing using the method described herein or as shown in the Plans.

For foundations requiring 100% dynamic testing of production piles, ensure each pile has achieved minimum penetration and the minimum required bearing for 6 inches of consecutive driving, or the minimum penetration is achieved, driving has reached practical refusal in firm material and the bearing capacity obtained in all the refusal blows.

For foundations not requiring 100% dynamic testing of production piles, ensure each pile has achieved minimum penetration, the blow count is generally the same or increasing and the minimum required bearing capacity obtained for 24 inches of consecutive driving with less than 1/4 inches rebound per blow, or the minimum penetration is achieved and driving has reached practical refusal in firm material.

455-5.11.2 Bearing Criteria: For foundations requiring 100% dynamic testing, determine the bearing of all piles using the data received from dynamic load testing equipment utilizing internally or externally mounted sensors according to the methods described in 455-5.12.1.

For foundations not requiring 100% dynamic testing, drive all piles to the blow count criteria established by the GFDEOR and the Dynamic Testing Engineer (DTE) using the methods described herein and presented in the production pile length and driving criteria letter (see 455-5.15.2).

455-5.11.3 Practical Refusal: Practical refusal is defined as 20 blows per inch or less than one inch penetration, with the hammer operating at the highest setting or setting determined by the DTE for driving piles without damage and less than 1/4 inches rebound per blow. Stop driving as soon as the pile has reached practical refusal.

455-5.11.4 Set-checks and Pile Redrive:

1. Set-checks: Set-checks consist of redriving the pile after certain period of time, typically up to 24 hours. Perform set-checks as required and at the waiting periods shown in the Contract Documents. Provide an engineer's level or other suitable equipment for elevation determinations to determine accurate pile penetration during the set-checks. A pile may be accepted when a set-check shows that it has achieved the minimum required pile bearing and has met all other requirements of this Section.

2. Pile Redrive: Pile redrive consists of redriving the pile after the following working day from initial driving to determine time effects, to reestablish pile capacity due to pile heave, or for other reasons.

3. Uninstrumented Set-Checks and Uninstrumented Pile Redrive: Piles may be accepted based on uninstrumented set-checks or uninstrumented pile redrives only when the piles are redriven for at least 24 inches. In these cases, the piles may be considered to have sufficient bearing resistance when the specified blow count criteria is achieved in accordance with 455-5.11.1 and 455-5.11.2. Unless practical refusal is obtained as defined in 455-5.11.3, set-checks or redrives for piles redriven less than 24 inches must be instrumented for pile acceptance.

4. Instrumented Set-Checks and Instrumented Pile Redrive: Use dynamic load tests using at least 6 hammer blows to determine whether the pile bearing is sufficient. The pile may be considered to have sufficient bearing resistance when dynamic measurements demonstrate the static pile resistance exceeds the required pile resistance for at least one hammer blow and the average static pile resistance during the next five hammer blows exceeds 95% of

the required pile resistance. If the pile is advanced farther, the static pile resistance during all subsequent blows must exceed 90% of the required pile resistance.

455-5.11.5 Pile Heave: Pile heave is the upward movement of a pile from its originally driven elevation. Drive the piles in an appropriate sequence to minimize the effects of heave and lateral displacement of the ground. Monitor piles previously driven in a pile group for possible heave during the driving of the remaining piles. Take elevation measurements to determine the magnitude of the movement of piles and the ground surface resulting from the driving process. Redrive all piles that have heaved 1/4 inches or more.

455-5.11.6 Piles with Insufficient Bearing: When the bearing capacity of any pile is less than the required bearing capacity, the Contractor may splice the pile and continue driving or may extract the pile and drive a pile of greater length, or drive additional piles.

455-5.11.7 Optional Soil Set-up approach: If the Contractor so desires, it may consider soil set-up. Production piles that are driven to less than the Nominal Bearing Resistance (NBR) may be accepted based on the anticipated soil setup without set checks on all piles, only if the following criteria are met:

(a) Pile tip penetration satisfies the minimum penetration requirement following 455-5.9.

(b) End of Initial Drive (EOID) resistance exceeds 1.10 times the Factored Design Load for the pile bent/pier, as determined by the dynamic testing or blow count criteria.

(c) The Resistance Factor for computing NBR is taken from the following table:

Resistance Factors for Pile Installation Using Soil Setup (all structures)				
Loading	Design Method	Construction QC Method	Resistance Factor, φ	
			Blow Count Criteria[4]	100% Dynamic Testing[5]
Compression	Davisson Capacity	EDC[1], or PDA and CAPWAP[2]	0.55	0.60
		Static Load Testing[3]	0.65	0.70
		Statnamic Load Testing[3]	0.60	0.65
Uplift	Skin Friction	EDC[1], or PDA and CAPWAP[2]	0.45	0.50
		Static Load Testing[3]	0.55	0.55

1 Using the analysis methods published by Tran et al (2012)
2. Dynamic Load Testing and Signal Matching Analysis
3 Used to confirm the results of Dynamic Load Testing and Signal Matching Analysis
4 Initial drive of production piles using Blow Count Criteria
5 Initial drive of all piles accepted by results of Dynamic Testing of all blows.

(d) At least one test pile is driven at each bent/pier with a successful set check at the anticipated production pile tip elevations and one of the following sets of dynamic load testing conditions are met at each bent/pier.

1. The bearing of at least 10% of piles in the bent/pier (round up to the next whole number) is confirmed by instrumented set-check, and all test piles and instrumented

set-checks demonstrate the pile resistance exceeds the NBR within seven days after EOID

2. The bearing of at least 20% of piles in the bent/pier (round up to the next whole number) is confirmed by instrumented set-check, and all test piles and instrumented set-checks demonstrate the pile resistance exceeds the NBR within 21 days after EOID.

(e) All uninstrumented piles are driven deeper and to a greater EOID resistance than the EOID resistance of all instrumented production piles in the same bent/pier.

455-5.12 Methods to Determine Pile Capacity:

455-5.12.1 General: Dynamic load tests using an externally mounted instrument system and signal matching analyses or internal gauges will determine pile capacity for all structures or projects unless otherwise shown on the Plans. Notify the Engineer two working days prior to placement of piles within the template and at least one working day prior to driving piles.

455-5.12.2 Wave Equation:

1. General: Use Wave Equation Analysis for Piles (WEAP) programs to evaluate the suitability of the proposed driving system (including the hammer, follower, capblock and pile cushions) as well as to estimate the driving resistance, in blows per 12 inches or blows per inch, to achieve the pile bearing requirements and to evaluate pile driving stresses.

Use Wave Equation Analyses to show the hammer meets the requirements described in 455-5.3.

2. Required Equipment For Driving: Hammer acceptance is solely based on satisfactory field trial including dynamic load test results and Wave Equation Analysis. Supply a hammer system that meets the requirements described in the specifications based on satisfactory field performance.

In the event piles require different hammer sizes, the Contractor may elect to drive with more than one size hammer or with a variable energy hammer, provided the hammer is properly sized and cushioned, will not damage the pile, and will develop the required resistance.

3. Maximum Allowed Pile Stresses:

a. General: The maximum allowed driving stresses for concrete, steel, and timber piles are given below. In the event dynamic load tests show that the hammer will overstress the pile, modify the driving system or method of operation as required to prevent overstressing the pile. In such cases provide additional cushioning, reduce the stroke, or make other appropriate agreed upon changes.

b. Prestressed Concrete Piles: Use the following equations to determine the maximum allowed pile stresses:

$$s_{apc} = 0.7\ f'_c - 0.75\ f_{cpe} \qquad (1)$$

$$s_{apt} = 6.5\ (f'_c)^{0.5} + 1.05\ f_{cpe} \qquad \text{(2a) for piles less than 50 feet long}$$

$$s_{apt} = 3.25\ (f'_c)^{0.5} + 1.05\ f_{cpe} \qquad \text{(2b) for piles 50 feet long and greater}$$

$$s_{apt} = 500 \qquad \text{(2c) within 20 feet of a mechanical splice}$$

where:

s_{apc}= maximum allowed pile compressive stress, psi

s_{apt}= maximum allowed pile tensile stress, psi

f'_c= specified minimum compressive strength of concrete, psi

f_{cpe}= effective prestress (after all losses) at the time of driving, psi, taken as 0.8 times the initial prestress force divided by the minimum net concrete cross sectional area of the pile (f_{cpe}= 0 for dowel spliced piles).

c. Steel Piles: Ensure the maximum pile compression and tensile stresses measured during driving are no greater than 0.9 times the yield strength (0.9 f_y) of the steel.

d. Timber Piles: Ensure the maximum pile compression and tensile stresses measured during driving are no greater than 3.6 ksi for Southern Pine and Pacific Coast Douglas Fir and 0.9 of the ultimate parallel to the grain strength for piles of other wood.

455-5.12.3 Temporary Piles: Submit for the Engineers review, an analysis signed and sealed by the GFDEOR which establishes the pile lengths for temporary piles. Submit for the Engineer's acceptance, a Wave Equation analysis signed and sealed by the GFDEOR which establishes the driving criteria for temporary piles at least five working days prior to driving temporary production piles. The required driving resistance is equal to the sum of the factored design load plus the scour and down drag resistances shown in the Plans, divided by the appropriate resistance factor or the nominal bearing resistance shown in the Plans, whichever is higher:

The maximum resistance factor is 0.45 when only wave equation analysis is performed. However, a larger resistance factor may be applicable when additional testing is provided by the GFDEOR in accordance with Section 3.5.6 of Volume 1 of the FDOT Structures Manual.

455-5.12.4 Dynamic Load Tests: Dynamic load testing consists of estimating pile capacity by the analysis of electronic data collected from blows of the hammer during driving of an instrumented pile in accordance with 455-5.14.

455-5.12.5 Static Load Tests: Static load testing consists of applying a static load to the pile to determine its capacity. Use the Modified Quick Test Procedure in accordance with 455-2.2.1.

455-5.12.6 Fender Pile Installation: For piles used in fender systems, regardless of type or size of pile, either drive them full length or jet the piles to within 2 feet of cutoff and drive to cutoff elevation to seat the pile. The Engineer will not require a specific driving resistance unless noted in the Plans. Use methods and equipment for installation that do not damage the piles. If the method or equipment used causes damage to the pile, modify the methods or equipment.

455-5.12.7 Structures Without Test Piles: For structures without 100% dynamic testing or test piles, dynamically test the first pile(s) in each bent or pier at locations shown in the Plans to determine the blow count criteria for the remaining piles. Dynamically test at least 5% of the piles at each bent or pier (rounded up to the next whole number).

455-5.13 Test Piles:

455-5.13.1 General: All test piles will have dynamic load tests. Drive piles of the same cross-section and type as the permanent piles shown in the Plans, in order to determine any or all of the following:

1. installation criteria for the piles.

2. nature of the soil.
3. lengths of permanent piles required for the work.
4. driving resistance characteristics of the various soil strata.
5. amount of work necessary to obtain minimum required pile penetration.
6. the ability of the driving system to do the work.
7. the need for point protection.

Because test piles are exploratory in nature, drive them harder (within the limits of practical refusal), deeper, and to a greater bearing resistance than required for the permanent piling. Except for test piles which are to be statically or Statnamically load tested, drive test piles their full length or to practical refusal. Splice test piles which have been driven their full length and have developed only minimal required bearing, and proceed with further driving.

As a minimum, unless otherwise accepted by the Engineer, do not cease driving of test piles until obtaining the required bearing capacity continuously, where the blow count is increasing, for 10 feet unless reaching practical refusal first. For test piles which are to be statically or Statnamically load tested, ignore this minimum and drive these piles as anticipated for the production piles.

When test piles attain practical refusal prior to attaining minimum penetration, perform all work necessary to attain minimum penetration and the required bearing. Where practical, use water jets to break the pile loose for further driving. Where jetting is impractical, extract the pile and install a preformed pile hole through which driving will continue. Install instruments on all test piles.

455-5.13.2 Location of Test Piles: Drive all test piles in the position of permanent piles at the designated locations. Ensure that all test piles designated to be statically load tested are plumb. In the event that all the piles are battered at a static load test site, an out-of-position location for driving a plumb pile for the static load test may be selected.

455-5.13.3 Equipment for Driving: Use the same hammer and equipment for driving test piles as for driving the permanent piles. Also use the same equipment to redrive piles.

455-5.14 Dynamic Load Tests: Take dynamic measurements during the driving of piles designated in the Plans. Provide all personnel, materials and equipment for dynamic testing. For concrete piles, install instruments prior to driving and monitor all blows delivered to the pile. For steel production piles, the Engineer may accept instrumented set checks or redrives. Perform dynamic load tests to evaluate the following:

1. Suitability of the driving equipment, including hammer, capblock, pile cushion, and any proposed follower.
2. Pile capacity.
3. Pile stresses.
4. Energy transfer to pile.
5. Distribution of soil resistance.
6. Soil variables including quake and damping.
7. Hammer-pile-soil system for Wave Equation analyses.
8. Pile installation problems.
9. Verify the bearing stratum is of sufficient thickness to prevent punching shear failure.

Either install internal gauges in the piles in accordance with Standard Plans, Index 455-003, or attach instruments (strain transducers to measure force and accelerometers to measure acceleration) with bolts to the pile for dynamic testing.

Monitor the stresses in the piles with the dynamic test equipment during driving to ensure the maximum allowed stresses are not exceeded. If necessary, add additional cushioning, replace the cushions, or reduce the hammer stroke to maintain stresses below the maximum allowable. If dynamic test equipment measurements indicate non-axial driving, immediately realign the driving system. If the cushion is compressed to the point that a change in alignment of the hammer will not correct the problem, add cushioning or change the cushion.

Drive the pile to the required penetration and resistance.

Do not use a cold diesel hammer for a set-check. Generally, warm up the hammer by driving another pile or applying at least 20 blows to a previously driven pile or to timber mats placed on the ground.

455-5.15 Pile Lengths:

455-5.15.1 Test Pile Length: Provide the length of test piles shown in the Plans or as directed by the GFDEOR.

455-5.15.2 Production Pile Length

The production pile lengths shall be the lengths determined by the DTE and the GFDEOR based on all information available before the driving of the permanent piles, including, but not limited to, information gained from the driving of test piles, dynamic load testing, static load testing, supplemental soil testing, etc. When authorized by the City of Doral, soil freeze information obtained during set checks and pile redrives may be used to determine authorized pile lengths for sites with extreme soil conditions.

After completion of the test pile program, production pile lengths and driving criteria shall be established in a letter signed and sealed jointly by the DTE and the GFDEOR. The letter will contain an itemized list of authorized pile lengths as well as the blow count criteria for acceptance of the pile, minimum penetrations, maximum strokes, criteria to replace cushions and any other conditions and limitations deemed appropriate for the safe installation of the piles. Use these lengths for furnishing the permanent piling for the structure. At least two working days, excluding weekends and City of Doral observed holidays, prior to beginning of production pile driving, submit the letter and load test reports to the Engineer including the following electronic files (Windows compatible): dynamic testing date data, signal matching data and results, and Wave Equation data and results.

If there are no test piles, provide the Production Pile Order Lengths in the Pile Data Table on the Structure Plans.

455-5.16 Allowable Driving Tolerances:

455-5.16.1 General: Meet the tolerances described in this Subarticle for the piles that are free standing without lateral restraint (after the template is removed). After the piles are driven, do not move the piles laterally to force them to be within the specified tolerances, except to move battered piles laterally to overcome the dead load deflections caused by the pile's weight. When this is necessary, submit calculations signed and sealed by a Specialty Engineer to the Engineer that verify the amount of dead load deflection prior to moving any piles.

455-5.16.2 Position: Ensure that the final position of the pile head at cut-off elevation is no more than 3 inches, or 1/6 of the diameter of the pile, whichever is less, laterally in the X or Y coordinate from the Plan position indicated in the Plans.

455-5.16.3 Axial Alignment: Ensure that the axial alignment of the driven piles does not deviate by more than 1/4 inches per foot from the vertical or batter line indicated in the Plans.

455-5.16.4 Elevation: Ensure that the final elevation of the pile head is no more than 1-1/2 inches above, or more than 4 inches below, the elevation shown in the Plans, however in no case shall the pile be embedded less than 8 inches into the cap or footing.

For fender piles, cut off piles at the elevation shown in the Plans to a tolerance of plus 0.0 inches to minus 2.0 inches using sawing or other means as accepted by the Engineer to provide a smooth level cut.

455-5.16.5 Deviation from Above Tolerances: Have the Contractor's Engineer of Record perform an evaluation of the as built foundation to determine whether a foundation redesign or an increase in the loading requirements of the piles is needed. Include the signed and sealed evaluation as part of the certification package submitted in accordance with 455-5.19. If the evaluation indicates the foundation or the pile load requirements must be modified, propose a redesign to incorporate out of tolerance piles into pile caps or footings, at no expense to the City of Doral. Submit signed and sealed redesign drawings and computations to the Engineer for review and acceptance. Do not begin any proposed construction until the redesign has been reviewed and accepted by the Engineer, excepted as noted in 455-5.20.

455-5.17 Disposition of Pile Cut-offs, Test Piles, and Load Test Materials:

455-5.17.1 Pile Cut-offs:

Take ownership of any unused cut-off lengths remaining, and remove them from the right-of-way. Provide areas for their disposal.

455-5.17.2 Test Piles: Cut off, or build-up as necessary, test piles, and leave them in place as permanent piles. Extract and replace test piles driven in permanent position and found not suitable for use. Pull, or cut off at an elevation 2 feet below the ground surface or bottom of proposed excavation, test piles driven out of permanent position, and dispose of the removed portion of the test pile.

When test piles are required to be driven in permanent pile positions, the Contractor may elect to drive the test pile out of position provided that a replacement pile is furnished and driven in the position that was to be occupied by the test pile. Unless otherwise directed in the Plans or by the Engineer, retain ownership of test piles that are pulled or cut off and provide areas for their disposal.

455-5.18 Recording: Inspect and record all the pile installation activities, including but not limited to handling, jetting, predrilling, preforming and driving on the Florida Department of Transportation's Pile Driving Record form. Steel piles and dynamically tested concrete piles in accordance with 455-5.14 will not require inspection during handling. Keep a pile driving log for each pile installed whether it is, or is not, instrumented. Within one working day after completing the installation of a pile, submit the Pile Driving Record to the Engineer.

455-5.19 Foundation Certification Packages: Submit certification packages of pile foundations to the Engineer prior to Pile Verification Testing. A separate Foundation Certification Package must be submitted for each foundation unit. A foundation unit is defined as all the piles within one bent or pier for a specific bridge for each phase of construction. Each Foundation Certification Package shall contain an original certification letter signed and sealed by the GFDEOR certifying the piles have the required axial capacity including compression and uplift, lateral stability, pile integrity, and settlement will not affect the functionality of the structure. The package shall also include all pile driving logs, EDC records, all supplemental

dynamic testing raw data and analyses for the foundation unit, and the signed and sealed evaluation performed to address out of tolerance piles in accordance with 455-5.16.5. The certification shall not be contingent on any future testing or approval by Engineer.

455-5.20 Verification: One working day, excluding weekends and City of Doral observed holidays, after receipt of the Foundation Certification Package, the Engineer will determine whether a pile in that foundation unit will be selected for verification testing. Based on its review of the certification package, the Engineer may or may not choose a pile for verification testing in any or all foundation units. For the pile selected by the Engineer for verification testing, the Engineer will provide the dynamic load test equipment and personnel for the Pile Verification Testing. Provide the driving equipment and pile driving crew for the Pile Verification Testing and provide support as needed to prepare the piles for testing. The Engineer will provide the results of the verification testing and identify additional needs for verification testing within one working day of testing.

If the capacity or integrity of any pile is found to be deficient, the Engineer will reject the entire certification package for the foundation unit, and the Contractor shall:

1. Correct the deficiency;
2. Correct the process that led to the deficiency;
3. Demonstrate to the Engineer that the remainder of the piles in the foundation unit are acceptable, including additional dynamic load tests to verify pile capacity and integrity, and;
4. Recertify the foundation unit.

One working day, excluding weekends and City of Doral observed holidays, after receipt of the recertification, the Engineer shall then determine whether additional verification testing is required in that foundation unit. If the capacity or integrity of a verification pile is found to be deficient, additional cycles of deficiency correction and verification testing shall be completed until no more pile capacity or integrity deficiencies are detected or the design is modified accordingly. Piles shall not be cut-off nor bent/pier caps placed prior to successful completion of the Pile Verification Testing Program for that foundation unit. In case of disagreement of dynamic testing results, the Engineer's results will be final and will be used for acceptance.

On land foundation units or water foundation units when the pile cutoff is at least six feet above mean high water, the Contractor may cut-off piles prior to a complete submittal of the Certification Package or to a successful completion of the Pile Verification Testing Program at its own risk. If any piles in a foundation unit are cut-off prior to the submittal of a certification package or completion of the Pile Verification Testing Program and the Engineer determines that verification testing is required, the Contractor shall perform, at no expense to the City of Doral, any work and labor required to expose any pile selected for verification to allow the installation of the instruments in dry conditions and to provide references and access to the Engineer for such testing. Piles experiencing damage during the verification testing or requiring build-up after the verification shall be repaired by the Contractor at no expense to the City of Doral. No pile bent/cap shall be poured prior to successful completion of the Pile Verification Testing Program for that foundation unit or notification by the Engineer that no verification will be required.

455-6 Timber Piling.

455-6.1 Description: Drive timber piles of the kind and dimensions specified in the Plans at the locations and to the elevations shown in the Plans.

455-6.2 Materials: Meet the timber piling requirements of Section 953. Treat the piles according to the applicable provisions of Section 955. Treat all cuts and drilled holes in accordance with 470-3.

455-6.3 Preparation for Driving:

455-6.3.1 Caps: Protect the heads of timber piles during driving, using a cap of approved type, that will distribute the hammer blow over the entire cross-section of the pile. When necessary, cut the head of the pile square before beginning pile driving.

455-6.3.2 Collars: Provide collars or bands to protect piles against splitting and brooming at no expense to the City of Doral.

455-6.3.3 Shoes: Provide piles shod with metal shoes, of a design satisfactory to the Engineer, at no expense to the City of Doral. Shape pile tips to receive the shoe and install according to the manufacturer's directions.

455-6.4 Storage and Handling: Store and handle piles in the manner necessary to avoid damage to the piling. Take special care to avoid breaking the surface of treated piles. Do not use cant dogs, hooks, or pike poles when handling and storing the piling.

455-6.5 Cutting Off: Saw off the tops of all timber piles at the elevation indicated in the Plans. Saw off piles which support timber caps to the exact plane of the superimposed structure so that they exactly fit. Withdraw and replace broken, split, or misplaced piles.

455-6.6 Build-ups: The Engineer will not permit splices or build-ups for timber piles. Extract piles driven below Plan elevation and drive a longer pile.

455-6.7 Pile Heads:

455-6.7.1 Piles with Timber Caps: On piles wider than the timber caps, dress off the part of the pile head projecting beyond the sides of the cap to a slope of 45 degrees. Coat the cut surface with the required preservative and then place a sheet of copper, with a weight of 10 ounces per square foot or greater, meeting the requirements of ASTM B370. Provide a cover measuring at least 4 inches more in each dimension greater than the diameter of the pile. Bend the cover down over the pile and fasten the edges with large head copper nails or three wraps of No. 12 copper wire.

455-6.7.2 Fender and Bulkhead Piles: Paint the heads of fender piles and of bulkhead piles with preservative and then cover with copper as provided above for piles supporting timber caps.

455-7 Prestressed Concrete Piling.

455-7.1 Description: Provide prestressed concrete piles that are manufactured, cured, and driven in accordance with the Contract Documents. Provide piles full length without splices when transported by barge or the pile length is less than or equal to 120 feet. When piles are transported by truck and the pile length exceeds 120 feet or the maximum length for a 3-point pick-up according to Standard Plans, Index 455-001, and splicing is desired, provide minimal splices. Include the cost of the splices in the cost of the pile.

455-7.2 Manufacture: Fabricate piles in accordance with Section 450. When internal gauges will be used for dynamic load testing, supply and install in square prestressed concrete piles in accordance with Standard Plans, Index 455-003. Ensure the internal gauges are installed by personnel approved by the manufacturer.

455-7.3 Storage and Handling:

455-7.3.1 Time of Driving Piles: Drive prestressed concrete piles at any time after the concrete has been cured in accordance with Section 450, and the concrete compressive strength is equal to or greater than the specified 28 day compressive strength.

455-7.3.2 Storage: Support piles on adequate dunnage both in the prestress yard and at the job site in accordance with the locations shown in the Standard Plans to minimize undue bending stresses or creating a sweep or camber in the pile.

455-7.3.3 Handling: Handle and store piles in the manner necessary to eliminate the danger of fracture by impact or of undue bending stresses in handling or transporting the piles from the forms and into the leads. In general, lift concrete piles by means of a suitable bridge or slings attached to the pile at the locations shown in the Standard Plans. Construct slings used to handle piles of a fabric material or braided wire rope constructed of six or more wire ropes which will not mar the corners or the surface finish of the piles. Do not use chains to handle piles. During transport, support concrete piles at the lifting locations shown in the Standard Plans or fully support them throughout 80% or more of their length. In handling piles for use in salty or brackish water, exercise special care to avoid damaging the surface and corners of the pile. If an alternate transportation support arrangement is desired, submit calculations, signed and sealed by the Specialty Engineer, for acceptance by the Engineer prior to transporting the pile. Calculations must show that the pile can be transported without exceeding the bending moments calculated using the support locations shown in the Plans.

455-7.4 Cracked Piles: The Engineer will reject any pile that becomes cracked in handling to the point that a transverse or longitudinal crack extends through the pile, shows failure of the concrete as indicated by spalling of concrete on the main body of the pile adjacent to the crack, which in the opinion of the Engineer will not withstand driving stresses, or becomes damaged during installation. The Engineer will not reject any pile for the occasional minor surface hairline cracking caused by shrinkage.

Do not drive piling with irreparable damage, which is defined as any cracks that extend through the pile cross-sectional area that are, or will be, below ground or water level at the end of driving. Remove and replace broken piles or piles cracked to the extent described above at no expense to the City of Doral. The Engineer will accept cracks less than 0.005 inches which do not extend through the pile. Using approved methods, cut off and splice or build-up to cut-off elevation piles with cracks greater than 0.005 inches at the pile head or above ground or water level, and piles with cracks above ground or water level which extend through the cross-sectional area of the pile. The Engineer, at his discretion, may require correction of pile damage or pile cracks by cutting down the concrete to the plane of sound concrete below the crack and rebuilding it to cut-off elevation, or the Engineer may reject the pile. Extract and replace rejected piles that cannot be repaired, at no expense to the City of Doral.

Take appropriate steps to prevent the occurrence of cracking, whether due to handling, transporting or driving.

455-7.5 Preparation for Transportation: Cut strands flush with the surface of the concrete using an abrasive cutting blade before transporting the piles from the casting yard.

Cut and patch the metal lifting devices in accordance with 450-9.2.1.

455-7.6 Method of Driving: Unless otherwise directed, drive piles by a hammer or by means of a combination of water jets and hammer when jetting is allowed. When using jets in combination with a hammer, withdraw the jets and drive the pile by the hammer alone to secure final penetration and to rigidly fix the tip end of the pile. Keep jets in place if they are being used to continuously eliminate the soil resistance in the scour zone.

455-7.7 Extensions and Build-ups Used to Increase Production Lengths:

455-7.7.1 General: Where splices, extensions and build-ups for concrete piles are necessary, construct them in accordance with Standard Plans, Index 455-002.

These requirements are not applicable to specially designed piling. Make splices for special pile designs as shown in the Plans.

455-7.7.2 Extensions to be Driven or Those 21 feet or Longer: Construct extensions to be driven or extensions 21 feet or longer in length in accordance with the details shown in the Plans and in a manner including the requirements, sequences, and procedures outlined below:

1. Cast a splice section in accordance with Section 450 with the dowel steel in the correct position and alignment.

2. Drill dowel holes using an approved steel template that will position and align the drill bit during drilling. Drill holes a minimum of 2 inches deeper than the length of the dowel to be inserted.

3. Clean the drilled dowel holes by inserting a high pressure air hose to the bottom of the hole and blowing the hole clean from the bottom upward. Eliminate any oil, dust, water, and other deleterious materials from the holes and the concrete surfaces to be joined.

4. Place forms around joints between the pile sections.

5. Mix the adhesive components in accordance with the manufacturer's directions. Do not mix sand or any other filler material with the epoxy components unless it is prepackaged by the manufacturer for this specific purpose. Use adhesives meeting the requirements of Section 926 for Type B Epoxy Compounds.

6. After ensuring that all concrete surfaces are dry, fill the dowel holes with the adhesive material.

7. Insert the dowels of the spliced section into the adhesive filled holes of the bottom section and position the spliced section so that the axes of the two sections are in concentric alignment and the ends of the abutting sections are spaced 1/2 inches apart. The Contractor may use small steel spacers of the required thickness provided they have 3 inches or more of cover after completing the splice. Fill the space between the abutting sections completely with the adhesive.

8. Secure the spliced sections in alignment until the adhesive is cured in accordance with the manufacturer's directions for the time appropriate with the prevailing ambient temperatures. Do not utilize the crane to secure the pile extension during the adhesive cure time. Utilize alignment braces to maintain the proper pile alignment during the epoxy cure time.

9. After curing is completed, remove alignment braces and forms and clean and dress the spliced area to match the pile dimensions.

When dowel splices need to be driven, perform dynamic instrumentation during the driving of each dowel spliced pile to monitor and control the stresses and to verify the splicing integrity. Replace any damaged pile splices in accordance with 455-3. Provide the Engineer 48 hours advance notification prior to driving spliced piles.

455-7.7.3 Precast Reinforced Non-Drivable Build-ups less than 21 feet: Construct precast reinforced non-drivable build-ups less than 21 feet in accordance with the requirements of this Subarticle, Section 346, and Section 400. Provide the same material for the form surfaces for precast build-ups as was used to form the prestressed piles. Use concrete of the same mix as used in the prestressed pile and dimension the cross-section the same as piling being built up. Install build-ups as specified in 455-7.7.2(2) through 455-7.7.2(9). Apply to the build-ups the same surface treatment or sealant applied to the prestressed piles.

455-7.8 Pre-Planned Splices: Construct splices in accordance with the dowel splice method contained in the Standard Plan Indexes or using proprietary splices which are listed on the Florida Department of Transportaion's Approved Product List (APL). Splice test piles in the same manner as the production piles. Include in the pile installation plan, the chosen method of splicing and the approximate locations of the splice. Generally, place the splice at approximately the midpoint between the estimated pile tip and the ground surface, considering scour if applicable. Stagger the splice location between adjacent piles by a minimum of 10 feet. Obtain the Engineer's approval prior to constructing any pile sections. Construct piles which are to be spliced using the dowel splice with preformed dowel holes in the bottom section and embedded dowels in the upper section.

When dowel splices need to be driven, perform dynamic instrumentation during the driving of each dowel spliced pile to monitor and control the stresses and verify the splicing integrity. Replace any damaged pile splices in accordance with 455-3. Provide the Engineer 48 hours advance notification prior to driving spliced piles.

. Mechanical pile splices must be capable of developing the following capacities in the pile section unless shown otherwise in the Plans and capable of being installed without damage to the pile or splice:

1. Compressive strength = (Pile Cross sectional area) x (28 day concrete strength)
2. Tensile Strength = (Pile Cross sectional area) x 900 psi

Pile Size (inches)	Bending Strength (kip-feet)
18	245
20	325
24	600
30	950

455-7.9 Pile Cut-offs: After the completion of driving, cut piles off which extend above the cut-off elevation with an abrasive saw. Make the cut the depth necessary to cleanly cut through the prestressed strands. Take ownership and dispose of cut-off sections not used elsewhere as allowed by this Section.

455-8 Steel Piling.

455-8.1 Description: Furnish, splice, drive, and cut off structural steel shapes to form bearing piles. Include in this work the preparation of a smooth and square pile top meeting the requirements of ASTM A252 or API 5L prior to driving, installation of structural steel bracing by bolting or welding, construction of splices and the filling of pipe piles with the materials specified in 455-8.9.

455-8.2 Material: For the material in steel piles, pile bracing, scabs, wedges, and splices, meet the requirements of Section 962.

455-8.3 Pile Splices: Order and use the full authorized pile length where practicable. Do not splice to obtain authorized lengths less than 40 feet except when shown in the Plans. Locate all splices in the authorized pile length in portions of the pile expected to be at least 15 feet below the final ground surface after driving. When it is not practicable to provide authorized pile lengths longer than 40 feet in a single length, use no more than one field splice per additional 40 feet of authorized pile length. Shop splices may be used to join single lengths of pile which

are at least 20 feet in length. One shorter segment of pile may be used to achieve the authorized pile length when needed.

Where the pile length authorized is not sufficient to obtain the required bearing value or penetration, order an additional length of pile and splice it to the original length.

Make all splices in accordance with details shown in the Plans and in compliance with the general requirements of AWS D1.1 or American Petroleum Institute Specification 5L (API 5L).

455-8.4 Welding: Make all welded connections to steel piles by electric arc welding, in accordance with details shown in the Plans and in compliance with the general requirements of AWS D1.5. Electroslag welding is not permitted. Welds will be inspected by visual methods.

455-8.5 Pile Heads and Tips: Cut off all piles at the elevation shown in the Plans. If using a cutting torch, make the surface as smooth as practical.

Where foundation material is so dense that the Contractor cannot drive the pile to the required penetration and firmly seat it without danger of crumpling the tip, reinforce the tips with cast steel point protectors. Construct point protectors in one piece of cast steel meeting the requirements of ASTM A27, Grade 65-35 heat treated to provide full bearing for the piles. Attach points by welding according to the recommendations of the manufacturer.

455-8.6 Pile Bent Bracing Members: Place structural steel sway and cross bracing, and all other steel tie bracing, on steel pile bents and bolt or weld in place as indicated in the Plans. Where piles are not driven into position in exact alignment as shown in the Plans, furnish and place fills and shims as required to square and line up faces of flanges for cross bracing.

455-8.7 Coating: Coat exposed parts of steel piling, wedging, bracing, and splices in accordance with the provisions for coating structural steel as specified in Section 560.

455-8.8 Storage and Handling: While handling or transporting the piles from the point of origin and into the leads, store and handle in the manner necessary to avoid damage due to bending stresses. In general, lift steel piles by means of a suitable bridge or a sling attached to the pile at appropriate points to prevent damage. Lift the pile from the horizontal position in a manner that will prevent damage due to bending of the flanges and/or web.

455-8.9 Filling Pipe Piles: Ensure closed-end pipe piles are watertight. When required by the Plans, fill pipe piles with the specified materials. Use clean concrete sands and concrete meeting the requirements of Section 346. Place concrete in open ended pipes containing water using methods in accordance with 455-15.9 with modified tremie and pump line sizes. Concrete may be placed directly into pipes which are dry. Construct and place reinforcement cages in accordance with 455-16, except the minimum number of spacers per level is three. Reinforcement cages may be installed before concrete placement or after concrete placement is completed if proper alignment and position is obtainable.

455-9 Sheet Piling.

455-9.1 Description: Leave permanent piling in place as part of the finished work and remove temporary piling after each construction phase unless otherwise authorized by the Engineer.

455-9.2 Materials: Meet the following requirements:

Concrete	Section 346
Bar Reinforcement	Section 931
Prestressing Reinforcement	Section 933
Steel Sheet Piles*	Section 962

*For temporary steel sheet piles meet the requirements specified in the Plans.

455-9.3 Steel Sheet Piling: Drive steel sheet piling and cut off true to line and grade. Install steel sheet piling with a suitable hammer. Remove and replace any section damaged during handling and installation at no additional expense to the City of Doral.

455-9.3.1 Method of Installation: Where rock or strong material is encountered such that the sheet piles cannot be set to grade by driving, remove the strong material by other acceptable means, such as excavation and backfilling, drilling or by punching.

455-9.4 Concrete Sheet Piling:

455-9.4.1 Description: Ensure that concrete sheet piling is of prestressed concrete construction and manufactured, cured, and installed in accordance with the requirements of the Contract Documents

455-9.4.2 Manufacture of Piles: Ensure that the piles are fabricated in accordance with Section 450.

455-9.4.3 Method of Installation: Jet concrete sheet piling to grade where practical. Use a minimum of two jets. Provide water at the nozzles of sufficient volume and pressure to freely erode material adjacent to the piles. Where encountering rock or strong material, such that the sheet piles cannot be set to grade by jetting, remove the strong materials by other acceptable means, such as excavation and backfilling, drilling or by punching with a suitable punch.

455-9.4.4 Grouting and Caulking: Concrete sheet piles are generally detailed to have tongues and grooves on their lower ends, and double grooves on their upper ends. Where so detailed, after installation, clean the grooves of all sand, mud, or debris, and fully grout the grooves. Use approved plastic bags (sheaths) which will meet the shape and length of the groove to be grouted to contain the plastic grout within the double grooves. Provide grout composed of one part cement and two parts sand. Use clean A-3 sand or sand meeting the requirements of Section 902 in this grout. In lieu of sand-cement grout, the Contractor may use concrete meeting the requirements of Section 347, using small gravel or crushed stone coarse aggregate. Deposit the grout through a grout pipe placed within a watertight plastic sheath (bag) extending the full depth of the double grooves and which, when filled, completely fills the slot formed by the double grooves.

455-9.5 Storage and Handling: Handle and store all sheet piles in a manner to prevent damage. Handle long sheet piles with fabric slings or braided wire rope constructed of six or more wire ropes placed at appropriate lift points to prevent damage due to excessive bending.

455-10 Pile Installation Plan (PIP).

455-10.1 General: At the preconstruction conference or at least 15 days prior to driving the first pile, submit a Pile Installation Plan for review by the Engineer. The PIP shall be used to govern all pile installation activities. In the event that deviations from the PIP are observed, the Engineer may perform Independent Verification Testing/Review of the Contractor's equipment, procedures, personnel and PIP at any time during production pile driving. If, as determined by the Engineer, pile driving equipment, procedures and/or personnel for the PIP is deemed inadequate to consistently provide undamaged driven piling meeting the contract requirements, the Contractor's PIP acceptance may be withdrawn pending corrective actions. Production driving shall then cease and not restart until corrective actions have been taken and the PIP re-accepted.

Ensure the Pile Driving Installation Plan information includes the following:

1. List and size of proposed equipment including cranes, barges, driving equipment, jetting equipment, compressors, and preformed pile hole equipment on the Florida

Department of Transportation's Pile Driving Installation Plan Form (Form No. 700-020-01). Include manufacturer's data sheets on hammers.

2. Methods to determine hammer energy in the field for determination of pile capacity. Include in the submittal necessary charts and recent calibrations for any pressure measuring equipment.

3. Detailed drawings of any proposed followers.

4. Detailed drawings of templates.

5. Details of proposed load test equipment and procedures, including recent calibrations of jacks and required load cells.

6. Sequence of driving of piles for each different configuration of pile layout.

7. Details of proposed features and procedures for protection of existing structures.

8. Required shop drawings for piles, cofferdams, etc.

9. Methods and equipment proposed to prevent displacement of piles during placement and compaction of fill within 15 feet of the piles.

10. Methods to prevent deflection of battered piles due to their own weight and to maintain their as-driven position until casting of the pile cap is complete.

11. Proposed pile splice locations and details of any proprietary splices anticipated to be used.

12. Methods and equipment proposed to prevent damage to voided or cylinder piles due to interior water pressure.

13. Name and experience record of pile driving superintendent or foreman in responsible charge of pile driving operations. Ensure the pile driving superintendent or foreman in responsible charge of the pile driving operations has the experience requirements of 105-8.13 installing driven piles of the size and depth shown in the Plans.

14. The names of the CTQP qualified inspectors assigned to inspect the pile installation.

15. The quality control processes to ensure the required capacity is achieved in all piles. Include in the PIP the steps and analyses that would be performed when driving conditions change (such as unanticipated tip elevations, hammer modifications, presence of temporary piles and structures, preforming, changes, etc.).

16. The name and contact information for the single representative of the Contractor, independent of field operations personnel, to resolve to the Engineer's satisfaction conflicts in the driving procedures or interpretations of the driving criteria. This person shall be available within two hours notice, and shall have the authority to refer issues to higher levels (corporate, if needed).

17. A letter from the GFDEOR certifying concurrence with the PIP.

Notify the Engineer of any test pile driving and production pile driving at least 1 week prior to beginning the installation operations of any pile.

455-10.2 Acceptance of the Pile Installation Plan: The Engineer will evaluate the PIP for conformance with the Contract Documents. Within five working days, excluding weekends and City of Doral observed holidays, after receipt of the plan, the Engineer will notify the Contractor of any comments and additional information required and/or changes that may be necessary to satisfy the Contract Documents. Submit changes and respond to the Engineer's

comments and allow at least two working days, excluding weekends and City of Doral observed holidays, for the Engineer to review the revised PIP.

All equipment and procedures are subject to satisfactory field performance. Make required changes to correct unsatisfactory field performance. The Engineer will give final acceptance after the Contractor makes necessary modifications. Do not make any changes in the driving system after acceptance without a revised PIP with concurrence of the GFDEOR and acceptance by the Engineer. A hammer repaired on site or removed from the site and returned is considered to have its performance altered (efficiency increased or decreased), which is considered a change in the driving system. Perform a dynamic load test in accordance with 455-5.14 on the first pile driven with this hammer to confirm the driving criteria is still appropriate at no additional compensation.

Acceptance of the PIP by the Engineer does not relieve the Contractor of the responsibility to perform the work in accordance with the Contract Documents. The Engineer's acceptance is not a guarantee that the chosen methods and equipment are capable of obtaining the required results; this responsibility lies with the Contractor.

455-11 Method of Measurement (All Piling).

455-11.1 General: The quantity to be paid for will be the length, in feet, furnished, placed, and accepted according to the authorized lengths list, including any additions and excluding any deletions thereto, as approved by the Engineer.

No adjustments in the length, in feet, of piling will be made if cut-offs are required after the pile has been driven to satisfactory bearing.

455-11.2 Prestressed Concrete Piling:

455-11.2.1 Length: The furnished length of precast concrete piles will be considered as the overall length from head to tip. Final pay length will be based on the casting length as authorized in accordance with 455-5.15.2 subject to provisions of 455-11.2.2 through 455-11.2.4, 455-11.8, 455-11.9 and 455-11.12.

455-11.2.2 Driving of Unplanned Epoxy-Bonded Dowel Splice: If a pile is driven below cut-off and satisfactory bearing is not obtained, and additional driving is required after construction of a satisfactory splice, an additional 10 feet of piling will be paid for the additional driving. This compensation for driving of splice, however, will not be allowed for test piles that are spliced and redriven.

455-11.2.3 Extracting Piles: In the event that a pile is driven below cut-off without obtaining the required bearing, and the Engineer elects to have the pile extracted and a longer pile substituted, the pile extraction will be paid for as Unforeseeable Work. In the event a pile is damaged or mislocated, and the damage or mislocation is determined to be the City of Doral's responsibility, and the Engineer elects to have the pile extracted, the pile extraction be paid for as Unforeseeable Work. If a replacement pile is required, compensation will be made under the item for piling, for both the original pile and replacement pile. Redriving of an extracted and undamaged pile will be paid for at 30% of the Contract unit price for piling.

The Contractor may substitute a longer pile in lieu of splicing and building-up a pile. In this event, the Contractor will be paid for the original authorized length of the pile, plus any additional length furnished by the Contractor up to the authorized length of the build-up, as piling. The Contractor will be paid 30 feet of piling as full compensation for extracting the original pile.

455-11.2.4 Underwater Driving: When the Contractor selects one of the optional underwater driving methods, payment will be made by selecting the applicable method from the following:

1. Using a pile longer than the authorized length: Measurement for piling will be made only for the authorized length at that location unless the length of pile from cut-off elevation to the final tip elevation is greater than the authorized length, in which case payment for piling will be made from cut-off elevation to final tip elevation. No payment will be made for pile splice, when this option is selected, unless the pile is physically spliced and the splice is driven below cut-off elevation to achieve bearing.

2. Using an underwater hammer or a pile follower: Measurement will be in accordance with 455-11.2.1.

455-11.3 Steel Piling Point Protectors:
The quantity to be paid for will be each for the total of point protectors authorized, furnished, and properly installed.

455-11.4 Test Piles: The quantity to be paid for of test piles of various types, will be the length, in feet, of test piling furnished, driven and accepted, according to the authorized length list, and any extensions thereof as approved by the Engineer.

Test piles left in place as permanent piles, will be paid for only as test piling. Any extensions necessary to continue driving the pile for test purposes, as authorized by the Engineer, will be paid for as test piling. Other extensions of piles, additional length paid for splicing and build-ups will be included in the quantities of regular piling and will not be paid for as test piling.

455-11.5 Dynamic Load Tests: Payment will be based on the number of dynamic load tests shown in the Plans, authorized by the Engineer, or required in 455-5.12.7, completed and accepted in accordance with the Contract Documents. No separate payment will be made for dynamic load tests used to evaluate changes in the Contractor's driving equipment. No payment will be made for dynamic load tests used to evaluate the integrity of a pre-planned epoxy-bonded dowel splice. Include all costs associated with dynamically testing production piles with epoxy-bonded dowel splices under Pay Item No. 455-34. No payment will be made for dynamic load tests on test piles.

For structures with 100% dynamic testing, the cost of supplying and installing internal gauges or attaching external gauges to each pile for dynamic load tests is included in the cost of the pile, no separate payment will be made.

For structures without 100% dynamic testing, the cost of supplying and installing internal gauges or attaching external gauges to each production pile for dynamic load testing prior to initial driving, authorized by the Engineer, will be 20 feet of additional pile. No payment will be made for attaching dynamic testing equipment for set-checks or redrives. No payment will be made for dynamic load tests performed when driving with followers.

455-11.6 Steel Sheet Piling: The quantity to be paid for will be the plan quantity area, in square feet, measured from top of pile elevation to the bottom of pile elevation and beginning and end wall limits as shown in the Plans with no allowance for variable depth surface profiles. Approved alternate support structures would be paid for as plan quantity computed for sheet pile. Sheet piling used in cofferdams and to incorporate the Contractor's specific means and methods, and not ordered by the Engineer, will be paid for as required in Section 125.

455-11.7 Concrete Sheet Piling: The quantity to be paid for will be the product of the number of such piles satisfactorily completed, in place, times their lengths in feet as shown in the Plans or authorized by the Engineer. This quantity will be based upon piles 2-1/2 feet wide.

When the Engineer approves, the Contractor may furnish the concrete sheet piling in widths wider than shown in the Plans; then the number of piles shall be the actual number of units completed times the width used divided by the width in the Plans.

455-11.8 Pile Splices: The quantity to be paid for authorized drivable splices and build-ups greater than 5 feet in length in concrete piling, and test piling, which are made for the purpose of obtaining authorized pile lengths longer than shown as the maximum length in the Standard Plans Indexes, for obtaining greater lengths than originally authorized by the Engineer, to incorporate test piling in the finished structure, for further driving of test piling, or for splices shown in the Plans, will be 30 feet of additional prestressed concrete piling under Pay Item No. 455-34.

For concrete piles and test piles, where the build-ups is 5 feet or less in length, the quantity to be paid for will be 9 feet of prestressed concrete piling under Pay Item No. 455-34 as compensation for drilling and grouting the dowels and all other costs for which provision has not otherwise been made.

The quantity to be paid for authorized splices in steel piling and test piling for the purpose of obtaining lengths longer than the lengths originally authorized by the Engineer will be 20 feet of additional steel piling under Pay Item No. 455-35.

455-11.9 Set-Checks and Redrives:

455-11.9.1 Set Checks/Test Piles: There will be no separate payment for the initial four set-checks performed the day of and the working day following initial driving. For each additional set-check ordered by the Engineer and performed within the following working day of initial driving, an additional quantity of 10 feet of piling will be paid.

455-11.9.2 Set Checks/Production Piles: There will be no separate payment for the initial two set-checks performed the day of and the working day following initial driving. For each additional set-check ordered by the Engineer and performed within the following working day of initial driving, an additional quantity of 10 feet of piling will be paid.

455-11.9.3 Redrives: The quantity to be paid for will be the number of redrives, each, authorized by the Engineer. Payment for any pile redrive (test pile or production pile) ordered by the Engineer will consist of 20 feet of additional piling.

455-11.10 Pile Extraction: Piles authorized to be extracted by the Engineer and successfully extracted as provided in 455-11.2.3 will be paid for as described in 455-11.2.3. No payment for extraction will be made for piles shown in the Plans to be extracted or piling damaged or mislocated by the Contractor that are ordered to be extracted by the Engineer.

455-11.11 Static Load Tests: The quantity to be paid for will be the number of static load tests of the designated tonnages, each, as shown in the Plans or authorized by the Engineer, actually applied to piles, completed and accepted in accordance with the Plans and these Specifications.

455-11.12 Preformed Pile Holes: The quantity added to the payment for piling will be 30% of the length of completed preformed pile holes from existing ground or the bottom of any required excavation, whichever is lower, to the bottom of preformed hole acceptably provided, complete for the installation of the bearing piles, regardless of the type of pile (test pile or production pile) installed therein. Only those holes authorized to be paid for, as provided in 455-5.10.3, will be included in the measurement for payment. The Engineer will authorize

payment for preformed pile holes only when the pile has been placed in proper position and has achieved the required penetration.

455-12 Basis of Payment (All Piling).

455-12.1 Treated Timber Piling: Price and payment will be full compensation for all labor, equipment and materials required for furnishing and installing all materials, including collars, metal shoes, copper cover sheets, preservatives and tar, and for wrapping pile clusters with wire cable, where so shown in the Plans.

455-12.2 Prestressed Concrete Piling: Price and payment will be full compensation for all labor, equipment and materials required for furnishing and installing all reinforcing steel, predrilled holes, furnishing the material for and wrapping pile clusters with wire cable where so shown in the Plans and grouting of preformed pile holes when shown in the Plans.

455-12.3 Steel Piling: Price and payment will be full compensation for all labor, equipment, and materials required for furnishing and installing steel piling, including welding and painting as specified and the cost of predrilling pile holes described in 455-5.1. The cost of any concrete fill and reinforcing steel in pipe piles will be included in the price for steel piling.

Bracing and other metal parts attached to or forming a part of piling or bracing and not otherwise classified, will be measured and paid for as provided in Section 460.

455-12.4 Test Piles: Price and payment will be full compensation for all incidentals necessary to complete all the work of this item except splices, build-ups, pile extractions and preformed pile holes authorized by the Engineer and paid for under other pay items or payment methods. The cost of all additional work not listed above necessary to ensure required penetration and attain required bearing of the test piles will be included in the price bid per foot of test pile, including driving and all other related costs.

455-12.5 Dynamic Load Tests:

455-12.5.1 Dynamic Load Tests/ Test Piles: All test piles will require dynamic load tests. Include all costs associated with assisting the Engineer in performing the dynamic load tests in the pay items for test piles.

455-12.5.2 Dynamic Load Tests/ Production Piles: Payment will be full compensation for all costs associated with assisting the Engineer in performing the dynamic load tests.

455-12.6 Steel Sheet Piling:

455-12.6.1 Permanent Sheet Piling: Price and payment will be full compensation for all labor, equipment, and materials required for furnishing and installing steel sheet piling including preformed holes and coating, but will not include furnishing and placing anchors when an anchored wall system is designed and detailed in the Plans. In such cases, furnishing and installing anchors will be paid separately.

455-12.6.2 Temporary Sheet Piling: For critical temporary steel sheet pile walls, walls which are necessary to maintain the safety of the traveling public or structural integrity of nearby structures, roadways and utilities during construction, that are detailed in the Plans, price and payment will be full compensation for all labor, equipment, and materials required for furnishing and installing steel sheet piling including preformed holes when shown in the Plans, and including wales, anchor bars, dead men, soil anchors, proof tests, creep tests, and other incidental items when an anchored wall system is required. Removal of the sheet piling, anchors, and incidentals will be included in the cost per square foot for steel sheet piling (critical temporary). When the temporary steel sheet pile walls are not detailed in the Plans, the cost of furnishing and installation shall be incidental to cost of other related items and no separate

payment shall be made. If the wall is not shown in the Plans, but deemed to be critical as determined by the Engineer, then a design shall be furnished by the City of Doral and paid for separately under steel sheet piling (critical temporary).

455-12.7 Concrete Sheet Piling: Price and payment will be full compensation for all labor, equipment, and materials required for furnishing and installing concrete sheet piling including reinforcing steel, grouting, plastic filter fabric, preformed holes and installation.

455-12.8 Preformed Pile Holes: Payment will be full compensation for all labor, equipment, casings and materials required to perform this work.

455-12.9 Point Protectors: Price and payment will be full compensation for all labor, equipment, and materials required for furnishing and installing point protectors.

455-12.10 Static Load Tests: Price and payment will be full compensation for all labor, equipment, materials, and incidentals required to perform this work, including instrumentation, data collection and professional services to prepare the report.

455-12.11 Pile Cut-Off: Anticipate all piles will require cutting-off, and include all costs associated with pile cut-off in the pay items for piling.

455-12.12 Payment Items: Payment will be made under:

Item No. 455- 2-	Treated Timber Piling - per foot.
Item No. 455- 14-	Concrete Sheet Piling - per foot.
Item No. 455- 34-	Prestressed Concrete Piling - per foot.
Item No. 455- 35-	Steel Piling - per foot.
Item No. 455- 36-	Concrete Cylinder Piling - per foot.
Item No. 455-119-	Test Loads - each.
Item No. 455-120-	Point Protection - each.
Item No. 455-133-	Sheet Piling - per square foot.
Item No. 455-143-	Test Piles (Prestressed Concrete) - per foot.
Item No. 455-144-	Test Piles (Steel) - per foot.
Item No. 455-145-	Test Piles (Concrete Cylinder) - per foot.

C. DRILLED SHAFTS

455-13 Description.

Construct drilled shaft foundations consisting of reinforced concrete drilled shafts.

455-14 Materials.

455-14.1 Concrete: Use concrete meeting the requirements of Section 346, unless otherwise shown in the Plans.

455-14.2 Reinforcing Steel: Meet the reinforcing steel requirements of Section 415.

455-15 Construction Methods and Equipment.

455-15.1 General Requirements:

455-15.1.1 Templates: When drilling from a barge, provide a fixed template, adequate to maintain shaft position and alignment during all excavation and concreting operations. Do not use floating templates (attached to a barge). When the Contractor fails to properly maintain shaft position and alignment without use of a template when drilling on land, provide a fixed template, adequate to maintain shaft position and alignment during all excavation and concreting operations.

455-15.1.2 Drilled Shaft Installation Plan (DSIP): At the preconstruction conference or at least 15 days prior to constructing the first drilled shaft, submit a Drilled Shaft Installation Plan (DSIP) for review and acceptance by the Engineer. The DSIP will be used to govern all drilled shaft construction activities. In the event that deviations from the DSIP are observed, the Engineer may perform Independent Verification Testing/Review of the Contractor's equipment, procedures and personnel at any time during production drilled shaft construction. If, as determined by the Engineer, drilled shaft construction equipment, procedures or personnel is deemed inadequate to consistently provide drilled shafts meeting the contract requirements, the Contractor's DSIP may be withdrawn pending corrective actions. All drilled shaft construction activities shall then cease and not restart until corrective actions have been taken and the DSIP has been re-accepted.

Include in the DSIP the following details:

1. Name and experience record of drilled shaft superintendent or foreman in responsible charge of drilled shaft operations. Ensure the drilled shaft superintendent or foreman in responsible charge of the drilled shaft operations has the experience requirements of 105-8.13 installing drilled shafts of the size and depth shown in the Plans using the following methods:

    a. Wet Method (mineral and polymer slurry),
    b. Casings up to the length shown in the Plans,
    c. Shaft drilling operations on water under conditions as shown in the Plans.

2. List and size of proposed equipment, including, but not limited to, cranes, drills, augers, bailing buckets, final cleaning equipment, desanding equipment, slurry pumps, core sampling equipment, tremies or concrete pumps, and casings and equipment to install and remove casing.

3. Details of sequence of construction operations and sequence of shaft construction in bents or shaft groups.

4. Details of shaft excavation methods, including casing installation procedures.

5. Details of slurry, including proposed methods to mix, circulate, desand, test methods, and proposed CTQP certified technicians that will perform and document the fluid tests.

6. Details of proposed methods to clean the shaft excavation.

7. Details of shaft reinforcement, including methods to ensure centering/required cover, cage integrity during placement, placement procedures, cage support, and tie downs.

8. Details of concrete placement, including elapsed concrete placement times and proposed operational procedures for concrete tremie or pump, including initial placement, raising during placement, and overfilling of the shaft concrete. Include provisions to ensure proper final shaft cutoff elevation.

9. Details of casing removal when removal is required, including minimum concrete head in casing during removal.

10. Required submittals, including shop drawing and concrete design mixes.

11. Details of any required load tests, including equipment and procedures, and recent calibrations for any jacks or load cells.

12. Proposed Cross-Hole Sonic Logging (CSL) and Thermal Integrity Testing for Drilled (TITDS) Specialty Engineer to supervise field testing and report the test results.

13. Methods and equipment proposed to prevent displacement of casing and/or shafts during placement and compaction of fill.

14. Provide the make and model of the shaft inspection device, if applicable, and procedures for visual inspection.

15. Details of environmental control procedures used to prevent loss of slurry or concrete into waterways or other protected areas.

16. Proposed schedule for test shaft installation, load tests and production shaft installation.

17. For drilled shafts for constructed using polymer slurry, identify the polymer slurry meeting the requirements of 455-15.8.3, the pH and viscosity ranges recommended by the manufacturer for the materials to be excavated and a description of the mixing method to be used. Submit the Material Safety Data Sheets (SDS) for the product, and a current certification that the polymer slurry and components meet the requirements of 455-15.8.3. The certification shall be attested to within the past one year by a person having legal authority to bind the manufacturing company. Submit the contact information for the manufacturer's representative available for immediate contact during shaft construction and the representative's schedule of availability.

18. Methods to identify and remediate drilled shaft deficiencies.

19. Names of the CTQP qualified inspectors assigned to inspect the drilled shaft installation.

20. The name and contact information for the single representative of the Contractor, independent of field operations personnel, to resolve to the Engineer's satisfaction, conflicts in the drilled shaft installation procedures. This person shall be available within two hours notice, and shall have the authority to refer issues to higher levels (corporate, if needed).

21. Procedure for grouting non-destructive testing access tubes.

22. A letter from the GFDEOR certifying concurrence with the DSIP.

455-15.1.2.1 Acceptance of the Drilled Shaft Installation Plan (DSIP).

The Engineer will evaluate the DSIP for conformance with the Contract Documents. Within five working days, excluding weekends and City of Doral observed holidays, after receipt of the plan, the Engineer will notify the Contractor of any comments and additional information required and/or changes that may be necessary in the opinion of the Engineer to satisfy the Contract Documents. The Engineer will reject any part of the plan that is unacceptable. Submit changes agreed upon for reevaluation. The Engineer will notify the Contractor within two working days, excluding weekends and City of Doral observed holidays, after receipt of proposed changes of their acceptance or rejection. All equipment and procedures are subject to trial and satisfactory performance in the field.

Acceptance by the Engineer does not relieve the Contractor of the responsibility to perform the work in accordance with the Contract Documents. The Engineer's acceptance is not a guarantee that the chosen methods and equipment are capable of obtaining the required results, this responsibility lies with the Contractor.

455-15.1.3 General Methods & Equipment: Perform the excavations required for the shafts, through whatever materials encountered, to the dimensions and elevations shown in the Contract Documents, using methods and equipment suitable for the intended purpose and the materials encountered. Provide drilling tools with a diameter not smaller than one inch of the shaft diameter required in the Plans. Provide equipment capable of constructing shafts supporting bridges to a depth equal to the deepest shaft shown in the Plans plus 15 foot or plus three times the shaft diameter, whichever is greater, except when the Plans require equipment capable of constructing shafts to a deeper depth. Provide equipment capable of constructing shafts supporting sign, signal, lighting and ITS structures to a depth equal to the deepest shaft shown in the Plans plus 5 feet.

Construct drilled shafts according to the Contract Documents using generally either the dry method, wet method, casing method, or permanent casing method as necessary to produce sound, durable concrete foundation shafts free of defects. Use the permanent casing method only when required by the Plans. When the Plans describe a particular method of construction, use this method. When the Plans do not describe a particular method, propose a method on the basis of its suitability to the site conditions and submit it for acceptance by the Engineer.

Set a suitable temporary removable surface casing from at least 1 foot above the ground surface to at least 1-1/2 shaft diameters below the ground surface to prevent caving of the surface soils and to aid in maintaining shaft position and alignment. Do not use a temporary casing larger than 12 inches of the shaft diameter. Fill the oversized temporary casing with drilled shaft concrete at no additional expense to the City of Doral. Withdraw the surface casing after concrete placement.

For drilled shafts installed to support sign, signal, lighting and ITS structures, provide temporary surface casings from at least 1 foot above the ground surface to at least 5 feet below the ground surface. For sign, signal, lighting and ITS structures foundations located within permanent sidewalks or within 5 feet of curb sections, provide temporary surface casings from no lower than the top of sidewalk to at least 5 feet below the ground surface.

For drilled shafts installed to support sign, signal, lighting and ITS structures, do not attempt to excavate the shaft using plain water or natural slurry. Do not attempt to excavate the shaft using dry construction method unless specifically indicated in the Plans or approved by the Engineer.

455-15.2 Dry Construction Method: Use the dry construction method only at sites where the ground water table and soil conditions, generally stiff to hard clays or rock above the water table, make it feasible to construct the shaft in a relatively dry excavation and where the sides and bottom of the shaft are stable and may be visually inspected prior to placing the concrete.

In applying the dry construction method, drill the shaft excavation, remove accumulated seepage water and loose material from the excavation and place the shaft concrete in a relatively dry excavation.

Use the dry construction method only when shaft excavations, as demonstrated in a test hole, have 12 inches or less of seepage water accumulated over a four hour period, the sides and bottom remain stable without detrimental caving, sloughing, or swelling for a four hour period, and the loose material and water can be satisfactorily removed prior to inspection and prior to placing concrete. Use the wet construction method or the temporary casing construction method for shafts that do not meet the requirements for the dry construction method.

455-15.3 Wet Construction Method: Use the wet construction method at all sites where it is impractical to provide a dry excavation for placement of the shaft concrete.

The wet construction method consists of keeping the shaft excavation filled with fluid (mineral slurry, polymer slurry, natural slurry or water), desanding and cleaning the slurry and final cleaning of the excavation by means of a bailing bucket, air lift, submersible pump or other suitable devices and placing the shaft concrete (with a tremie or concrete pump extending to the shaft bottom) which displaces the water or slurry during concreting of the shaft excavation.

Where drilled shafts are located in open water areas, construct the shafts by the wet method using exterior casings extending from above the water elevation into the ground to protect the shaft concrete from water action during placement and curing of the concrete. Install the exterior casing in a manner that will produce a positive seal at the bottom of the casing so that there is no intrusion or extrusion of water or other materials into or from the shaft excavation.

455-15.4 Temporary Casing Construction Method: Use the temporary casing method at all sites where it is inappropriate to use the dry or wet construction methods without the use of temporary casings other than surface casings. In this method, the casing is advanced prior to excavation and withdrawn after concrete placement. When a formation is reached that is nearly impervious, seal in the nearly impervious formation. Proceed with drilling as with the wet method to the projected depth. Proceed with the placement of the concrete as with the dry method. In the event seepage conditions prevent use of the dry method, complete the excavation and concrete placement using wet methods.

Where drilling through materials having a tendency to cave, advance the excavation by drilling in a mineral or polymer slurry. In the event that a caving layer or layers are encountered that cannot be controlled by slurry, install temporary removable casing through such caving layer or layers. The Engineer may require overreaming to the outside diameter of the casing. Take whatever steps are required to prevent caving during shaft excavation including installation of deeper casings. If electing to remove a casing and replace it with a longer casing through caving soils, backfill the excavation. The Contractor may use soil previously excavated or soil from the site to backfill the excavation. The Contractor may use other acceptable methods which will control the size of the excavation and protect the integrity of the foundation soils to excavate through caving layers.

Before withdrawing the casing, ensure that the level of fresh concrete is at such a level that the fluid trapped behind the casing is displaced upward. As the casing is withdrawn, maintain the level of concrete within the casing so that fluid trapped behind the casing is displaced upward out of the shaft excavation without mixing with or displacing the shaft concrete.

The Contractor may use the casing method, when accepted by the Engineer, to construct shafts through weak caving soils that do not contribute significant shaft shear resistance. In this case, place a temporary casing through the weak caving soils before beginning excavation. Conduct excavation using the dry construction method where appropriate for site conditions and the wet construction method where the dry construction method is not appropriate. Withdraw the temporary casing during the concreting operations unless the Engineer accepts otherwise.

455-15.5 Permanent Casing Construction Method: Use the permanent casing method when required by the Plans. In this method, place a casing to the prescribed depth before

beginning excavation. If the Contractor cannot attain full penetration, the Contractor may excavate through the casing and advance the casing until reaching the desired penetration.

Construct the shaft in accordance with 455-15.4 except for cutting the casing off at the prescribed elevation upon reaching the proper construction sequence and leaving the remainder of the casing in place.

455-15.5.1 Temporary Extension of Permanent Casing: When the wet method does not provide enough support to excavate and clean the drilled shaft extension below the permanent casing tip elevations shown in the Plans, the permanent casing may be temporarily extended to an elevation deeper than the tip elevation at no additional expense to the City of Doral. The rock socket length must be extended as specified in 455-15.7 and the casing raised to the original casing tip elevation shown in the Plans after the concrete placement. Include details of this procedure in the DSIP for the Engineer's review and approval.

455-15.5.2 Temporary Casing to Stabilize Excavation below Permanent Casing: To stabilize the excavation below the permanent casing tip elevation, a temporary casing inside an oversized permanent casing may be used at no additional expense to the City of Doral. The permanent casing must have an inside diameter no more than 6 inches larger than the drilled shaft diameter specified in the Plans.

The following requirements apply:

1. Excavate and clean the materials from inside the permanent casing. Ensure all materials are removed from the inside wall of the permanent casing.
2. Install the temporary casing prior to excavating below the permanent casing tip elevation. The temporary casing must have a minimum internal diameter equal to the shaft diameter required in the Plans.
3. If the temporary casing is advanced deeper than the minimum top of rock socket elevation as shown in the Plans, or the top of rock elevation if deeper, extend the rock socket length in accordance with 455-15.7.
4. Place concrete in accordance with 455-15.9.3 through the temporary casing. Do not allow concrete to fall or overflow into the annular space between the temporary and permanent casing.
5. After placement of the concrete, remove the temporary casing in accordance with 455-15.4, 455-15.7 and 455-17. During withdrawal of the temporary casing, maintain adequate concrete head in both the temporary and permanent casings to avoid breaching, caving, or contamination of the concrete.

Include details of this procedure in the DSIP for the Engineer's review and approval.

455-15.6 Excavations: When pilot holes and/or load tests are performed, the GFDEOR shall use the pilot hole and load test results when load tests are performed to determine the production tip elevations and/or the installation criteria of the drilled shafts. Drilled shaft construction shall not begin until the proposed shaft tip elevations are accepted by the Engineer.

455-15.6.1 Pilot Hole: When pilot holes are shown in the Plans core a pilot hole, prior to shaft excavation, in accordance with ASTM D2113 Standard Practice for Rock Core Drilling and Sampling of Rock for Site Excavation and the Florida Department of Transportation's Soils & Foundations Handbook using a double or triple wall core barrel through part or all of the shaft, to a minimum depth of 3 times the diameter of the drilled shaft below the tip elevation shown in the Plans. Prior to excavating load test shafts, provide pilot holes to a minimum depth of three times the diameter of the drilled shaft below the tip elevation designed

for these shafts. For test holes, provide pilot holes prior to excavation, to a minimum depth of 5 feet below the tip of the test hole.

455-15.6.2 Cores: Take cores to determine the character of the material directly below the shaft excavation when pilot borings are not performed at the shaft location. Provide equipment to retrieve the core from a depth of 5 times the diameter of the drilled shaft below the bottom of the drilled shaft excavation in accordance with ASTM D2113 Standard Practice for Rock Core Drilling and Sampling of Rock for Site Excavation. Cut the cores with an acceptable core barrel to a minimum depth of 3 times the diameter of the drilled shaft below the bottom of the drilled shaft excavation after completing the shaft excavation, as directed by the Engineer.

For cores or pilot holes, use only a double or triple wall core barrel designed:

1. to cut a core sample from 4 inches to 6 inches in diameter, at least 5 feet in length, and,
2. so that the sample of material cored can be removed from the shaft excavation and the core barrel in an undisturbed state.

When called for in the Plans and approved by the Engineer, substitute Standard Penetration Tests (SPT) using a drill rig equipped with an automatic hammer for coring.

Provide areas for the disposal of unsuitable materials and excess materials as defined in 120-5 that are removed from shaft excavations, and dispose of them in a manner meeting all environmental requirements.

Furnish the additional drilled shaft concrete over the theoretical amount required to complete filling any excavations for shafts which are larger than required by the Plans or authorized by the Engineer, at no expense to the City of Doral.

455-15.6.3 Production Shaft Tip Elevations: After completion of load tests, pilot holes, rock cores and lab testing, the GFDEOR shall submit the required minimum rock socket lengths and shaft tip elevations to the Engineer in a signed and sealed letter for review and acceptance. This letter shall include the assumptions and geotechnical parameters used, the report of core borings of all pilot holes, rock core records, lab testing, load test reports prepared in accordance with 455-2.11, and numerical analysis and calculations. Submit this letter at least three working days, excluding weekends and City of Doral observed holidays, prior to beginning production shaft construction. Additional data or analysis may be required by the Engineer.

Production shaft lengths may be based on the load transfer characteristics measured during the load test. End bearing characteristics may be based on load test results if the properties of the material below the tips of the production shafts meet or exceed the strength of the materials below the tip of the test shaft. If the theoretical bearing strength of the material below the tips of the production shafts is less than the theoretical bearing strength of the materials below the tip of the test shaft, the production shafts shall be extended to meet design capacity by side shear only, unless the end bearing resistance of the weaker material is verified by additional load testing.

455-15.7 Casings: Ensure that casings are metal, of ample strength to withstand handling and driving stresses and the pressure of concrete and of the surrounding earth materials, and that they are smooth and water tight. Ensure that the inside diameter of casing is not less than the specified size of shaft except as provided below. The City of Doral will not allow extra compensation for concrete required to fill an oversize casing or oversize excavation.

The Engineer will allow the Contractor to supply casing with an outside diameter equal to the specified shaft diameter (O.D. casing) provided additional shaft length is supplied at the shaft tip. Determine the additional length of shaft required by the following relationship:

$$Additional\ Length = \frac{(D_1 - D_2)\,L}{D_2}$$

where:

D_1= casing inside diameter specified = shaft diameter specified
D_2= casing inside diameter provided ($D_2 = D_1$ minus twice the wall thickness).
L= authorized shaft length below ground for temporary casing methods or below casing for permanent casing methods.

Bear all costs relating to this additional length including but not limited to the cost of extra excavation, extra concrete, and extra reinforcing steel.

Install and remove casing by rotating, exerting downward pressure, or with a vibratory hammer, unless otherwise shown in the Contract Documents. Remove all casings from shaft excavations except those used for the Permanent Casing Method. Ensure that the portion of casings installed under the Permanent Casing Method of construction below the shaft cut-off elevation remains in position as a permanent part of the drilled shaft. When casings that are to be removed become bound in the shaft excavation and cannot be practically removed, submit a proposed redesign to the Engineer for review and acceptance.

If temporary casing is advanced deeper than the minimum top of rock socket elevation shown in the Plans or actual top of rock elevation if deeper, withdraw the casing from the rock socket and overream the shaft. If the temporary casing cannot be withdrawn from the rock socket before final cleaning, extend the length of rock socket below the authorized tip elevation one-half of the distance between the minimum top of rock socket elevation or actual elevation if deeper, and the temporary casing tip elevation.

Form drilled shafts extending through a body of water with permanent casings. When the shaft extends above ground or a body of water, the Contractor may form the exposed portion with removable casing, unless otherwise specified in the Plans. Remove the portion of metal casings between an elevation 2 feet below the lowest water elevation or 2 feet below ground whichever is higher and the top of shaft elevation after the concrete is cured. Remove casings to expose the concrete as required above in a manner which will not damage the drilled shaft concrete. Dismantle removable casings in accordance with the provisions of 455-17.5.

When practical, do not start the removal until completing all concrete placement in the shaft. Extract casing at a slow, uniform rate with the pull in line with the axis of the shaft. Withdraw temporary casings while the concrete remains fluid.

When conditions warrant, the Contractor may pull the casing in partial stages. Maintain a sufficient head of concrete above the bottom of the casing to overcome the hydrostatic pressure of water outside the casing. At all times maintain the elevation of the concrete in the casing high enough to displace the drilling slurry between the outside of the casing and the edge of the hole while removing the casing.

Expandable or split casings that are removable are not permitted for use below water.

455-15.8 Slurry and Fluid in Excavation:

455-15.8.1 General: Thoroughly premix the slurry with clean fresh water prior to introduction into the shaft excavation. Introduce slurry before the excavation advances below the bottom of the casing. Ensure that the percentage of polymer or mineral admixture used to make the suspension is such as to maintain the stability of the shaft excavation. The Engineer will require adequate water or slurry tanks when necessary to perform the work in accordance with these Specifications. The Engineer will not allow excavated pits on projects requiring slurry tanks without the written permission of the Engineer. Take the steps necessary to prevent the slurry from "setting up" in the shaft, including but not limited to agitation, circulation, and adjusting the composition and properties of the slurry. Provide suitable offsite disposal areas and dispose of all waste slurry in a manner meeting all requirements pertaining to pollution.

Provide a CTQP qualified drilled shaft inspector to perform control tests using suitable apparatus on the slurry mixture to determine the slurry and fluid properties as specified in sub-articles 455-15.8.2 to 455-15.8.4.

Measure the viscosity of the freshly mixed slurry regularly as a check on the quality of the slurry being formed using an approved measuring device.

Perform tests from the fluid in the excavation to determine density, viscosity, and pH value to establish a consistent working pattern, taking into account the mixing process and blending of freshly mixed slurry and previously used slurry. Repeat tests to determine density, viscosity, and pH value at intervals not exceeding 2 hours during the first 8 hours slurry is in use and every 4 hours thereafter, including overnight, until concrete placement. Perform density, viscosity and pH tests again when the excavation reaches the midpoint.

The City of Doral may perform comparison tests as determined necessary during the mineral and polymer slurry operations.

If, at any time in the opinion of the Engineer, the wet construction method fails to stabilize the excavation discontinue this method of construction, backfill the excavation and submit modifications in procedure or alternate means of construction for approval.

455-15.8.2 Mineral Slurry: When mineral slurry is used in an excavation, use only processed attapulgite or bentonite clays with up to 2% (by dry weight) of added polymer. Use mineral slurry having a mineral grain size such that it will remain in suspension and having sufficient viscosity and gel characteristics to transport excavated material to a suitable screening system. Use a percentage and specific gravity of the material to make the suspension sufficient to maintain the stability of the excavation and to allow proper placement of concrete. Ensure that the material used to make the slurry is not detrimental to concrete or surrounding ground strata. During construction, maintain the level of the slurry at a height sufficient to prevent caving of the hole. In the event of a sudden significant loss of slurry such that the slurry level cannot practically be maintained by adding slurry to the hole, backfill the excavation and delay the construction of that foundation until an alternate construction procedure has been approved.

Perform the following tests on the mineral slurry supplied to and in the shaft excavation and ensure that the results are within the ranges stated in the table below:

Item to be measured	Range of Results at 68ºF	Test Method
Density	64 to 73 lb/ft^3 (in fresh water environment) 66 to 75 lb/ft^3 (in salt water environment)	Mud density balance: FM 8-RP13B-1
Viscosity	30 to 40 seconds	Marsh Cone Method: FM 8-RP13B-2
pH	8 to 11	Electric pH meter or pH indicator paper strips: FM 8-RP13B-4
Sand Content	4% or less	FM 8-RP13B-3

The Contractor may adjust the limits in the above table when field conditions warrant as successfully demonstrated in a test hole or with other methods approved by the Engineer. The Engineer must approve all changes in writing before the Contractor can continue to use them.

During construction, maintain the level of mineral slurry in the shaft excavation within the excavation and at a level not less than 4 feet above the highest expected piezometric water elevation along the depth of a shaft.

455-15.8.3 Polymer Slurry: Materials manufactured expressly for use as polymer slurry for drilled shafts that meet the requirements of this subarticle may be used as slurry for drilled shaft excavations. A representative of the manufacturer must be on-site or available for immediate contact to assist and guide the construction of the first three drilled shafts at no additional cost to the City of Doral. This representative must also be available for on-site assistance or immediate contact if problems are encountered during the construction of the remaining drilled shafts. Use polymer slurry only if the soils below the casing are not classified as organic, and the pH of the fluid in the hole can be maintained in accordance with the manufacturer's published recommendations. Submit the SDS for the product, the manufacturer's published mixing procedures, and the manufacturer's published range of values for pH and viscosity of the mixed slurry. Submit a report in accordance with Section 2.4, Volume II of the Florida Department of Transportation's Material Manual, which may be viewed at the following URL: http://www.fdot.gov/programmanagement/Implemented/URLinSpecs/Section24V2.shtm . The report must include test results, certification and documentation that demonstrate the polymer slurry and additives meet the following requirements:

1. The polymer slurries to be used on the project and their waste products are classified as non-hazardous as defined by Resource Conservation and Recovery Act (RCRA) Subpart C rules, Table 1 of 40 CFR 261.24 Toxicity Characteristic.
2. Pull out tests demonstrate the bond between the bar reinforcement and the concrete is not materially affected by exposure to the slurry under typical construction conditions, over the typical range of slurry viscosities to be used.
3. Load tests demonstrate the bond between the concrete and the soil is not materially affected by exposure to the polymer slurry under typical construction conditions, over the typical range of polymer slurry viscosities to be used.
4. The method of disposal meets the approval of all federal, state and local regulatory authorities.

Perform the following tests on the polymer slurry supplied to and in the shaft excavation and ensure that the results are maintained within the ranges stated in the table below:

Mixed Polymer Slurry Properties		
Item to be measured	Range of Results at 68ºF	Test Method
Density	62 to 65 lb/ft^3 (fresh water) 64 to 67 lb/ft^3 (salt water)	Mud density balance: FM 8-RP13B-1
Viscosity	50 seconds to upper limit published by the manufacturer, limited by 455-15.8.3 (2) and (3) above, for materials excavated	Marsh Cone Method: FM 8-RP13B-2
pH	Range published by the manufacturer for materials excavated	Electric pH meter or pH indicator paper strips: FM 8-RP13B-4
Sand Content	0.5% or less	FM 8-RP13B-3

Premix polymer slurry in accordance with the manufacturer's published procedures. Do not mix in the excavation as a means to initially prepare slurry; adjustments to slurry properties can be made in the excavation as needed.

During construction, maintain the level of the slurry at a height sufficient to prevent caving of the hole and which should not be lower than 4 feet above the highest expected piezometric water elevation along the depth of the shaft.

455-15.8.4 Fluid In Excavation At Time Of Concrete Placement: When any fluid is present in any drilled shaft excavation, including shafts to support sign, signal, lighting and ITS structures, the applicable test methods and reporting requirements described in 455-15.8.1, 455-15.8.2 and 455-15.8.3 apply to tests of fluid in the shaft prior to placing the concrete.

Test samples of the fluid in the shaft from within 1 inch of the base of the shaft and from the middle of the shaft height for shafts up to 60 feet in depth. Test samples of the fluid in the shaft from within 1 inch of the base of the shaft and at intervals not exceeding 30 feet up the shaft for shafts deeper than 60 feet. Use a sampling tool, approved by the Engineer, designed to sample over a depth range of 12 inches or less. Take whatever action is necessary prior to placing the concrete to bring the fluid within the specification and reporting requirements, outlined in the tables in 455-15.8.2 and 455-15.8.3, except as follows:

The Engineer will not require tests for pH or viscosity, nor require the fluid to meet the minimum density specified in 455-15.8.2 and 455-15.8.3 when neither polymer nor mineral slurry has been introduced into the shaft excavation.

455-15.9 Tremies and Pumps:

455-15.9.1 General: The requirements of the applicable provisions of Section 400 will apply when using a tremie or a pump to place drilled shaft concrete.

455-15.9.2 Dry Excavations: Ensure that the tremie for depositing concrete in a dry drilled shaft excavation consists of a tube of solid construction, a tube constructed of sections which can be added and removed, or a tube of other accepted design. The Contractor may pass

concrete through a hopper at the top of the tube or through side openings as the tremie is retrieved during concrete placement. Support the tremie so that the free fall of the concrete is less than 5 feet at all times. If the free falling concrete causes the shaft excavation to cave or slough, control the movement of concrete by reducing the height of free fall of the concrete and/or reducing the rate of flow of concrete into the excavation.

455-15.9.3 Wet Excavations: Construct the tremie or pump line used to deposit concrete beneath the surface of water so that it is water-tight and will readily discharge concrete. Construct the discharge end of the tremie or pump line to prevent water intrusion and permit the free flow of concrete during placement operations. Ensure that the tremie or pump line has sufficient length and weight to rest on the shaft bottom before starting concrete placement.

During placement operations, ensure that the discharge end of the tremie or pump line is within 6 inches of the bottom of the shaft excavation until at least 10 feet of concrete has been placed. Ensure the discharge end of the tremie or pump line is continuously embedded at least 10 feet into the concrete after 10 feet of concrete has been placed and until the casing is overpoured sufficiently to eliminate all contaminated concrete. Ensure that the free fall of concrete into the hopper is less than 5 feet at all times. Support the tremie so that it can be raised to increase the discharge of concrete and lowered to reduce the discharge of concrete. Do not rapidly raise or lower the tremie to increase the discharge of the concrete. Maintain a continuous flow of concrete and a positive pressure differential of the concrete in the tremie or pump line at all times to prevent water or slurry intrusion into the shaft concrete.

455-15.10 Excavation and Drilling Equipment:

455-15.10.1 General: All shaft excavation is unclassified shaft excavation. Overream the drilled shaft sidewall when necessary. These terms are defined in 455-15.10.2, 455-15.10.3, and 455-15.10.4, respectively.

Use excavation and drilling equipment having adequate capacity, including power, torque, and crowd (downthrust), and excavation and overreaming tools of adequate design, size, and strength to perform the work shown in the Plans or described herein. When the material encountered cannot be drilled using conventional earth augers and/or underreaming tools, provide special drilling equipment, including but not limited to rock augers, core barrels, rock tools, air tools, blasting materials, and other equipment as necessary to continue the shaft excavation to the size and depth required. In the event blasting is necessary, obtain all necessary permits. The Contractor is responsible for the effects of blasting on already completed work and adjacent structures. The Engineer must approve all blasting.

455-15.10.2 Unclassified Shaft Excavation: Unclassified shaft excavation is defined as all processes required to excavate a drilled shaft of the dimensions shown in the Contract Documents to the depth indicated in the Plans plus 15 feet or plus 3 shaft diameters, whichever is deeper, completed and accepted. Include in the work all shaft excavation, whether the material encountered is soil, rock, weathered rock, stone, natural or man-made obstructions, or materials of other descriptions.

455-15.10.3 Unclassified Extra Depth Excavation: Unclassified extra depth excavation is defined as all processes required to excavate a drilled shaft of plan dimensions which is deeper than the limits defined as unclassified shaft excavation.

455-15.10.4 Drilled Shaft Sidewall Overreaming: Drilled shaft sidewall overreaming is defined as the unclassified excavation required to roughen its surface or to enlarge the drilled shaft diameter due to softening of the sidewalls or to remove excessive buildup of slurry cake when slurry is used. Increase the shaft radius a minimum of 1/2 inch and a

maximum of 3 inches by overreaming. The Contractor may accomplish overreaming with a grooving tool, overreaming bucket, or other suitable equipment.

Meet the limit for depth of sidewall overreaming into the shaft sidewall material and the elevation limits between which sidewall overreaming is required.

455-15.11 Inspection of Excavations:

455-15.11.1 Dimensions and Alignment: Provide equipment for checking the dimensions and alignment of each permanent shaft excavation. Determine the dimensions and alignment of the shaft excavation under the observation and direction of the City of Doral. Generally, check the alignment and dimensions by any of the following methods as necessary:

1. Check the dimensions and alignment of dry shaft excavations using reference stakes and a plumb bob. Verify that the bottom of the hole is level.
2. Check the dimensions and alignment of casing when inserted in the excavation.
3. .Use an acceptable caliper system
4. Insert any casing, rod or pipe assembly, or other device used to check dimensions and alignment into the excavation to full depth.

455-15.11.2 Depth: Generally, reference the depth of the shaft during drilling to appropriate marks on the Kelly bar or other suitable methods. Measure final shaft depths with a suitable weighted tape or other accepted methods after final cleaning.

455-15.11.3 Shaft Inspection Device (SID): Furnish all power and equipment necessary to inspect the bottom conditions of a drilled shaft excavation for bridge foundations and to measure the thickness of bottom sediment or any other debris using a SID. Provide a means to position and lower the SID into the shaft excavation to enable the bell housing to rest vertically on the bottom of the excavation. Continuously videotape the inspection of each drilled shaft excavation after final cleaning. Clearly identify in the recordings by audio or other means, the location and items being observed.

Furnish a SID meeting the following requirements:

1. A remotely operated, high resolution, color video camera sealed inside a watertight bell housing.
2. Provides a clear view of the bottom inspection on a video monitor at the surface in real time.
3. Provides a permanent record of the entire inspection with voice annotation on a quality DVD with a resolution of not less than 720 x 480.
4. Provides a minimum field of vision of 110 square inches, with at least two graduated measuring devices to record the depth of sediment on the bottom of the shaft excavation to a minimum accuracy of 1/2 inch and a length greater than 1-1/2 inches.
5. Provides sufficient lighting to illuminate the entire field of vision at the bottom of the shaft in order for the operator and inspector to clearly see the depth measurement scale on the video monitor and to produce a clear recording of the inspection.
6. Provides a regulated compressed air or gas system to precisely adjust the drilling fluid level within the bell housing, and a pressurized water system to assist in determination of bottom sedimentation depth

Obtain the Engineer’s approval of the device in advance of the first inspection contingent on satisfactory field performance. Notify the Engineer for approval before a different device is used for any subsequent inspection.

455-15.11.4 Shaft Cleanliness Requirements: Adjust cleaning operations so a minimum of 50% of the bottom of each shaft will have less than 1/2 inches of sediment at the time of placement of the concrete. Ensure the maximum depth of sedimentary deposits or any other debris at any place on the bottom of the shaft excavation does not exceed 1-1/2 inches. Determine shaft cleanliness by visual inspection for dry shafts. For bridge foundations, use a shaft inspection device for wet shafts. For drilled shaft foundations for sign, signal, lighting and ITS structures the use of a weighted tape is permitted to verify level and clean hole bottom conditions at the time of concrete placement.

When using slurry, meet the requirements of 455-15.8 at the time of concrete placement.

455-15.11.4.1 Exceptions for Shafts for Sign, Signal, Lighting and ITS Structures: Ensure the depth of sedimentary deposits or other debris does not exceed 1 inch over the bottom of the shaft when installing drilled shafts to support sign, signal, lighting and ITS structures.

455-15.11.5 Time of Excavation: Overream the sidewalls of any unclassified excavation work using mineral slurry lasting more than 36 hours (measured from the beginning of excavation for all methods except the Temporary or Permanent Casing Method, which begins at the time excavation begins below the casing) before placement of the concrete. Ensure that the minimum depth of overreaming the shaft sidewall is 1/2 inches and the maximum depth is 3 inches. Provide any overreaming required at no expense to the City of Doral when exceeding the 36 hour limit.

When using mineral slurry, adjust excavation operations so that the maximum time that slurry is in contact with the bottom 5 feet of the shaft (from time of drilling to concreting) does not exceed 12 hours. If exceeding the 12 hour time limit, overream the shaft socket or the full shaft when socket is not specified, at no additional expense to the City of Doral prior to performing other operations in the shaft.

455-16 Reinforcing Steel Construction and Placement.

455-16.1 Cage Construction and Placement: Completely assemble and place as a unit the cage of reinforcing steel, consisting of longitudinal bars, ties, and cage stiffener bars, immediately after the Drilled Shaft Inspector inspects accepts the shaft excavation and immediately prior to placing concrete. Tie all intersections of drilled shaft reinforcing steel with cross ties or “figure 8” ties. Use double strand ties, ties with larger tie wire, U-bolts, or similar when necessary.

455-16.2 Splicing Cage: If the bottom of the constructed shaft elevation is lower than the bottom of the shaft elevation in the Plans, extend a minimum of one half of the longitudinal bars required in the upper portion of the shaft the additional length. Continue the tie bars for the extra depth, spaced on 2 foot centers, and extend the stiffener bars to the final depth. The Contractor may lap splice these bars or use unspliced bars of the proper length. Do not weld bars to the planned reinforcing steel unless shown in the Contract Documents.

For drilled shafts supporting sign, signal, lighting and ITS structures, if the shaft cleaning operations result in excavating below the required tip elevation, the reinforcing steel cage does not need to be extended. The reinforcing steel cage may be spliced to rest on the bottom of the excavation or suspended in place from the top.

455-16.3 Support, Alignment, and Tolerance: Tie and support the reinforcing steel in the shaft so that the reinforcing steel will remain within allowable tolerances as specified in 455-20 and Section 415.

Use centering devices consisting of wheels or other approved noncorrosive spacing devices within 3 feet of the bottom, within 6 feet of the top, and intervals not exceeding 10 feet along the shaft to ensure concentric spacing for the entire length of the cage. When a casing with an inside diameter (I.D.) larger than the required shaft diameter is used, provide, within the portion of the oversized casing, centering devices specially dimensioned to ensure the casing and the cage are concentric. Do not use block or wire type spacers. Ensure no metallic elements will be within the concrete cover space. Use a minimum of one spacer per 30 inches of circumference of cage with a minimum of four at each level. Provide spacers at the bottom of the drilled shaft reinforcing cage as required to maintain the proper position of the cage.

Check the elevation of the top of the steel cage before and after placing the concrete. If the cage is not within the specified tolerances, correct, and submit a revised DSIP to the Engineer for approval. Do not construct additional shafts until receiving approval from the Engineer.

455-16.4 Nondestructive Integrity Testing Access Tubes: Install access tubes full length in all drilled shafts from the tip of shaft to a point high enough above top of shaft to allow Thermal Integrity Testing for Drilled Shafts (TITDS) and Cross-Hole Sonic Logging (CSL) testing, but not less than 30 inches above the top of the drilled shaft, ground surface or water surface, whichever is higher. Equally space tubes around circumference of drilled shaft. Securely tie access tubes to the inside of the reinforcing cage and align tubes to be parallel to the vertical axis of the center of the cage. Access tubes from the top of the reinforcing cage to the tip of the shaft shall be NPS 1-1/2 Schedule 40 black iron or black steel (not galvanized) pipe. Access tubes above the top of the reinforcing cage may be the same black iron or black steel pipe or Schedule 40 PVC pipe. Ensure that the access tubes are free from loose rust, scale, dirt, paint, oil and other foreign material. Couple tubes as required with threaded couplers, such that inside of tube remains flush. Seal the bottom and top of the tubes with threaded caps. The tubes, joints and bottom caps shall be watertight. Seal the top of the tubes with lubricated, threaded caps sufficient to prevent the intrusion of foreign materials. Stiffen the cage sufficiently to prevent damage or misalignment of access tubes during the lifting and installation of the cage. Exercise care in removing the caps from the top of the tubes after installation so as not to apply excess torque, hammering or other stress which could break the bond between the tubes and the concrete.

Provide the following number (rounded up to the next whole number of tubes) and configuration of access tubes in each drilled shaft based on the diameter of the shaft.

Shaft Diameter	Number of Tubes Required	Configuration around the inside of Circular Reinforcing Cage
36 to 48 inches	4	90 degrees apart
Greater than 48 inches	1 tube per foot of Shaft Diameter	360 degrees divided by the Number of Tubes

Insert simulated or mock probes in each access tube prior to concreting to ensure the serviceability of the tube. Fill access tubes with clean potable water and recap prior to concreting. Repair or replace any leaking, misaligned or unserviceable tubes as in a manner acceptable to the Engineer prior to concreting.

For drilled shaft foundations requiring anchor bolts, verify access tubes will not interfere with anchor bolt installation before excavating the shaft. When access tube locations

conflict with anchor bolt locations, move the access tube location plus or minus 2 inches along the inner circumference of the reinforcing cage.

For drilled shafts supporting sign, signal, lighting and ITS structures, if the shaft cleaning operations result in excavating below the required tip elevation, the access tubes do not need to be extended. If the reinforcing steel cage is suspended in place from the top rather than resting on the bottom of the excavation, clearly mark the top of shaft location on each tube.

When called for in the Contract Documents, provide embedded thermal wires and equipment to allow TITDS in accordance with ASTM D7949 Method B.

455-17 Concrete Placement.

455-17.1 General: Place concrete in accordance with the applicable portions of Sections 346 and 400, 455-15.2, 455-15.3, 455-15.4, 455-15.5, 455-15.8, 455-15.9, and the requirements herein.

Place concrete as soon as possible after completing all excavation, cleaning the shaft excavation, inspecting and finding it satisfactory, and immediately after placing reinforcing steel. Continuously place concrete in the shaft to the top of the casing. Continue placing concrete after the casing is full until good quality concrete is evident at the top of the casing. Place concrete through a tremie or concrete pump using accepted methods. After the shaft is overpoured sufficiently to eliminate all contaminated concrete, additional concrete may be added to the shaft without the use of a tremie or pump in accordance with Section 400.

If the pressure head is lost during concrete placement for any reason, perform integrity testing at no expense to the City of Doral.

Immediately after concreting, check the water levels in the CSL access tubes and refill as necessary. If tubes become unserviceable, core new holes in the drilled shaft as directed by the Engineer.

455-17.2 Placement Time Requirements: The elapsed time for placing drilled shaft concrete includes the concrete mixing and transit time, the concrete placement time, the time required to remove any temporary casing that causes or could cause the concrete to flow into the space previously occupied by the casing, and the time to insert any required column steel, bolts, weldments, etc. Maintain a minimum slump of 5 inches throughout the elapsed time. Use materials to produce and maintain the required slump through the elapsed time that meets the class of concrete specified. Provide slump loss tests that demonstrate to the Engineer that the concrete will maintain a 5 inch or greater slump for the anticipated elapsed time before beginning drilled shaft construction.

455-17.3 Forms: When the top of shaft elevation is above ground or above water, form the portion of the shaft above ground and the portion of the shaft above water with a removable form or another suitable method to the dimensions shown in the Plans

When the shaft extends above the ground through a body of water, the Contractor may form the portion through the water with removable forms except when the Permanent Casing Method is specified.

455-17.4 Riser Blocks: The Contractor may cast a riser block of equal diameter as the column and of a maximum height of 6 inches at the top of the completed shaft. When this option is chosen, extend any dowel steel above the top of shaft an additional 6 inches.

455-17.5 Curing: Cure the top surface in accordance with the applicable provisions of Section 400, and construct any construction joint area as shown in the Plans. Protect portions of drilled shafts exposed to a body of water from the action of water by leaving the forms in place for a minimum of seven days after casting the concrete. The Contractor may remove forms prior

to seven days provided the concrete strength has reached 2,500 psi or greater as evidenced by cylinder breaks.

455-17.6 Non-Destructive Testing of Drilled Shaft Integrity:

455-17.6.1 Thermal Integrity Testing for Drilled Shafts (TITDS): Perform all TITDS testing in accordance with ASTM D7949. Test all drilled shafts in bridge bents or piers considered nonredundant in the Plans, using TITDS. For all other drilled shafts supporting bridges and sign, signal, lighting and ITS structures, perform TITDS on any shaft suspected of containing defects. The Engineer may select shafts for TITDS based on observations in the field or the review of the drilled shaft logs.

Engage a qualified Specialty Engineer to supervise the TITDS. The qualified TITDS Specialty Engineer must have a minimum six months experience of TITDS and have a Florida Licensed Professional Engineer and supervise the collection and interpretation of data. The individual performing the TITDS in the field must work for the Specialty Engineer firm and have a minimum of six months experience of TITDS. The Contractor shall provide all necessary access and assistance to the TITDS Specialty Engineer to satisfactorily perform the testing.

After acceptance of production shafts by the Engineer, remove all water from the access tubes or core holes and fill the tubes or core holes with a structural non-shrink grout meeting the requirements of Section 934 from the bottom via tremie tube. Place the grout utilizing enough pressure to fill the tubes or core holes completely.

If the Contractor determines at any time during the non-destructive testing and evaluation of the drilled shaft that the drilled shaft should be replaced, no further testing or evaluation of that shaft is required.

455-17.6.1.1 Equipment: Furnish TITDS test equipment in accordance with ASTM D7949 as follows:

1. Provide thermal probes with four orthogonally oriented infrared sensors able to be used in 1.5 inch I.D. pipes.
2. Provide a computer based TITDS data acquisition system for display of signals during data acquisition.
3. Provide a computer based TITDS data acquisition system for display of signals during data acquisition.
4. Provide an air compressor and power supply with sufficient pressure to air lift the water from the access tubes.

455-17.6.1.2 Procedure: Perform TITDS testing between the minimum and maximum times shown below after the batching time of the first truck load placed in the drilled shaft, unless otherwise accepted by the Engineer.

Shaft Diameter (inches)	Minimum time (hours)	Maximum time (hours)
36-48	24	54
49-60	24	72
61-72	24	72
73-84	24	90
85-120	24	108

The Contractor may propose modifications in the above table for site specific and special concrete mix conditions, as demonstrated from lab and field testing and instrumentation. The Engineer must approve all changes to the testing times prior to the Contractor using them.

Furnish information regarding the shaft, tube lengths and depths, construction dates, and other pertinent shaft installation observations and details to the City of Doral at the time of testing. Verify access tube lengths and their condition in the presence of the City of Doral, at the end of concrete placement. If the access tubes do not provide access over the full length of the shaft, repair the existing tube(s) or core additional hole(s), as directed by the Engineer, at no additional cost to the City of Doral.

Just prior to inserting the thermal probe, remove water from the access tubes. Store the removed water in an insulated container for later replacement. Allow the thermal probe to acclimate in accordance with the equipment manufacturer recommendations. Continuously record temperatures at depth intervals of 3.0 inches or less from the top to the bottom of each access tube. Repeat the test at each access tube until two sets of data from the same access tube provide similar results. Return the warm water to the access tubes immediately after the testing has been completed.

Immediately report any potential defects indicated by lower temperature anomalies to the Engineer.

455-17.6.1.3 Required TITDS Reports: Submit the TITDS data and analysis to the Engineer in a signed and sealed report, together with all electronic data, within 48 hours of testing. The report shall include as minimum the following items:

1. Graphs displaying all temperature measurements and average temperature versus depth.
2. Indication of unusual temperatures, including cooler local deviations from the average at any depth from the overall average over the entire length.
3. A graph displaying the average temperature and theoretical temperature versus depth.
4. Variations in temperature between access tubes which may indicate variations in cage alignment.
5. The calculated radius of the shaft throughout the entire depth.
6. Alignment of the reinforcing cage along the shaft.
7. Calculated concrete cover throughout the entire depth.
8. Shaft Details, Probe Details, Environmental Details, Tube Run Selection and Shaft Adjustment Data that show the measurements, inputs and adjustments to the data. Screen captures of these pages from the “TIP Reporter” software will be acceptable.
9. A conclusion stating whether the tested shaft is free from integrity defects and meets the minimum concrete cover and diameter requirements by the specifications. When anomalies are detected, include in the report a three dimensional rendering of the shape of the shaft.

455-17.6.1.4 Evaluation of TITDS Test Results: Drilled shafts not meeting the minimum cover and diameter requirements, or having integrity defects, are not acceptable without an engineering analysis.

455-17.6.1.5 Coring and/or Repair of Drilled Shafts: If a drilled shaft is unacceptable based on the TITDS tests and other testing, or problems observed during drilled shaft construction, core the shaft to allow further evaluation and repair, or replace the shaft. If coring to allow further evaluation of the shaft and repair is chosen, one or more core samples

shall be taken from each unacceptable shaft for full depth of the shaft or to the depth directed by the GFDEOR. The GFDEOR shall determine, with concurrence of the Engineer, the number, location, and diameter of the cores based on the results of the TITDS. Keep an accurate log of cores. Properly mark and place the cores in a crate showing the shaft depth at each interval of core recovery. Deliver the cores to the GFDEOR and submit the coring log to the Engineer. Perform strength testing by an AASHTO certified lab on portions of the cores that exhibit questionable concrete as determined by the GFDEOR. If the TITDS and coring indicate the shaft is defective, propose remedial measures for approval by the Engineer. Such improvement may consist of, but is not limited to correcting defective portions of the shaft, providing straddle shafts to compensate for capacity loss, or providing a replacement shaft. Repair all detected defects and conduct post repair integrity testing using horizontal and offset CSL testing and 3-D tomographic imaging as described in 455-17.6.2. Engage a Specialty Engineer to perform gamma-gamma density logging calibrated to 1-1/2 inch black iron access tubes, prior to and after the repair is performed, to verify the integrity of the shaft outside the reinforcing cage in the same locations where the repair was required. When straddle shafts or replacement shafts are used to correct a deficient foundation perform TITDS in accordance with 455-17.6.1 through 455-17.6.3 to verify integrity of these shafts. Submit all results to the Engineer within five days of test completion for acceptance. Perform all work described in this sub-article at no additional cost to the City of Doral, and with no increase in Contract Time.

455-17.6.2 Cross Sonic Logging (CSL) and Tomography: When required by the Engineer perform CSL testing in accordance with ASTM D6760. Engage a qualified Specialty Engineer to perform the CSL testing. The qualified CSL Specialty Engineer must be a Professional Engineer in the State of Florida and have a minimum six months experience of CSL testing, supervising the collection of CSL data and interpretation of CSL results. The individual performing the CLS testing in the field must work for the Specialty Engineer firm and have a minimum of six months experience of six months of CSL testing. The Contractor shall provide all necessary access and assistance to the CSL Specialty Engineer to satisfactorily perform the testing.

When a shaft contains four tubes, test every possible tube combination. For shafts with five or more tubes, test all pairs of adjacent tubes around the perimeter, and one-half of the remaining number of tube combinations, as chosen by the Engineer. Pull the probes simultaneously, starting from the bottoms of the tubes, over an electronic depth measuring device. Perform the CSL tests with the source and receiver probes in the same horizontal plane. Continuously record CSL signals at depth intervals of 2-1/2 inches or less from the bottom of the tubes to the top of each shaft. Remove all slack from the cables prior to pulling to provide accurate depth measurements in the CSL records. When the measurements indicate a 30% or greater reduction in velocity between one or more pairs perform 3D tomography analysis as indicated below.

To perform 3D tomography analysis conduct offset CSL measurements between the tube pair combinations in addition to the horizontal measurements. Record offset measurements with source and receiver vertically offset in the tubes. These measurements add four measurements per tube combination to the horizontal measurements described in this section. Offset measurements are described by the angle, in degrees, and direction the signal travels between the probes with respect to the horizontal plane: plus 45, plus 22.5 (source below receiver), and minus 45, minus 22.5 (source above receiver). Record offset measurements from the point where the higher probe is at least 5 feet below the velocity reduction to the point where

the lower probe is at least 5 feet above the velocity reduction. When repairs are done, provide offset measurements from the point where the higher probe is at least 5 feet below the lower limit of the repaired zone to the point where the lower probe is at least 5 feet above the upper limit of the repaired zone. Perform offset measurements and provide CSL logs and 3D tomographic analysis at no additional cost to the City of Doral.

After acceptance of production shafts by the Engineer, fill the tubes or core holes with a structural non-shrink grout in accordance with 455-17.6.1.

If the Contractor determines at any time during the non-destructive testing and evaluation of the drilled shaft that the drilled shaft should be replaced, no further testing or evaluation of that shaft is required.

455-17.6.2.1 Required CSL Reports: Present the CSL data and analysis results to the Engineer in a signed and sealed report. Include CSL logs with analyses of first pulse arrival time (FAT) versus depth and pulse energy/amplitude versus depth. Present a CSL log for each tube pair tested with any defect zones identified on the logs and discussed in the test report as appropriate. When offset measurements are required, perform 3D tomographic analysis using all offset data, and include color coded 3D tomographic images in the report.

455-17.6.2.2 Evaluation of Cross-Hole Sonic Logging Testing: Drilled shafts with velocity reduction exceeding 30% are not acceptable without an engineering analysis.

455-17.6.2.3 Coring and/or Repair of Drilled Shafts: If a drilled shaft is unacceptable based on the CSL Testing and tomographic analyses and other testing, core the shaft to allow further evaluation and repair, or replace the shaft in accordance with 455-17.6.1.5.

If repairs are performed or additional shafts installed to correct a deficient foundation, conduct integrity testing and submit the results to the Engineer in accordance with 455-17.6.1.5.

455-18 Method Shafts.

The Engineer will use the construction of method shafts (test holes) to determine if the methods and equipment used by the Contractor are sufficient to produce a shaft excavation meeting the requirements of the Contract Documents. During method shaft excavations, the Engineer will evaluate the ability to control dimensions and alignment of excavations within tolerances; to seal the casing into impervious materials; to control the size of the excavation under caving conditions by the use of slurry or by other means; to properly clean the completed shaft excavation; to construct excavations in open water areas; to determine the elevation of ground water; to place reinforcing steel and concrete meeting the requirements of these Specifications within the prescribed time frame; and to execute any other necessary construction operation. Revise the methods and equipment as necessary at any time during the construction of the method shaft when unable to satisfactorily carry out any of the necessary operations described above or when unable to control the dimensions and alignment of the shaft excavation within tolerances.

Successfully construct method shafts out of permanent position at the location shown in the Plans. Ensure the diameter and depth of the method shafts are the same diameter and maximum depth as the production drilled shafts. When there are shafts both on land and in water, successfully construct a method shaft for each condition. When there is more than one size of drilled shaft, perform a method shaft for the largest diameter for each condition. Reinforce the method shaft unless otherwise directed in the Contract Documents. Conduct integrity tests on each shaft, using both cross-hole sonic logging and TITDS test methods. Fill the method shaft with concrete in the same manner production drilled shafts will be constructed. Backfill method

shafts which are not filled with concrete with suitable soil in a manner satisfactory to the Engineer. Leave concreted method shafts in place, except remove the top of the shaft to a depth of 2 feet below the ground line. Use the same procedure for shafts constructed in water. Restore the disturbed areas at the sites of method shafts drilled out of position as nearly as practical to their original condition. When the Contractor fails to demonstrate to the Engineer the adequacy of his methods or equipment, and alterations are required, make appropriate modifications and provide additional method shafts at no expense to the City of Doral. Make no changes in methods or equipment after initial acceptance without the consent of the Engineer.

A separate method shaft is not required for drilled shafts installed under sign, signal, lighting and ITS structures. The first production shaft will serve as a method shaft for determining acceptability of the installation method.

455-19 Test Bells.

Test bells are no longer used.

455-20 Construction Tolerances.

Meet the following construction tolerances for drilled shafts:

1. Ensure that the top of the drilled shaft is no more than 3 inches laterally in the X or Y coordinate from the position indicated in the Plans.

2. Ensure that the vertical alignment of the shaft excavation does not vary from the alignment shown in the Plans by more than 1/4 inches per foot of depth.

3. After placing all the concrete, ensure that the top of the reinforcing steel cage is no more than 6 inches above and no more than 3 inches below plan position.

4. Ensure that the reinforcing cage is concentric with the shaft within a tolerance of 1-1/2 inches. Ensure that concrete cover is a minimum of 4-1/2 inches unless shown otherwise in the Plans.

5. All casing diameters shown in the Plans refer to I.D. (inside diameter) dimensions. However, the Contractor may use casing with an outside diameter equal to the specified shaft diameter if the extra length described in 455-15.7 is provided. In this case, ensure that the I.D. of the casing is not less than the specified shaft diameter less 1 inch. The Contractor may elect to provide a casing larger in diameter than shown in the Plans to facilitate meeting this requirement. Ensure that the minimum diameter of the drilled shaft is 1 inch less than the specified shaft diameter. When conditions are such that a series of telescoping casings are used, provide the casing sized to maintain the minimum shaft diameters listed above.

6. Except when a butting or encroaching within a sidewalk, ensure that the top elevation of the drilled shaft concrete has a tolerance of plus 1 inch and minus 3 inches from the top of shaft elevation shown in the Plans.

7. When abutting or encroaching within a sidewalk, ensure that the top elevation of the drilled shaft is flush with the sidewalk surface.

8. The dimensions of casings are subject to American Petroleum Institute tolerances applicable to regular steel pipe.

9. Use excavation equipment and methods designed so that the completed shaft excavation will have a flat bottom. Ensure that the cutting edges of excavation equipment are normal to the vertical axis of the equipment within a tolerance of plus or minus 3/8 inches per foot of diameter.

455-21 Drilled Shaft Excavations Constructed out of Tolerance.

Do not construct drilled shaft excavations in such a manner that the concrete shaft cannot be completed within the required tolerances. The Contractor may make corrections to an unacceptable drilled shaft excavation by any combination of the following methods:

1. Overdrilling the shaft excavation to a larger diameter to permit accurate placement of the reinforcing steel cage with the required minimum concrete cover.
2. Increasing the number and/or size of the steel reinforcement bars.

When the tolerances are not met, the Contractor may propose a redesign to incorporate shafts installed out of tolerance into caps or footings. Incorporate shafts installed out of tolerance at no expense to the City of Doral. Ensure the Contractor's Engineer of Record performs any redesign and signs and seals the redesign drawings and computations. Do not begin any proposed construction until the redesign has been reviewed and accepted by the Engineer.

Backfill any out of tolerance shafts in an accepted manner when necessary until the redesign is complete and accepted. Furnish additional materials and work necessary, including engineering analysis and redesign, to effect corrections of out of tolerance drilled shaft excavations at no expense to the City of Doral.

455-22 Recording, Certification and Verification.

455-22.1 Recording: Inspect and record all the drilled shaft operations. Keep a set of drilled shaft logs for each drilled shaft including test holes, load test shafts and production shafts. Use the Florida Department of Transportation's Drilled Shaft Log forms to record the information. Submit to the Engineer drilled shaft logs and concrete logs within 24 hours of concrete placement. The documentation shall include the drilled shaft installation procedures, actual dimensions and quantities of the materials used, fluid testing results, bottom cleanliness inspection results, sequencing, as well as any problems encountered during construction and concrete placement. Allow two working days, excluding weekends and City of Doral observed holidays, for the City of Doral to review the data and determine whether shafts will be selected for CSL integrity testing. Perform CSL testing on any shaft selected by the City of Doral at this stage in accordance with 455-17.

455-22.2 Foundation Certification Packages: Submit certification packages of drilled shaft foundations to the Engineer prior to Verification Testing. Each Foundation Certification Package shall include a letter signed and sealed by the GFDEOR certifying the drilled shafts have the required axial capacity, torsional capacity, uplift capacity, overturning and lateral stability, integrity deficiencies have been corrected, and settlements will not affect the functionality of the structure. Include all shaft excavation and concreting logs, videos of visual shaft bottom inspections, all CSL reports and electronic data, gamma-gamma testing reports, slurry test data, supplemental testing data, analyses for the foundation unit and the concrete strength test results of the lots sampled. The certification shall not be contingent on any future testing or approval by the Engineer. Submit a separate Foundation Certification Package for each foundation unit. A foundation unit is defined as all the shafts within one bent or pier for a specific bridge for each phase of construction. For sign, signal, lighting and ITS structures, a foundation unit is defined as all the shafts within one intersection/interchange, for each phase of an intersection/interchange or all the shafts included in the structure.

455-22.3 Verification: The Engineer reserves the right to observe and perform verification testing on any drilled shafts during any phases of the foundation operation.

Provide safe access and cooperate with the Engineer for verification of the drilled shafts, both during construction of shafts and after submittal of the certification package. The

Engineer may verify the bottom cleanliness by over the shoulder review of the Contractor's visual inspection methods and/or by independent means. The Engineer may verify properties of drilling fluid at the time of concreting.

Within one working day, excluding weekends and City of Doral observed holidays, of receipt of the Foundation Certification Package, the Engineer will examine the Certification Package and determine whether shafts in that foundation unit will be selected for Verification Testing. The Engineer may select every shaft for Verification Testing if defects are suspected, or choose not to require verification testing on any or all foundation units. The Engineer will provide equipment and personnel as needed for Verification Testing. Methods used for Verification Testing of a completed shaft are at the discretion of the Engineer and may include coring, cross-hole sonic logging, gamma-gamma density logging, low-strain dynamic integrity testing, or other methods.

After Verification Testing for a foundation unit is performed, the Engineer will provide the results within five working days, excluding weekends and City of Doral observed holidays. Integrity testing access tubes shall not be grouted and construction of footings, caps, columns or any superstructure elements shall not occur until the Engineer has notified the Contractor that additional Verification Testing is not required.

If any shaft is found to be deficient, correct the deficiency (i.e. repair or replace the shaft) and/or modify the design to compensate for the deficiency. After the deficiency is corrected, retest and recertify the shaft. The Engineer may then perform additional Verification Testing. In case of disagreement of test results, the Engineer's results will be final and used for determination of acceptance.

455-23 Method of Measurement.

455-23.1 Drilled Shafts: The quantity to be paid for will be the length, in feet, of the reinforced concrete drilled shaft of the diameter shown in the Plans, completed and accepted. The length will be determined as the difference between the top of shaft elevation as shown in the Plans and the final bottom of shaft elevation as authorized and accepted. When the Contractor elects to provide outside diameter (O.D.) sized casing rather than inside diameter (I.D.) sized casing as allowed in 455-15.7, the pay quantity measured as described above will be multiplied by a factor (F) determined as follows:

$$F = \frac{2D_2 - D_1}{D_2}$$

where:

F= factor to adjust pay quantities to compensate for smaller shafts.

D_1= casing inside diameter specified = shaft diameter specified.

D_2= casing inside diameter provided ($D_2 = D_1$ minus twice the wall thickness).

455-23.2 Drilled Shafts (Unreinforced): The quantity to be paid for will be the length, in feet, of unreinforced concrete drilled shaft of the diameters shown in the Plans, completed and accepted. The length will be determined as the difference between the top of shaft elevation as shown in the Plans and the final bottom of shaft elevation as authorized and accepted. When the

Contractor elects to use O.D. casing, the quantity as determined above will be multiplied by the factor "F" determined as described in 455-23.1.

455-23.3 Unclassified Shaft Excavation: The quantity to be paid for will be the length, in feet, of unclassified shaft excavation of the diameter shown in the Plans, completed and accepted, measured along the centerline of the shaft from the ground surface elevation after any required excavation per 455-1.2 to the plan bottom of shaft elevation authorized and accepted plus up to 15 feet or 3 shaft diameters, whichever is deeper, of additional excavation as authorized by the Engineer. When drilled shafts are constructed through fills placed by the Contractor, the original ground surface before the fill was placed will be used to determine the quantity of unclassified shaft excavation. When the Contractor elects to use O.D. casing, the quantity as determined above will be multiplied by the factor "F" determined as described in 455-23.1.

455-23.4 Unclassified Extra Depth Excavation: When excavation is required by the Engineer to extend more than 15 feet or 3 shaft diameters, whichever is deeper, below the bottom of the shaft elevation shown in the Plans, the work will be considered as Unforeseeable Work.

455-23.5 Method Shafts: The cost of all method shafts will be included in the cost of drilled shafts.

455-23.6 Core (Shaft Excavation): The quantity to be paid for will be the length, in feet, measured from the bottom of shaft elevation to the bottom of the core-hole, for each authorized core drilled below the shaft excavation, completed and accepted. When the Engineer authorizes pilot holes extending through part or all of the shaft, prior to excavation, to some depth below the shaft bottom, the quantity paid as core (shaft excavation) will be the length in feet, measured from the top elevation to the bottom elevation authorized by the Engineer, completed and accepted. When SPT tests are substituted for coring or pilot holes as provided in 455-15.6, the quantity will be determined as described above in this Section.

455-23.7 Casings: The quantity to be paid for will be the length, in feet, of each size casing as directed and authorized to be used. The length will be measured along the casing from the top of the shaft elevation or the top of casing whichever is lower to the bottom of the casing at each shaft location where casing is authorized and used, except as described below when the top of casing elevation is shown in the Plans. Casing will be paid for only when the Permanent Casing Method is specified, when the Plans show a casing that becomes a permanent part of the shaft, or when the Engineer directs the Contractor to leave a casing in place which then becomes a permanent part of the shaft. No payment will be made for casings which become bound or fouled during shaft construction and cannot be practically removed. The Contractor shall include the cost of all temporary removable casings for methods of construction other than that of the Permanent Casing Method in the bid price for unclassified shaft excavation item.

When the Permanent Casing Method and the top of casing elevation are specified, the casing will be continuous from top to bottom. Authorization for temporary casing will not be given unless the Contractor demonstrates that he can maintain alignment of the temporary upper casing with the lower casing to be left in place during excavation and concreting operations. When artesian conditions are or may be encountered, the Contractor shall also demonstrate that he can maintain a positive water-tight seal between the two casings during excavation and concreting operations.

When the top of casing elevation is shown in the Contract Documents, payment will be from the elevation shown in the Plans or from the actual top of casing elevation, whichever is lower, to the bottom of the casing. When the Contractor elects to use an approved

special temporary casing system in open water locations, the length to be paid for will be measured as a single casing as provided above.

455-23.8 Load Tests: The quantity to be paid for will be the number and type of load tests conducted.

455-23.9 Instrumentation and Data Collection: The quantity to be paid for will be at the lump sum price.

455-23.10 Thermal Integrity Testing for Drilled Shafts and Cross-Hole Sonic Logging: The quantity of TITDS to be paid for will be the number of drilled shafts accepted based on TITDS tests. When TITDS is not performed in accordance with 455-17.6.1, perform CSL testing at no cost to the City of Doral. No payment will be made for any integrity testing when such testing indicates the shaft cannot be accepted based on the integrity testing itself. No payment will be made for integrity testing performed to evaluate the integrity of post-repair work or for CSL testing not requested by the Engineer. When the Engineer requests CSL tests and the results indicate the shaft is acceptable, the testing will be paid as unforeseen work.

455-24 Basis of Payment.

455-24.1 Drilled Shafts: Price and payment will be full compensation for all drilled shafts, including the cost of concrete, reinforcing steel, nondestructive integrity testing access tubes, embedded thermal wires when required by the Contract Documents, and including all labor, materials, equipment, and incidentals necessary to complete the drilled shaft. The cost of the reinforcing steel, including lap lengths, to accommodate shaft lengths longer than shown in the Plans is included in the cost of drilled shafts. Costs associated with repairing defects found in the drilled shaft shall be included in the cost of the drilled shaft.

455-24.2 Drilled Shafts (Unreinforced): Price and payment will be full compensation for all drilled shafts (unreinforced), including the cost of concrete and all labor, equipment, materials, and incidentals necessary to complete the drilled shaft.

455-24.3 Unclassified Shaft Excavation: Price and payment will be full compensation for the shaft excavation (except for the additional costs included under the associated pay items for casing); removal from the site and disposal of excavated materials; restoring the site as required; cleaning and inspecting shaft excavations; using slurry as necessary; using drilling equipment; blasting procedures, special tools and special drilling equipment to excavate the shaft to the depth indicated in the Plans; and furnishing all other labor, materials, and equipment necessary to complete the work in an acceptable manner.

455-24.4 Method Shafts: No separate payment will be made for method shaft (test hole). All cost of test holes will be included in the cost of drilled shafts.

455-24.5 Core (Shaft Excavation): Price and payment will be full compensation for drilling and classifying the cores/pilot hole, delivering them to the City of Doral, furnishing drilled shaft concrete to fill the core/pilot hole, and all other expenses necessary to complete the work. When SPT tests are substituted for cores/pilot holes as provided in 455-15.6, they will be paid for at the price per foot for coring.

455-24.6 Casings: Price and payment will be full compensation for additional costs necessary for furnishing and placing the permanent casing in the shaft excavation above the costs attributable to the work paid for under associated pay items for unclassified shaft excavation.

455-24.7 Load Tests: Price and payment will include all labor, equipment, material and incidentals required to perform this work, including instrumentation, data collection and professional services to prepare the report.

455-24.8 Thermal Integrity Testing for Drilled Shafts and Cross-Hole Sonic Logging: Price and payment will include all costs related to the performance of the TITDS and CSL testing and incidentals to the thermal integrity and cross-hole sonic tests.

455-24.9 Payment Items: Payment will be made under:

Item No. 455- 88-	Drilled Shaft - per foot.
Item No. 455-107-	Casing - per foot.
Item No. 455-111-	Core (Shaft Excavation) - per foot.
Item No. 455-119-	Test Loads - each.
Item No. 455-122-	Unclassified Shaft Excavation - per foot.
Item No. 455-147-	Thermal Integrity Testing for Drilled Shafts - each.

D. SPREAD FOOTINGS

455-25 Description.

Construct reinforced concrete spread footing foundations, including dewatering when necessary, excavating to the required limits, compacting the underlying soil as required, and constructing seals when required.

455-26 General Requirements.

Meet the following requirements for all spread footings:

1. Perform excavations, including the removal of all material, of whatever nature, necessary for the construction of spread footings. As used herein, the term “soil” shall constitute any material, whether soil, rock, or other materials.
2. Slope excavations as required, or support them with sheeting, and shore them if necessary, to provide a safe excavation that is adequate for construction purposes and that will adequately protect any existing adjacent structures.
3. Ensure that the foundation soils are firm, stable, and meet or exceed the design bearing and compressibility requirements before constructing the footings or any required seals. The City of Doral may elect to use any type of tests to evaluate the foundation soils that is appropriate in the opinion of the Engineer. Cooperate with the Engineer in the evaluation of the foundation soils, and assist the Engineer as necessary to provide access to the site.
4. Modify the elevation of the bottom of footings or seals and the depth of over-excavation shown in the Plans as may be necessary to secure a satisfactory foundation.
5. Place all spread footing concrete in the dry.

Provide safe access and cooperate with the Engineer to perform verification of the spread footing construction.

455-26.1 Foundation Certification Packages

Submit two copies of a letter signed and sealed by the GFDEOR to the Engineer certifying each spread footing has the required axial, lateral and torsional capacity, overturning stability and integrity; and settlement will not affect the functionality of the structure. A separate Foundation Certification Package must be submitted for each foundation unit. A foundation unit is defined as a spread footing. Spread footings must be certified and the certification accepted before continuing with the construction of any structural element above the foundation unit. Correct all integrity problems and non compliance issues prior to submitting the certification packages. The certification shall not be contingent on any future testing or approval by the Engineer.

Within one working day, excluding weekends and City of Doral observed holidays, after receipt of the Foundation Certification Package, the Engineer will examine the records and determine the acceptability of the shallow foundation.

455-27 Monitor Existing Structures.

Monitor existing structures in accordance with Section 108.

455-28 Dewatering.

The Contractor is responsible for the design, installation, and operation of an adequate dewatering system to dewater excavations for spread footings. Use a well point or well system. Submit a dewatering plan to the Engineer for his records before beginning construction.

Use well points or wells where the piezometric water level is above an elevation 3 feet below the bottom of the excavation. Maintain the water table 3 feet or more below the maximum depth of excavation. Provide continuous dewatering until completing construction of the footing and backfill the excavation at least 3 feet above the piezometric water table elevation. In the event of a dewatering failure, determine the effects of such a failure on the foundation soils, and take whatever corrective measures are required at no additional expense to the City of Doral. When discontinuing dewatering, decrease the rate of pumping, allowing the water level to rise slowly. Use a rate, in feet per hour, that the water table is allowed to rise equal to the total number of feet the water table was lowered, divided by ten hours or a rate of 1 foot per hour, whichever is less.

Install one piezometer well approximately every 15 feet of footing perimeter. Provide a minimum of two piezometers at locations within 2 feet from the outside of the footing perimeter. Install piezometer wells to a depth at least 10 feet below the bottom of footing elevation. Measure water elevation in the piezometer wells prior to excavation and at 12-hour intervals between excavation and discontinuation of dewatering. Maintain the piezometers in working condition throughout the dewatering process, and repair or replace them when damaged at no expense to the City of Doral.

455-29 Excavations

If the excavation must be carried deeper than shown in the Plans to obtain a satisfactory foundation, revise the Plans.

455-29.1 Dry Excavations: Dry excavations are excavations that can be completed without the need to lower the piezometric water level. Perform dry excavations when the piezometric water level at the time of construction is and, in the opinion of the Engineer, will remain at least 3 feet below the bottom of the authorized excavation or over-excavation. Demonstrate to the Engineer that a stable excavation can be made without dewatering. Make adequate provisions to divert surface runoff and to collect and remove any water entering the excavation.

Excavate to the bottom of footing, to the over-excavation limits shown in the Plans or as required for forming. Save any suitable materials for backfill. Provide areas for the disposal of all unsuitable materials, and dispose of them in a satisfactory method. Compact the foundation soils below the footing as described herein before constructing the footing.

455-29.2 Dewatered Excavations: Dewatered excavations are excavations made after first lowering the piezometric water level with wellpoints or wells. Perform dewatering as described in 455-28. Excavate in the dry after lowering of the water table.

When dewatering is required, the Contractor may excavate within 3 feet of the ground water table before dewatering begins if the dewatering system is operating and the Contractor has demonstrated that the water level has been lowered to and maintained at acceptable limits. Where large excavations require stage lowering of the water table (additional wellpoint systems installed at lower elevations), the Contractor may continue excavating as long as the water elevation is maintained at least 3 feet below the excavation.

Ensure that surface runoff is diverted from the excavation. Compact the foundation soils as shown in the Plans or as described herein before constructing the footing.

455-29.3 Wet Excavations: Wet excavations are excavations made below the existing water table without prior dewatering. When the Plans show a cofferdam and seal, perform the excavation in the wet. Maintain the water level during excavation at or above the water level outside the cofferdam.

Place the seal directly upon the foundation soils or rock when using wet excavations. Do not compact foundation soils for wet excavations. Ensure that the foundation soils or rock are disturbed as little as practical. Remove all loose or disturbed materials before placing the seal concrete.

455-30 Fill or Backfill.

In all excavations, including over-excavations below the footing, use only fill or backfill materials considered Select in accordance with Standard Plans, Index 120-001. Ensure the material is free of rubble, debris, or rocks that would prevent uniform placement and compaction. Ensure the material below the top of the footing is free of Recycled Asphalt Pavement (RAP). Perform sampling and testing in accordance with 120-10.1.4, except replace FM 1-T99 with FM 1-T180,.

455-31 Compaction and Density Requirements.

Compact the bottom of the excavation with suitable equipment. Compact the soil beneath footing excavation (whether dug to the bottom of footing or over-excavated) to a density not less than 95% of the maximum density as determined by FM 1-T180 for a minimum depth of 2 feet below the bottom of the excavation or to the depth shown in the Plans before backfilling begins. For every 500 feet of excavation or isolated compaction operation, perform two Quality Control (QC) density tests with a 12 inch depth of measurement: one QC density test with the gauge placed at an elevation of 1 foot below the bottom of the excavation and one QC density test with the gauge placed at the bottom of the excavation in accordance with FM 1-T238. Compact the backfill in footing excavations which have been over-excavated to a density not less than 95% of the maximum density as determined by FM 1-T180. Ensure that the maximum lift thickness after compaction does not exceed 6 inches. For every 500 feet of backfill or isolated compaction operation, perform at least one QC density test. The Engineer will conduct one density verification test per every four QC test with a minimum of one density test below the bottom of the excavation and one density test in the backfill. Verification comparison criteria and resolution procedures will be in accordance with 120-10.4 except replace FM 1-T99, with FM 1-T180.

For compaction, use a suitable heavy vibratory roller with a static drum weight of at least 4 tons. Compact each lift to the required density. Also, compact the final lift below the footing with a suitable sled vibratory compactor to remove any upper disturbance caused by the drum roller. When conditions require use of smaller compaction equipment, obtain the Engineer’s acceptance for the equipment, and reduce the lift thickness to achieve the required density.

Perform backfilling to the original ground surface, finished grade, or subgrade as required by the Plans in the immediate vicinity by suitable mechanical compactors weighing less than 1,000 pounds. The Contractor may compact backfill located more than 15 feet away from the exterior periphery of the footing with heavier compactors. Do not place backfill on the footing until the Engineer has given permission and until the concrete is at least seven days old.

When the plans indicate spread footing abutments on mechanically stabilized earth (MSE) walls, place and compact the backfill material underneath the footing in accordance with the requirements of 548-8.5. Meet the density requirements of 548-9.4.

455-32 Forming.

Form spread footings if it cannot be demonstrated that the natural soil or rock is strong enough to prevent caving during construction. For forms, meet the applicable requirements of 400-5. When forms are not required, meet the requirements of 400-5.4.4.

455-33 Materials.

455-33.1 Concrete: Meet the requirements of Section 346.

455-33.2 Reinforcing Steel: Meet the requirements of Section 415. For spread footing reinforcing steel, use Grade 60.

455-34 Reinforcing Steel Placement.

Place and fasten reinforcing steel for footings according to the applicable provisions of 415-5.

455-35 Concrete Placement.

455-35.1 Placement: Place all footing concrete in the dry and according to the applicable provisions of Section 400. Do not construct joints in footings.

455-35.2 Finish: After placing and consolidating the concrete, strike-off the top surface to the grades shown in the Contract Documents, leaving the surface smooth and free of undesirable cavities and other defects. Do not provide a special finish unless the footing will be visible after construction, in which case, meet the applicable provisions of Section 400.

455-35.3 Curing: Provide continuous-moisture-curing for footings. For cover materials, use clean sand, sawdust, or other materials accepted by the Engineer. Continuously wet the cover materials for a period of 72 hours.

455-36 Method of Measurement

455-36.1 Dewatering: No separate payment will be made for dewatering.

455-36.2 Excavation: No separate payment will be made for backfill or will separate payment be made for excavation above bottom of footing elevation. The cost of this work will be included in the Contract unit price for concrete (substructure). For footings with excavation (over-excavation) below the bottom of the footing elevation shown in the Plans, the cost of this excavation, backfilling, and compaction will be included in the Contract unit price for excavation for structures. The pay quantity will be the volume in cubic yards bounded by vertical planes 12 inches outside of the limits of the footing and parallel thereto and extending from the bottom of the footing elevation to the authorized bottom of over-excavation or within the pay limits shown in the Plans. If the elevation of a footing as shown in the Plans is changed to a higher or lower elevation, the Engineer will not consider such change as a material change to the original

Contract Documents, a waiver of any condition of the Contract, or an invalidation of any of the provisions of the Contract.

455-36.3 Reinforcing Steel: The quantity to be paid for will be the total weight, in pounds, determined as described in Section 415.

455-36.4 Concrete: The quantity to be paid for will be the volume of the classes shown in the Plans, in cubic yards, determined as described in Section 400.

455-37 Basis of Payment.

455-37.1 Dewatering: No separate payment will be made for dewatering of footing excavations, including installing, maintaining, and monitoring piezometer wells. Dewatering will be considered Unforeseeable Work when the Engineer determines that dewatering deeper than the requirements described in 455-28 is required.

455-37.2 Excavation: Price and payment will be full compensation for all work related to over-excavating below the bottom of footing elevation, backfill, and compaction as specified.

455-37.3 Reinforcing Steel: Price and payment will be full compensation for all work required to furnish and place the steel as shown in the Plans and as specified herein.

455-37.4 Concrete: Price and payment will be full compensation for all work required to construct footings and seals as shown in the Plans and described herein.

No separate payment will be made for sheeting and shoring required for excavation and footing construction except when a separate pay item for sheeting and shoring is included in the Plans. The cost of all work not specifically mentioned in the other footing items will be included in the price per cubic yard for substructure concrete.

455-37.5 Payment Items: Payment will be made under:

Item No. 125- 1-	Excavation For Structures - per cubic yard.
Item No. 400- 2-	Class II Concrete - per cubic yard.
Item No. 400- 3-	Class III Concrete - per cubic yard.
Item No. 400- 4-	Class IV Concrete - per cubic yard.
Item No. 415- 1-	Reinforcing Steel - per pound.

E. STRUCTURES (OTHER THAN BRIDGE) FOUNDATIONS-AUGER CAST PILES

455-38 Description.

Furnish and install auger cast piles (ACP) or augered cast-in-place (ACIP) piles used for structural support, other than bridge foundations.

ACP piles are defined as a foundation made by rotating a hollow-stem auger into the ground to the required pile depth with sufficient crowd (downward thrust) to prevent mining of the soil. A fluid cement grout is injected through the auger shaft under continuous positive pressure as the auger is being withdrawn. A reinforcing steel cage, as specified, is inserted into the column of fluid grout following the completion of grout placement.

455-39 General Requirements.

455-39.1 Contractor's Operations: Submit an Auger Cast Pile Installation Plan in accordance with 455-47. Prior to the start of production piles, demonstrate to the satisfaction of

the Engineer, the dependability of the equipment, techniques, and source of materials by construction of a demonstration pile.

Provide safe access and cooperate with the Engineer to perform verification of the auger cast pile installation.

455-39.2 Monitor Existing Structures: Monitor existing structures in accordance with Section 108.

455-40 Materials.

Meet the following material requirements:

Portland Cement and Blended Cement	Section 921
Supplementary Cementitious Materials	Section 929
Fine Aggregate (Sand)*	Section 902
Admixtures	Section 924
Water	Section 923
Fluidifier**	ASTM C 937
Reinforcing Steel	Section 415

* The Engineer will only permit Silica Sand except as provided in 902-5.2.3.
** The fluidifier shall not contain chlorides.

455-41 Grout Mix Proportions.

Use a grout mix consisting of a mixture of cementitious materials, admixtures, sand and water. Proportion and mix to produce a grout capable of maintaining the solids in suspension without appreciable bleed water which may be pumped without difficulty and will fill open voids in the adjacent soils and rock. The grout mix may include a fluidifier used in accordance with the manufacturer's technical representative. Proportion these materials to produce a hardened grout of the required strength.

455-42 Mixing and Pumping Cement Grout.

Meet the following requirements:

1. Only use pumping equipment accepted by the Engineer in the preparation and handling of the grout. Before using the mixers, remove all oil or other rust inhibitors from the mixing drums, stirring mechanisms, and other portions of the equipment in contact with the grout.

2. Use a quantity of water and mixing time that will produce a homogenous grout having an efflux of not less than 21 seconds, when tested with a flow cone in accordance with ASTM D6449. Reject loads with efflux of less than 21 seconds. Notify the production facility to adjust the mix design. Calibrate the flow cone in accordance with ASTM D6449. Conduct the calibration initially before its first use and as directed by the Engineer, when there is a question of the flow cone's accuracy.

Technicians performing the efflux test must take the Auger Cast Pile course and pass the final examination to be qualified to test for any auger cast pile installations in the field. Assist the Engineer in verifying the technicians meet these requirements.

Conduct test for efflux time at the beginning of each day's grouting operation and as directed by the Engineer to ensure the Specification requirements are met.

3. Mix the grout at least one minute. If agitated continuously, the grout may be held in the mixer or agitator for a period not exceeding 2.5 hours at grout temperatures below

70ºF; two hours for temperatures from 70°F to 100ºF. Do not place grout when its temperature exceeds 100ºF. If there is a lapse in the operation of grout injection, recirculate the grout through the pump, or through the mixer drum or agitator.

4. Use mixers capable of combining components into a thoroughly mixed and uniform mass, free from balls or lumps and capable of discharging the grout with a satisfactory degree of uniformity. The Engineer's acceptance of grout mixers and all other equipment will be contingent on proper performance during construction of the demonstration pile and subsequent production work.

5. Use a screen no larger than 3/4 inch mesh between the mixer and pump to remove large particles which might clog the injection system.

6. Use a positive displacement piston type grout pump equipped with a pressure gauge, capable of developing displacing pressures at the pump not less than 350 psi. The pump must be appropriately sized to the pile diameter. Provide a grout pressure gage in clear view of the equipment operator. Provide a second pressure gauge near the drill rig where it can be observed by the Engineer.

7. Accurately monitor the volume and pressure of the grout flow. Test and calibrate the equipment during construction of the demonstration pile to demonstrate flow volume measurement accuracy of plus or minus 3% over the range of grouting pressures anticipated during this work. Provide a pump stroke counter in good working condition on the grout pump. Perform a calibration test of the pumping equipment, prior to construction of the demonstration piles, to determine the average volume of grout for every pump stroke, in accordance with FM 5-612. Also calibrate the equipment any time the Engineer determines the grout pump performance may have changed.

455-43 Testing Cement Grout.

Prepare three 4 inches x 8 inches cylinders for each LOT in accordance with ASTM C31, except pour grout in a single lift into cylinders molds without rodding. Plastic properties in accordance with ASTM C31 are not required. A LOT is defined as the lesser of 50 cubic yards of cement grout placed or one day of pile placement. Prepare two additional QC "hold" cylinders on the LOT selected by the Engineer for Verification. Provide curing facilities for all QC and Verification test cylinders in accordance with ASTM C31. Test the cylinders at 28 days, in accordance with ASTM C39.

When one of the three QC cylinders from a LOT is lost, missing, damaged or destroyed, determination of compressive strength will be made by averaging the remaining two cylinders. If more than one QC cylinder from a LOT is lost, missing, damaged or destroyed, core the structure at no additional expense to the City of Doral to determine the compressive strength. Acceptance of LOT may be based on verification data at the discretion of the Engineer. Obtain the approval of the Engineer to core, and of the core location prior to coring. Repair core holes after samples are taken with a product meeting the approval of the Engineer, at no additional cost to the City of Doral.

For each QC cylinder that is lost, missing, damaged or destroyed, payment for that LOT will be reduced by $750.00 per 1,000 psi of the specified design strength [Example: For f'_c=5,500 psi, and the loss of two auger cast pile grout QC cylinders that have no verification data will require the element to be cored and a pay reduction will be assessed (5,500 psi / 1,000 psi) x $750 x 2 = $8,250]. This reduction will be in addition to any pay adjustment for low strength.

The Engineer will cast three verification cylinders and two "hold" cylinders from one of every four consecutive Lots, randomly selected. The Engineer will compare QC and Verification results in accordance with Section 346. If the results do not compare, the Engineer will initiate a Resolution Investigation in accordance with Section 346

Personnel making/curing grout cylinders shall be certified as ACI Concrete Field Testing Technician Grade I. Personnel performing tests on hardened properties of grout, such as strength determination of cylinders or beams, shall be certified as ACI Concrete Strength Testing Technician.

All low strength cement grout accepted by the Engineer will be subject to reduced payment as follows: $0.80 per cubic yard for each 10 psi of strength test value below the specified minimum strength. The Engineer will use the average compressive strength of the LOT tests for the computation of this pay reduction.

The Engineer will compute the volume of grout for which the reduction will be applied as 115% of the theoretical volume of the auger cast pile diameter required in the Contract Documents. Reduction in pay will be applied to the entire length of all piles containing low strength cement grout, in any quantity. The quantity of cement grout affected by the payment reduction may exceed the quantity of cement grout contained in the LOT.

When a cement grout acceptance strength test falls more than 500 psi below the specified minimum strength, perform one of the following:

1. Remove and replace the piles affected fully or partially by the low strength LOT at no additional cost to the City of Doral, or

2. Submit a structural analysis performed by the Contractor's Engineer of Record. If the results of the analysis, approved by the City of Doral, indicate adequate strength to serve the intended purpose with adequate durability, the concrete may remain in place.

Otherwise, abandon and install additional piles to the foundation, or remove and replace the piles affected fully or partially by the low strength LOT of grout at no additional cost to the City of Doral. When installing additional piles to resolve the strength deficiency, submit a foundation redesign to add piles into pile caps or footings, at no expense to the City of Doral in accordance with 455-46.

455-44 Pile Installation.

Meet the following requirements:

1. Locate the piles as shown on the drawings.

2. Should soft, compressible muck, organics, clay or other unsuitable materials (non A-1, A-3, A-2-4 or limestone materials) be encountered, remove the unsuitable material to a maximum depth of 5 feet and a radial distance around the pile centerline of two pile diameters unless otherwise indicated in the Plans. Backfill with clean granular backfill materials (A-1, A-3, A-2-4), placed and compacted in maximum 12 inch lifts to at least 95% of maximum dry density as determined by FM 1-T180. Complete this work to the Engineer's satisfaction prior to ACP construction. Should more than 5 feet depth or excessive quantities of unsuitable material be encountered, submit a revised design to the Engineer for review and acceptance prior to proceeding with pile construction.

3. Provide continuous auger flighting from the auger head to the top of auger with no gaps or other breaks. Ensure the auger flights are uniform in diameter throughout its length, and of the diameter specified for the piles less a maximum of 3%. Provide augers with a distance between flights of approximately half the diameter of the auger.

4. Use augers with the grout injection hole located at the bottom of the auger head below the bar containing the cutting teeth, and with pile auger leads containing a bottom guide.

5. Construct piles of the length and diameter shown on the Plans.

6. Clearly mark the auger leads to facilitate monitoring of the incremental drilling and grout placement. Provide individual foot marks with 5 foot increments highlighted and clearly visible. Provide a clear reference mark on the moving auger assembly to facilitate accurately monitoring the vertical movement of the auger.

7. Place piles by rotating a continuous flight hollow shaft auger into the ground at a continuous rate that prevents removal of excess soil. Stop advancement after reaching the predetermined depth.

8. Should auger penetration to the required depth prove difficult due to hard materials/refusal, the pile location may be predrilled, upon concurrence by the GFDEOR and acceptance of the Engineer, through the obstruction using appropriate drilling equipment, to a diameter no larger than 1/2 the prescribed finish diameter of the ACP. Commence ACP construction immediately upon completion of predrilling to minimize ground loss and soil relaxation.

9. Plug the hole in the bottom of the auger prior to advancing into the ground..

10. Pump the grout with sufficient pressure as the auger is withdrawn to completely fill the auger hole, preventing hole collapse and to cause the lateral penetration of the grout into soft or porous zones of the surrounding soil or rock. Prior to commencing withdrawal of the auger, establish a head of at least 5 feet of grout by pumping a volume of grout equivalent to 5 feet of pile volume. Maintain this head of at least 5 feet of grout above the injection point around the perimeter of the auger to displace and remove any loose material from the hole. Maintain positive rotation of the auger at least until placement of the grout.

11. Once the grout head has been established, greatly reduce the speed of rotation of the auger and commence extraction at a rate consistent with the pump discharge. Maintain extraction at a steady rate to prevent a locked-in auger, necking of the pile, or a substantially reduced pile section. Ensure grout starts flowing out from the hole when the cutting head is at least 5 feet below the ground surface. Place a minimum volume of grout in the hole of at least 115% of the column of the auger hole from a depth of 5 feet to the tip. Place a minimum volume of grout in the hole of at least 105% of the column of the auger hole from the ground surface to a depth of 5 feet. Do not include any grout needed to create surplus grout head in the volume of grout placed into the hole. If the grout does not flow out from the hole when the cutting head is at least 5 feet below the ground surface, redrill the pile. If grouting is interrupted for any reason, reinsert the auger by drilling at least 5 feet below the tip of the auger when the interruption occurred, and then regrout.

Use this method of placement at all times. Do not depend on the stability of the hole without the earth filled auger. Place the required steel reinforcement while the grout is still fluid, but no later than 1/2 hour after pulling of the auger.

12. Assume responsibility for the grout volume placed. If less than 115% of the theoretical volume of grout is placed in any 5 foot increment (105% in the top 5 foot increment), reinstall the pile by advancing the auger 10 feet or to the bottom of the pile if that is less, followed by controlled removal and grout injection.

13. Furnish and install the reinforcing steel and anchoring bolts as shown in the Contract Documents. Use wheels or other approved noncorrosive spacing devices within 3 feet of the bottom, within 3 feet of the top, and intervals not exceeding 10 feet along the pile to

ensure concentric spacing for the entire length of the cage. Do not use block or wire type spacers. Use a minimum of one spacer per 30 inches of circumference or perimeter of cage with a minimum of three at each level.

14. Use reinforcement that is without kinks or nonspecified bends, free of mud, oil or other coatings that could adversely affect the bond. Make splices in reinforcement as shown on the Contract Documents, unless otherwise accepted by the Engineer. Place the required steel reinforcement while the grout is still fluid, and immediately after finishing grouting and clearing it from any contaminating material. Install t steel cage into the grout by its own weight or manually. Do not use a mechanical equipment or tool to impact the steel cage or to force it into the grout.

15. Leave any temporary supports of/for items placed into a grouted pile (reinforcement template, anchor bolt template, precast column supports, etc.) in place for a minimum of 12 hours after completion of the pile. Do not place wall panels or other significant loads, before the grout has set a minimum of seven days or reached the 28 day strength.

455-45 Construction Tolerances.

Locate piles as shown on the Plans. Locate pile centers to an accuracy of plus or minus 3 inches. Ensure that the top of pile elevation is within plus or minus 3 inches of the Plan elevation. Ensure the tolerances of 534-5.1 can be met.

455-46 Unacceptable Piles.

Repair or replace unacceptable piles and/or modify the design to compensate for the deficiency at no cost to the City of Doral. Unacceptable piles are defined as piles that fail for any reason, including but not limited to the following: piles placed out of position or to improper elevation; piles with reduced cross section, contaminated grout, lack of grout consolidation (honeycombed), or deficient grout strength; and piles with reinforcement, anchor devices or other components cast or placed into the fluid grout out of position. When the Engineer determines that a pile is unacceptable, the Contractor may propose a foundation redesign to add piles to the foundation, at no expense to the City of Doral. The Contractor's Engineer of Record must perform any redesign, and sign and seal the redesign drawings and calculations. Do not begin any proposed construction until the redesign has been reviewed and approved by the Engineer.

455-47 Auger Cast Pile Installation Plan (ACPIP).

No later than 15 days before ACP construction begins, submit the ACPIP for acceptance by the Engineer. The ACPIP shall govern all ACP construction activities. In the event that deviations from this installation plan are observed, the City of Doral may perform Independent Verification Testing/Review of the Contractor's equipment, procedures, personnel and ACP construction at any time during ACP construction. If, as determined by the City of Doral, construction equipment, procedures and/or personnel is deemed inadequate to consistently provide auger cast piles meeting the contract requirements, the Contractor's ACPIP acceptance may be withdrawn pending corrective actions. All ACP construction activities shall then cease and not restart until corrective actions have been taken and the ACPIP has been re-accepted.

Provide the following detailed information on the ACPIP:

1. Name and experience record of ACP superintendent or foreman in responsible charge of ACP operations. Place a person in responsible charge of day to day ACP operations meeting the experience requirements of 105-8.13 constructing ACP similar to those described in

the Contract Documents. The Engineer will give final acceptance subject to satisfactory performance in the field.

2. List and size of the proposed equipment, including cranes, augers, concrete pumps, mixing equipment etc.

3. Details of grout mixing procedures and proposed pump calibration procedures.

4. Details of pile installation methods.

5. Details of reinforcement placement and method of centering in pile, including details of all temporary supports for reinforcement, anchor bolts, precast columns, etc.

6. Details of how and by whom the grout volumes will be determined, monitored and documented.

7. Required submittals, including shop drawings and cement grout design mixes.

8. Equipment and procedures for visual inspection, and any methods to identify and remediate auger cast pile deficiencies.

9. Name of the inspectors assigned to monitor the installation of the auger cast piles, including evidence of the inspectors having taken and passed the CTQP computer based training course for auger cast piles.

10. Other information requested by the Engineer.

11. A letter from the GFDEOR certifying concurrence with the ACPIP.

The Engineer will evaluate the ACPIP for conformance with the Contract Documents. Within five working days after receipt of the plan, excluding weekends and City of Doral observed holidays, the Engineer will notify the Contractor of any comments and additional information required and/or changes that may be necessary to satisfy the Contract Documents. The Engineer will reject any part of the plan that is unacceptable. Submit changes agreed upon for reevaluation. The Engineer will notify the Contractor within two working days, excluding weekends and City of Doral observed holidays, after receipt of proposed changes of their acceptance or rejection. All equipment and procedures are subject to trial and satisfactory performance in the field. Acceptance by the Engineer does not relieve the Contractor of the responsibility to perform the work in accordance with the Contract Documents. The Engineer's acceptance is not a guarantee that the chosen methods and equipment are capable of obtaining the required results, this responsibility lies with the Contractor.

455-48 Inspection and Records.

Monitor and record pile installation utilizing the most recent version of the Florida Department of Transportation's Auger Cast-In-Place Pile Installation Record form.

455-49 Method of Measurement.

The quantity to be paid for auger cast pile will be at the Contract unit price per foot between tip and required pile top elevations for all piles completed and accepted.

455-50 Basis of Payment.

455-50.1 Auger Cast Piles: Price and payment will be full compensation for all labor, materials, and incidentals for construction of ACP of the sizes and depths indicated on the Contract Documents or as otherwise directed by the Engineer. Price and payment will also include the removal and proper disposal off site of all spoil from the auger operation and all excess grout displaced from the auger hole, unless otherwise approved by the Engineer. Work to remove and replace unsuitable material when necessary as specified in 455-44 will be considered Unforeseeable Work.

455-50.2 Payment Items: Payment will be made under:

Item No. 455-112- Auger Grouted Piles - per foot.

455-51 Foundation Certification Packages

Submit two copies of a letter signed and sealed by the GFDEOR to the Engineer certifying each foundation unit has the required axial capacity, lateral stability and integrity, and settlements will not affect the functionality of the structure. A separate Foundation Certification Package must be submitted for each foundation unit. The foundation unit is defined as a group of piles per wall segment or per full wall. Every ACP must be certified and the certification accepted before continuing with the construction of any structural element over the foundation unit. Each Foundation Certification Package shall include all ACP logs, the Department spreadsheet properly completed for every ACP and the grout strength test results of the lots sampled. Correct all integrity problems and noncompliance issues prior to submitting the certification packages. The certification shall not be contingent on any future testing or approval by the Engineer. Within three working days, excluding weekends and City of Doral observed holidays, after receipt of the Foundation Certification Package, the Engineer will examine the records and determine the acceptability of the auger cast piles. The Engineer will reject any certification package that is incomplete or indicates noncompliance with the specifications without the issue being corrected to the satisfaction of the Engineer.

If any ACP is found to be deficient, correct the deficiency (i.e. repair or replace the ACP) and/or modify the design to compensate for the deficiency. In case of disagreement of test results, the Engineer's results will be final and used for determination of acceptance.

After meeting the time requirements of 455-44(15), the Contractor may place panels prior to a complete submittal of the Certification Package at their own risk. If the Engineer determines that verification testing is needed, the Contractor will perform all work and provide all labor, at no additional cost to the City of Doral, necessary to allow access to the piles requiring verification. Replace or redesign and reconstruct, to the satisfaction of the Engineer, any foundation found to be unacceptable after submittal of the certification packages or after verification testing, at no cost to the City of Doral.

City of Doral

DESIGN-BUILD PROJECT FOR PEDESTRIAN BRIDGE OVER NW 41ST STREET AT HEFT
FINANCIAL PROJECT ID: 441642-1-58-01

ATTACHMENT A-13
Value Added Bridge Component
(DEV 475)

VALUE ADDED BRIDGE COMPONENTS.
(City of Doral Revision 01-16-2020)

Section 475 (Rev 3-18-15) is replaced with the following:

SECTION 475
VALUE ADDED BRIDGE COMPONENTS

475-1 Description.

Construct Value Added Bridge Components (VABC), when included in the Contract, consisting of those features provided for in the Design and Construction Criteria and/or the Technical Proposal and subject to a Materials and Workmanship Warranty.

The Contractor shall assume responsibility for all the associated warranty work specified in this section for a minimum period of five years, unless otherwise stated in the contract, after final acceptance of the Contract in accordance with 5-11, including continued responsibility as to any deficiencies to which notice was provided to the Contractor within such warranty period until all such pre-existing deficiencies are resolved.

475-2 Responsible Party.

For the purpose of VABC, the Contractor shall be the Responsible Party unless otherwise agreed to in writing by the City of Doral. Upon final acceptance of the Contract in accordance with 5-11, the Contractor's responsibility for maintenance of all the work or facilities within the project limits of the Contract will terminate in accordance with 5-11; with the sole exception that the obligations set forth in this section for bridge components shall continue thereafter to be the responsibility of the Responsible Party as otherwise provided in this section.

475-3 Evaluation and Remedial Action.

475-3.1 Definition of Value Added Bridge Components: The following is a definition of the bridge components for which this provision applies and for which the Responsible Party shall warrant performance:

Bridge Deck Expansion Joint Devices and Hardware: Any device, with its accompanying hardware, that is installed inside the top of an expansion joint of a bridge deck in order to provide a smooth riding surface across the joint opening and to prevent water and debris from entering the joint. This includes expansion devices that are designed to handle large expansions and contractions such as modular bridge expansion devices.

Coatings: Paints, applied finishes or applied coatings that are used on the metal, concrete or wood surfaces of structures for the purpose of protection from the elements or for aesthetic enhancement.

Bearing Devices: A metal and/or elastomeric device that transfers loads and accommodates rotation and translation from a bridge superstructure element such as a beam, to a bridge substructure element such as a pier or bent without damage or overstress of either the substructure or the superstructure. All bearings transfer vertical loads, but fixed bearings only

allow rotation and do not allow the superstructure to translate horizontally (expand and contract) in relation to the substructure. Expansion bearings allow the superstructure to translate horizontally as well as to rotate in relation to the substructure.

Bridge Lighting/Electrical Systems: All electric power, electric control devices, and solar power units with accompanying hardware that are used to provide bridge navigation lighting, aesthetic lighting, and electric power for receptacles and lights used by maintenance and inspection personnel.

Drainage Systems: All components of the bridge deck drainage system including anchorages, hangers, pipes, couplings, bends, inlets, cleanouts and grates.

475-3.2 Value Added Performance Period: The Responsible Party shall warrant performance of bridge components for at least the following periods or for a longer period if offered by the Contractor in his proposal which starts on the date of final acceptance of the Contract:

(a) Bridge Deck Expansion Joint Devices and Hardware: Armor and Hardware - 5 years, Seals - 5 years
(b) Coatings: 5 years
(c) Bearing Devices: 5 years
(d) Bridge Lighting/Electrical Systems: 5 years
(e) Drainage Systems: 5 years

475-3.3 Deficiencies/Defects Requiring Remedial Action. The following is a detailed description, for each type of structural component, of deficiencies/defects that will require remedial action by the Responsible Party:

475-3.3.1 Bridge Deck Expansion Joint Devices and Hardware: water leakage through joints; separation of the seal from the steel or concrete substrate; failure of the seal material such as cracking, chalking, scaling, peeling, or splitting; sagging of elastomeric seal; warping of the steel plate or extrusion that is detrimental to the functioning of the joint; separation of the steel plate or extrusion from the deck concrete; spalling or delamination of the deck concrete within 18 inches of either side of the joint; and any defect in modular bridge expansion joint elements including backing bars, steel extrusions, flexible membranes, proportioning bars, bushings, pins, bearings, side frames, and tracks.

475-3.3.2 Coatings: visible corrosion or corrosion break through; blistering, peeling or scaling of the coating; application of the coating over debris, blasting medium, mill scale or corrosion products; coating thickness less than specified by the manufacturer; damage to the paint system due to the Contractor's operations during construction; or excessive fading or chalking of the coating as determined by the paint manufacturer's performance standards for the coating in question.

475-3.3.3 Bearing Devices: evidence of failure of any of the elements of the bearing assembly; cracks, checks, peels or corrosion present in the protective coating of the bearing or in the neoprene of elastomeric bearings; the bearing freezes or fails to allow the bridge to move as designed; or the bearing moves out or "walks out" of its designated position and; therefore, does not perform as designed.

475-3.3.4 Bridge Lighting/Electrical Systems: loose, substandard or failed wiring, conduit, anchorages, expansion couplings, and junction boxes; inoperable lighting

fixtures, contactors, switches or receptacles; inadequate grounding or surge protection; and defective circuit breakers, step down transformers and photo cells.

475-3.3.5 Drainage Systems: grates that will not stay in position as designed or that fail to collect debris as intended; leaking pipes, couplings, bends, cleanouts or inlets; anchorages and hangers that are defective or that do not function properly; unacceptable drainage discharge rates due to blockages in the system that are a result of construction defects and not solely attributable to accumulation of debris.

475-3.4 Required Remedial Action and Response Times: The Responsible Party will be required to remediate the deficiencies/defects described in 475-3.3, by taking the actions set forth in this provision for each type of VABC. The Responsible Party shall perform the required remedial actions within the maximum response times set forth in this provision and which start when written notification is received by the Responsible Party from the City of Doral or when there is an emergency situation, response time starts with the City of Doral's verbal notification which will be followed up in writing. If replacement components require a lengthy acquisition period, the maximum repair duration as specified in this provision will be extended at the Engineer's discretion. If the maximum response time will result in the Responsible Party completing the work after the performance period, as specified in 475-3.2, has expired then the expiration date for the affected structural component will automatically be extended to whichever comes first: the end of the maximum response time period or completion of the remedial action.

The Responsible Party shall complete all remedial work to the satisfaction of the Engineer.

The Statewide Disputes Review Board will resolve any disputes regarding the adequacy of the remedial work. Approval of remedial work does not relieve the Responsible Party from continuing responsibility under the provisions of this Specification.

Not less then 7 days prior to beginning any non-emergency remedial work, notify the Engineer in writing of the date when remedial work will begin. Meet the requirements of the Florida Department of Transportation's latest version of the Standard Specifications for Road and Bridge Construction when performing any remedial work.

Submit a written Work Plan to the Engineer for approval and do not begin remedial work until approval is received. The Work Plan shall describe the phases of construction that are planned and generally explain for each phase, the construction methods to be employed. In addition, the Work Plan shall list the materials that will be incorporated into the permanent VABC. For emergency situations, the Responsible Party shall discuss the Work Plan with the Engineer verbally and the Engineer will issue a temporary approval in order to allow work to begin in a timely manner. A written Work Plan as specified above will be required if the duration of the emergency remedial work extends beyond 72 hours.

Perform all remedial work at no cost to the City of Doral.

475-3.4.1 Bridge Deck Expansion Joint Devices and Hardware: Damaged seals shall be removed and replaced with new seals. Seals that are displaced shall be completely removed, the joint shall be cleaned, and the seal may be reinstalled if not damaged during removal. Steel elements that are damaged, misaligned, or non-functional shall be restored to complete and full functionality. Remedial action for joint defects that represent an immediate

traffic safety hazard (an emergency condition) shall begin within 4 hours of notification and work shall progress without interruption, 24 hours a day, until the immediate traffic safety hazard has been eliminated. Any remaining remedial work shall be completed as a non-emergency condition. For defects that may become a safety hazard in the near future, such as loose joint armor, remediation shall begin after 4 hours or as determined by the Engineer and shall be completed within 90 days. For all other defects, remediation shall be completed within 180 days.

475-3.4.2 Coatings: Repair or restore coatings as recommended in writing by the coating manufacturer's technical advisors with concurrence of the Engineer. Remediation shall be completed within 180 days.

475-3.4.3 Bearing Devices: Bearings shall be removed and replaced with new bearings or with approval of the Engineer, be restored to new condition and be reinstalled. Remediation shall be completed within 30 days if the structure is displaying any sign of immediate structural damage to any element other than the bearing device/s due to a bearing device defect. All other bearing device defects shall be corrected within 90 days.

475-3.4.4 Bridge Lighting/Electrical Systems: Navigation lights shall be restored immediately (emergency situation) and the Responsible Party may use a temporary system if the permanent lighting cannot be restored immediately. If, after verbal notification of failure by the City of Doral, the Responsible Party states that it cannot respond immediately to a navigation light failure then the City of Doral will respond at the Responsible Party's expense. Aesthetic and inspection lighting shall be restored within 90 days. Defective electrical components that are isolated such as receptacles, photo cells or surge protectors, and that are not causing an entire electrical system to malfunction, shall be corrected within 120 days.

475-3.4.5 Drainage Systems: Replace or repair defective grates. Permanently repair any system leaks. Full drainage discharge rates shall be restored if reduced drainage discharge rates exist due to construction defects or other system deficiencies that occurred because of substandard construction practices. Repair or replace any nonfunctional or defective anchorages and hangers. Remedial action for drainage deficiencies that represent an immediate traffic safety hazard (an emergency condition) shall begin within 6 hours of notification by the City of Doral and work shall progress without interruption, 24 hours a day, until the immediate traffic safety hazard has been eliminated. Any remaining remedial work shall be completed as a non-emergency condition. For all other deficiencies, remediation shall be completed within 180 days.

475-4 Notification of Deficiencies/Defects and Inspections.

The City of Doral will identify deficiencies/defects in a written report that will be transmitted to the Responsible Party along with an official notification of required remedial action if warranted. The City of Doral will also transmit copies of periodic bridge deficiency reports to the Responsible Party as they become available so that the Responsible Party can be aware of a deteriorating condition that may not require immediate remediation but that could give the Responsible Party an opportunity to perform an optional, more economical, preventive action. If an "Emergency Situation" exists, Responsible Party notification shall be provided verbally by the City of Doral with written follow-up. In either case, the Responsible Party shall perform remedial actions in accordance with 475-3.4. If the Responsible Party fails to, or

provides notification that it is unable to, begin work within the time designated in 475-3.4 or if the Responsible Party notifies the City of Doral that it is unable to perform an acceptable remedial action, then the City of Doral reserves the right to perform the remedial action at the Responsible Party's expense.

475-5 Disputes Resolution.

A Statewide Disputes Review Board dedicated to the resolution of value added disagreements will be utilized to resolve any and all disputes that may develop as a result of the administration and enforcement of this specification. The Responsible Party and the City of Doral acknowledge that use of the Statewide Disputes Review Board is required and the determinations of the Board for disputes arising out of this VABC specification will be binding on both the Responsible Party and the City of Doral, with no right of appeal by either party.

Any and all Board meetings after final acceptance of the Contract in accordance with 5-11, shall be requested and paid for by the Responsible Party. The City of Doral will reimburse the Responsible Party for all fees associated with meetings.

475-6 Value Added Work.

During the value added performance period, the Responsible Party shall perform all necessary remedial work described in the Contract. Should an impasse develop in any regard as to the need for remedial work or the extent required, the Statewide Disputes Review Board will render a final decision.

The value added obligation for VABC will not apply to deficiencies if any of the following factors are found to be beyond the control of the Responsible Party: determination that the deficiency was due to the failure of other features not a part of the Contract; determination that the deficiency was the responsibility of a third party performing work not included in the contract or was the responsibility of an individual(s) that is not under the control of the Responsible Party or Contractor; or determination that the deficiency was caused by an act or event after final acceptance of the project, such as storm damage or vehicle impact, that is not under the control of the Responsible Party or Contractor.

475-7 Failure to Perform.

Should the Responsible Party fail to satisfactorily perform any remedial action, or fail to compensate the City of Doral for any remedial action performed by the City of Doral, as determined by the Statewide Disputes Review Board to be the Responsible Party's responsibility, the City of Doral shall suspend, revoke or deny the Responsible Party's certificate of qualification under the terms of Section 337.16(d)(2), Florida Statutes, until the remedial work has been satisfactorily performed or full and complete payment for the remedial work is made to the City of Doral. In no case shall the period of suspension, revocation, or denial of the Contractor's certificate of qualification be less than six (6) months. Should the Responsible Party choose to challenge the City of Doral's notification of intent for suspension, revocation or denial of qualification and the City of Doral's action is upheld, the Responsible Party shall have its qualification suspended for a minimum of six (6) months or until the remedial action is satisfactorily performed, whichever is longer.

The remedial work is not an obligation of the Contractor's bond required by Section 337.18, Florida Statutes.

475-8 Traffic Control.

During remedial action operations, perform all signing and traffic control in accordance with the current edition of the Florida Department of Transportation's Design Standards, Traffic Control through Work Zones. Provide Maintenance of Traffic (MOT) during remedial work at no additional cost to the City of Doral. For non-emergency remedial work, the Engineer must approve all lane closures and traffic control plans in advance and notification of lane closures shall be made to the Engineer 48 hours in advance. For emergency remedial work and if the Responsible Party requests it, the City of Doral will provide temporary MOT until the Engineer approves the Responsible Party's Traffic Control Plan. If MOT is requested, the Responsible Party shall reimburse the City of Doral for all temporary MOT costs. In addition, if the urgency of the remedial work is such that the City of Doral must provide MOT immediately and without delay prior to contacting the Responsible Party then the responsible Party shall reimburse the City of Doral for all temporary MOT costs. Regardless of the City of Doral's provision of MOT, the Responsible Party shall make every effort to submit a Traffic Control Plan in a timely manner to the Engineer and upon approval, shall deploy the permanent MOT expeditiously.

475-9 Basis of Payment.

All costs associated with remediation of VABC including, but limited to, labor, equipment and materials required for satisfactorily completion of the remediation work; traffic control through the work zone; and access to the remediation site shall be paid for solely by the Responsible Party unless the Statewide Disputes Review Board determines otherwise.

City of Doral

DESIGN-BUILD PROJECT FOR PEDESTRIAN BRIDGE OVER NW 41ST STREET AT HEFT
FINANCIAL PROJECT ID: 441642-1-58-01

ATTACHMENT A-14
PAVEMENT DESIGN MEMORANDUM

M E M O R A N D U M

DATE: January 6, 2020

TO: Eugene Collings-Bonfill, P.E., Chief Engineer

FROM: Allan B. Sequeira, P.E., Engineer of Record

COPIES: File

SUBJECT: **Pavement Design Memorandum**
Financial Project ID: TBD
Pedestrian Bridge crossing over Doral Boulevard (NW 41st Street) at HEFT
Miami Dade County

The purpose of this project is to install a pedestrian bridge over Doral Boulevard/NW 41st Street in the vicinity of the Florida Turnpike. The proposed pedestrian bridge is a needed link between existing Turnpike Trail shared use paths north and south of NW 41st Street/Doral Boulevard, a heavily traveled arterial within the City of Doral. The proposed pedestrian bridge will provide a safe passage for pedestrians and bicycles and will also be an opportunity to be a landmark for the City of Doral and serve as a gateway into the City from the Florida Turnpike.

Per Table 5.5 in the 2020 FDOT Flexible Pavement Design Manual, the minimum pavement design for a new shared use path is 1.5" of structural course (Type SP-9.5) over OBG 1. A 12" stabilized subgrade (LBR 40) is required to establish a satisfactory working platform. This memo will serve to document the proposed pavement design.

_____
Engineer of Record: Allan B. Sequeira, P.E.
Date: _____

_____
Concurred by:
David Soler, P.E.
Senior Project Manager
Date: _____

_____
Concurrence by:
Eugene Collings-Bonfill, P.E.
Chief Engineer
City of Doral
Date: _____

City of Doral

DESIGN-BUILD PROJECT FOR PEDESTRIAN BRIDGE OVER NW 41ST STREET AT HEFT
FINANCIAL PROJECT ID: 441642-1-58-01

ATTACHMENT A-15
VIDEO SURVEILLANCE SYSTEM AND INFORMATION TECHNOLOGY(VSSIT) REQUIREMENTS

TABLE OF CONTENTS

1 VIDEO SURVEILLANCE SYSTEM AND INFORMATION TECHNOLOGY (VSSIT) GENERAL REQUIREMENTS

This section sets forth the requirements for design, construction, and technical requirements for Video Surveillance System and Information Technology (VSSIT) component readiness as part of the Pedestrian Bridge Over NW 41st Street at HEFT.

1.1 PROJECT OVERVIEW

The requirements herein are for the design and construction of the Pedestrian Bridge facility's VSSIT elements desired by the City of Doral hereinafter referred to as the City. This sub-section provides a general description of requirements for the design and installation of the following VSSIT readiness components to be installed as part of the Pedestrian Bridge facility.

- Pedestrian Bridge Video Surveillance System (VSS) provisions;
- IT Communication Equipment Room (IT Room);
- Specialty Lighting Provisions (conduit and pull boxes only); and
- Conduit for power and communications.

The readiness components installed on the Project will be used by the City of Doral to install a Video Surveillance System (VSS) consisting of closed television (CCTV) cameras, network switches and servers to be furnished by the City.

1.2 PROJECT OBJECTIVE

The Design-Build Firm shall design, furnish and install readiness components described in this document. The components installed with this Project will allow the City of Doral with the functionality and capability for:

- Pedestrian Facility Video Surveillance System for real time remote monitoring from the City Hall
- 100% Video coverage of the Pedestrian Bridge Facility (Lower and Upper Levels)
- IT Communications Equipment Room for connectivity with the City Hall
- Provisions for Electronic Access Control System to the IT Communications Equipment Room
- Provisions for network expansion to support other City of Doral technology (e.g. specialty lighting)

1.3 PROJECT DESCRIPTION AND GENERAL REQUIREMENTS

The Project includes the design and installation of a VSS readiness components including access points for CCTV camera locations, conduits, supporting infrastructure and construction of an IT communications equipment room for connectivity of the Pedestrian Bridge and the City Hall.
All proposed CCTV camera location access points shall include conduit runs terminating inside the IT equipment room on the southside of the pedestrian bridge facility. Communications from the Pedestrian Bridge facility with the City Hall's headquarters will be by way of a leased line connection or other leased line to be provided by the City of Doral. The Design-Build Firm shall coordinate with the City for final determination of these connections during the design process.

At a minimum, the Design-Build Firm shall provide the following VSSIT components:

- Design and install video surveillance system CCTV camera access locations for the Pedestrian Bridge to provide full coverage of the facility's lower and upper level public access areas (locations described separately herein)
- Design and construction of an environmentally controlled IT Room.
- Design and install 1" conduit infrastructure for communications of the proposed surveillance CCTV cameras with the IT Room (see conduit requirements).
- Design and install 1" conduit in the IT Room to support electronic access control system.
- Design and install pull boxes and conduits the Leased line access point to the IT Room.
- Design and install a power system for the IT Room.
- Design and install all ancillary elements necessary for the proper functioning of the CCTV camera system, except for the installation of the CCTV cameras.

All CCTV cameras will be furnished and installed by the City of Doral. Back-office components (servers, network switches, monitoring stations) for Video Surveillance System will be provided by City of Doral's Information Technology department and will be housed at the City Hall located at:

8401 NW 53rd Terrace,
Doral, FL 33166

1.4 ROLES AND RESPONSIBILITIES

The Design-Build Firm shall be responsible for the preliminary and final design, engineering analysis, QA/QC, coordination with the City of Doral, permitting, and construction of the Project.

The Design-Build Firm shall be responsible to obtain all permits for Construction. The Engineer of Record for the Design-Build Firm shall prepare a set of Plans to be used to build the Project. The Design-Build Firm shall be responsible to deliver accurate as-built plans prior to Final Acceptance.

Elements of the Work include VSSIT components, IT Room construction, communications infrastructure and power connectivity. At the conclusion of the Project's VSSIT component readiness construction, the Design-Build Firm shall furnish all documents and As-Built Plans to the City.

The Design-Build Firm shall use the criteria presented in the Solicitation Documents as a basis for the Design, unless otherwise approved by the City of Doral.

The City of Doral will provide contract oversight, Construction Engineering & Inspection (CE&I) Services and quality acceptance review of all Work associated with the development and preparation of the Plans and construction of the improvements.

1.5 GOVERNING REGULATIONS AND PROVISIONS FOR WORK

This section sets forth the minimum design standards and requirements in addition to those listed in Section V of the RFP for design and construction of the proposed Surveillance System and IT components as identified in this document.

The services performed by the Design-Build Firm shall be in compliance with all applicable Standards, Manuals and Guidelines including but not limited to those listed in this document and the Solicitation and Contract Documents.

All components, supplies, installations and testing shall comply with the Project requirements, the latest editions of the following standards, as applicable, and the applicable standards of the entities in the following list. The following list is not intended to be all-inclusive:

- Telcordia / Bellcore Technical Standards;
- American Society for Testing and Materials (ASTM) standards;
- Institute of Electrical and Electronics Engineers (IEEE) standards;
- International Standards Organization (ISO) standards;
- American National Standards Institute (ANSI);
- National Electrical Manufacturers Association (NEMA);
- Underwriters' Laboratories (UL);
- National Fire Protection Association (NFPA);
- Electrical Testing Laboratories (ETL);
- Electronic Industries Alliance (EIA);
- National Electrical Code (NEC);
- Lightning Protection Institute (LPI);
- American Standard Code for Information Interchange (ASCII);
- National Television System Committee (NTSC);
- Moving Picture Experts Group (MPEG);
- National Transportation Communications for ITS Protocol (NTCIP);
- Telecommunications Industry Association (TIA).

1.6 MISCELLANEOUS DELIVERABLES

The Design-Build Firm shall provide to the City of Doral deliverables as listed below, including but not limited to:

- Design Plans
- Utility Layout Plans
- As-Built Plans
- IT Room Layout
- Power and Communication conduit runs
- IT Room HVAC user manual

The Design-Build Firm shall provide to City hard copies and electronic of the As-Built Plans, manuals and warranties as required int the RFP.

2 PROJECT TECHNICAL REQUIREMENTS

2.1 GENERAL

This document sets forth the minimum requirements for the design and construction of the various VSSIT elements within the Pedestrian Bridge facility. At a minimum, the VSSIT includes:

- Pedestrian Bridge Video Surveillance System CCTV Camera Access Points;
- IT Communication Equipment Room (IT Room);
- Network Equipment Rack;
- Specialty Lighting Provisions; and
- Conduit for power and communications.

The Design-Build Firm shall be responsible for all Work required in this document, as well as all additional site specific Work required to construct the VSSIT elements including but not limited to coordination with stakeholders and City of Doral.

2.2 VIDEO SURVEILLANCE SYSTEM ACCESS POINTS

2.2.1 Description

The City currently is currently operating and maintaining Video Surveillance System installed at various public/pedestrian access areas. The Video Surveillance System consists of CCTV cameras which are monitored remotely from the City Hall's headquarters. Cameras used by the City are manufactured by Axis and as such current vendor CCTV cameras will be furnished and installed by the City.

2.2.2 Design Requirements

The Design-Build Firm shall design and install a Video Surveillance System (VSS) access points to monitor all general public access areas (upper and lower level) in the Pedestrian Bridge. The VSS components shall consist of:

- CCTV camera access points as described below
- Conduit runs to IT Room

The proposed video surveillance system shall include a minimum of six (6) access point locations to provide one-hundred percent (100%) coverage of the following areas:

- One (1) on the south end of the bridge
- One (1) on the north end of the bridge
- One (1) under the south approach ramp to cover entrance door to the IT Room
- One (1) at the center of the bridge
- One (1) at the North elevator tower/staircase
- One (1) at the South elevator tower/staircase

The list above shall be used by the Design-Build Firm as guidance for the minimum coverage area requirements. The Design-Build Firm is responsible for providing additional CCTV camera access points to provide coverage of unforeseen blind spots. It is the Design-Build Firm's responsibility to submit a surveillance CCTV camera access point layout showing the intended field of view coverage to the City for review and approval prior to construction of the access point.

2.3 NETWORK EQUIPMENT RACK

2.3.1 Description

The Design-Build Firm shall furnish and install a network equipment rack inside the IT Room to support all network communications equipment such Ethernet switches, routers, and other network and control equipment such as specialty lighting controller to be installed by the City. The equipment rack shall consist of a four-post frame with square-punched mounting rails used to support 19" wide rack-mount network, computer server and data storage equipment and shelves.

The rack shall include the following key features and components:

- EIA-310-D compliant mounting rails support 19" wide rack-mount equipment
- The rear mounting rails adjust in depth front-to-rear to match equipment mounting requirements;
- Rack-mount unit spaces (U) marked and numbered on the front mounting rails;
- Mounting rails can be flipped to change numbering bottom-to-top or top-to-bottom;
- Includes a Top-Mount Cable Waterfall Tray to manage cables;
- One (1) 7U T-shaped cable guide - front or rear rack application and aligns with each U space
- Open design for unrestricted airflow and easy access to equipment and cabling
- 120 VAC power distribution unit (PDU), Amperage rating and number of receptacles per design load
- One universal horizontal nineteen inch (19")cable managers, 1U
- One universal horizontal nineteen inch (19")cable managers, 2U
- One nineteen inch (19")W x 1U shelf with adjustable depth rear mounting brackets
- One fan assembly with fan guards and two 75 CFM fans

The rack shall be a self-squaring assembly with welded front and rear frames to reduce assembly time.

2.3.2 Network Equipment Rack Specifications

The equipment rack shall meet the following specifications:

• Capacity-Rack Units	Thirty-eight rack units (38U)
• Dimensions (Typical)	
Rack Height	72 inches
Rack Width	23.6 inches
Rack Depth	23.62 inches
Rack Maximum Depth	29.52 inches
• Color	Black
• Compliance	19" EIA-310-D compliant;
• Certifications	UL Listed

The equipment rack shall also include the following components and assembly hardware:

- Two (2) Mounting frames;
- Four (4) horizontal braces;
- Two (2) front mounting rails;
- Two (2) rear mounting rails;
- One (1) top-mount cable tray;
- One (1) 7U cable guide;
- Antioxidant joint compound; and
- Fifty (50) #12-24 cage nuts and screws.

The equipment rack shall also include a two mounting hole ground terminal block for easy attachment to the telecommunication ground.

2.3.3 Warranty

The equipment rack provided by the Design-Build Firm for the Project shall include a manufacturer's warranty of five (5) years commencing on the date of Final Acceptance. The Design-Build Firm shall provide the warranty documentation to City.

2.4 COMMUNICATIONS CONNECTIVITY

2.4.1 Description

The Design-Build Firm shall coordinate with the City for data communications service and service provider requirements. The City will provide a leased line connection for connectivity between the Pedestrian Bridge facility and the City Hall's headquarters. The Design-Build Firm shall be responsible providing communications connectivity infrastructure to allow installation of the leased line. The infrastructure shall consist of telco board, conduit and pull box(es). It is the Design-Build's responsibility to coordinate with the City's communications service provider to identify the access point.

2.4.2 IT Room Termination Requirements

The Design-Build Firm shall be responsible for all communications termination inside the IT Room required for all VSSIT equipment. All required hardware shall be furnished and installed by the Design-Build firm including incidental items such fasteners, equipment rack and cable tray/raceway grounding and conduits from the IT Room to proposed CCTV camera access points and other interior and exterior conduit runs.

The following is a list of the minimum communications hardware and termination to be provided by the Design-build Firm.

- Telco Board – ¾-inch thick marine-grade plywood, forty-eight inches by forty-eight inches
- Network Equipment Rack (19-Inch described separately)
- Cable tray/raceway extending from Network Equipment Rack to IT Room conduit penetration

2.4.3 CCTV Camera Conduits

The Design-Build Firm shall furnish and install conduits throughout the Pedestrian Bridge facility from the IT Room to all proposed CCTV camera access points. No externally mounted conduits shall be installed on walls and aesthetically finished surfaces. Any conduits attached to the Pedestrian Bridge structural system, truss system, shall be concealed from public view or installed within the structure.

All conduit and infrastructure designated for CCTV camera access points shall include:

- One (1) one-inch conduit to each proposed CCTV camera access point
- Junction Boxes
- Conduit bodies at access point
- Wall plate covers

The Design-Build Firm shall proof each conduit and install a pull string, conduit plugs and cover plates at all finished wall locations. The Design-Build Firm shall provide spare conduits as deemed necessary through its coordination with the City. No more than 1 spare

conduit will be required by the City of Doral for each CCTV camera location described above.

The Design-Build Firm shall perform a mandrel test on all new conduit using a non-metallic mandrel having a diameter of approximately one eighth (1/8) of an inch less than the inside diameter of the conduit through which it is to be blown. If the conduit is found to be damaged, the Design-Build Firm shall replace the entire conduit segment with a new conduit. Conduit(s) shall be plugged with conduit manufacturer recommended plugs. The use of duct tape is not allowed.

2.4.4 Communications Conduit – Leased Line

The Design-Build Firm shall furnish and install HDPE, SDR 11 conduit from the IT Room to the communications service provider access point. The lease line communications conduit run shall also be furnished and installed with the following components:

- Two (2) two-inch HDPE conduit
- Locate wire
- Warning tape
- Standard route marker (if applicable, conduit run to service provider access point greater than 500 feet)

After the installation of the communications conduits and upon completion of the tamping and backfill process, the Design-Build Firm shall verify that conduits are clean and dry. The Design-Build Firm shall perform a mandrel test in both directions on each individual conduit between adjacent pull boxes to ensure that no conduit has been damaged for the entire conduit length.

The Design-Build Firm shall perform a mandrel test on all new conduit using a non-metallic mandrel having a diameter of approximately one eighth (1/8) of an inch less than the inside diameter of the conduit through which it is to be blown. If the conduit is found to be damaged, the Design-Build Firm shall replace the entire conduit segment with a new conduit. Conduit(s) shall be plugged with conduit manufacturer recommended plugs. The use of duct tape is not allowed.

2.4.5 Communications Pull Box-Leased Line

The Design-Build Firm shall provide pull box(es) for the leased line to accommodate fiber and respective slack. Communications pull box design and installation shall comply with FDOT Standard Specifications for Road and Bridge Constructions and FDOT Design Standards. The words “CITY OF DORAL COMM” shall be integrally cast into all proposed communications pull box covers. All communication pull boxes shall be flush mounted with the concrete pad or concrete finish when installed in sidewalks or walk areas. All communication pull boxes shall include concrete apron around the pull box of one (1) foot minimum width from edge of the pull box by six (6) inches deep.

2.5 POWER CONNECTIVITY

2.5.1 General Requirements

The Design-Build Firm is responsible for obtaining Electrical Service for all Pedestrian Bridge facility electrical requirements included in this attachment as well as other electrical

features in the Pedestrian Bridge facility. It shall be the Design-Build Firm's responsibility for determining the adequate power connectivity and electrical distribution panel inside the IT Room. Elevator and pedestrian facility lighting and other miscellaneous power requirements shall be separate from the VSSIT electrical requirements and housed in a separate electrical panel. The circuit panel shall be UL listed and sized to support the proposed IT Room load requirements described separately in this document.

Main and distribution electrical panels for remaining Pedestrian Bridge facility mechanical (elevator), lighting, landscape shall be housed per the Project's Architectural Plans.

2.5.2 Power Conduit - Exterior Connections

The Design-Build Firm shall furnish and install HDPE, SDR 11 conduit for all exterior underground power runs from the electrical IT Room's electrical panel to locations listed below. Conduit shall be two-inch (2") UL listed HDPE conduit. Above ground conduit installations shall be rigid galvanized steel (RGS). RGS conduits shall be concealed from public view when attached to the Pedestrian Bridge structural system.

At a minimum, the Design-Build Firm shall install the following conduits from the IT Room electrical panel to locations listed below.

- Two (2) two-inch conduits plus (1) two-inch spare conduit, each terminated in a pull box in eastern and western side of the south bridge tower.
- Two (2) two-inch conduits plus (1) two-in spare conduit, each terminated in a pull box in eastern and western side of the north bridge tower.

The Design-Build Firm shall proof each conduit and install a pull string. Each conduit shall be capped inside each pull box and inside the IT Room with conduit manufacturer plugs.

2.5.3 Power Pull Boxes

All proposed power pull boxes shall be listed on the Florida Department of Transportation Approved Product List (APL). All power pull box covers shall be equipped with a minimum 0.5-inch by 2-inch lifting slot. The words "CITY OF DORAL ELECTRICAL" shall be integrally cast into all proposed power pull box covers. All power pull boxes shall be flush mounted with the concrete pad.

All power pull boxes shall be structurally designed and sized per FDOT Standard Specifications. All power pull boxes shall include concrete apron around the pull box of one (1) foot minimum width from edge of the pull box by six (6) inches deep.

2.6 IT ROOM REQUIREMENTS

2.6.1 Description

The design and construction of the Pedestrian Bridge Facility shall include an environmentally controlled IT Room with the following minimum requirements. The building shall be constructed on concrete block and reinforcement material (rebars) under the bridge approach ramp between the MSE Wall A-2 and Pier 2. The exterior of the proposed building shall look integral and match the MSE wall finish and color scheme. All areas between the front face of the MSE Wall 2, End Bent 1, Pier 2 and bottom of the bride deck shall be accessible for inspection and future maintenance. All conduit penetrations

into the IT Room shall transition through the floor slab with a minimum stub-up conduit length of nine inches (9").

All building plans shall be signed and sealed by registered professional engineer in the State of Florida and shall be submitted to the City of Doral for permitting purposes. The Design-Build Firm shall submit plans and rendering of IT Room to the City for review and approval prior to Release for Construction (RFC) plans.

A. Structure — The specifications listed below are for conceptual design purposes and may be modified, with approval by City of Doral to meet equipment requirements, building codes for South Florida and applicable FDOT standards.

Construction:	Concrete Block or Reinforced Concrete Walls (Florida Building Code Compliant) Reinforced Concrete Slabs
Interior Dimensions:	10' Wide x 10' Long x 9' High (Finished Inside)
Floor load:	250 PSF
Roof load:	100 PSF
Wind load:	160 MPH

B. Exterior — Smooth finish painted to match Project's Bridge Aesthetics Requirements

C. Interior

R-14 Insulation on Walls

R-21 Insulation on Ceiling

Walls and Ceiling covered with at least 3//8" Nu-Poly panels (white finish) or equivalent

Floor finish – painted epoxy (Design-Build Firm to submit paint colors for review and approval)

D. Door and Openings

Door:	3'-0" x 7'-0" mortise steel door with cast in steel frame
Locks/Hardware:	Non removable pin (NRP) ball bearing stainless steel hinges, door closure, electric strike plate, door holder, door stops, door sweeps, door pull handles, threshold, weather stripping
Door Hood:	Door drip cap – 2 ½" wide

E. Electrical

Power Service:	200A single phase 120/240V electrical panel
Disconnect Switch:	200A Exterior Disconnect Switch
Distribution Panel:	200A single phase, 30 spaces One 30A Double Pole circuit (Cable Ladder) Four 30A Single Pole circuits
Convenience Outlets:	Four (4)120V/30A, 3 for no door walls, 1 on Cable Ladder
Surge Suppression:	100KA

Convenience Outlets: 125v/20A Duplex outlets (6 to 8)

F. Grounding

Grounding Bar: OSP 4" X 20" X ¼" Ground Bus
Telco Boar Ground Bus

Ground Rod: 5/8" Rod per FDOT Spec 620

G. Lighting

Interior: LED light fixtures sufficient for shelter size and configuration

Exterior: One Exterior LED light fixture with photocell and motion detector, vandal resistant mounted on the outside near the entrance door

H. Environmental

HVAC: One single phase HVAC Unit with heater, economizer sized by Design-Build Firm
Thermostat with SNMP Ethernet Card

I. Alarms Conduit provisions only for alarm panel and door open/close sensor.

J. Cable Ladder 18" ladder and cable tray placed over equipment rack to power and communications access.

K. Miscellaneous Items

Smoke Detection: One (1) Smoke Detector

Fire Extinguishers: One (1) 5 Lb. CO2 Fire Extinguisher

2.6.2 Electronic Access Control System Provision

The Design-Build Firm shall furnish all conduit, cabling and gang electrical boxes and hardware required for the electronic access control card reader. The City will furnish and install the electric card access reader and integration to Electronic Access Control System prior to opening of the Pedestrian Bridge facility. The following general criteria shall be used for the design and construction Electronic Access Control System provisions.

- If the reader will be mounted to the building wall façade then a hole can be drilled through the building walls (if permissible and material allows) for the wiring to pass through. The reader will mount over the access hole on the outside while the hole on the inside would tie into conduit that runs to the door controller in the equipment rack.
- The door controller (provided by others) will be installed in the IT Room by the City. Wiring from the card reader and electric door strike shall be ran to the controller through conduit.
- An electric door strike and door lock with integrated key lock shall be installed for access to the IT Room in the event that the door controller or card reader fails.
- All conduits for the security card readers shall not be attached externally to walls.

2.6.3 Warranty

The IT Room, its components, hardware and HVAC system shall have a five year manufacturer's warranty covering defects and workmanship. All warranty documentation

shall be submitted to the City prior to Project's Final Acceptance. Grounding and bonding warranty requirements described separately herein this document.

2.7 CONDUIT SCHEDULE

2.7.1 General Requirements

The Design-Build Firm is responsible for providing the size and number of conduits to meet the requirements herein, RFP and applicable governing design, construction and industry standards. Conduit size for IT Room power service entrance shall be determined by the Design-Build Firm. At a minimum, the Design-Build Firm shall be responsible for providing conduit runs as described herein and per the conduit schedule below. All other conduits required for delivery of a complete VSSIT is the responsibility of the Design-Build Firm unless otherwise stated in this document or RFP.

Purpose	Conduit Size	Number of Conduits	Conduit Run
CCTV Camera Access Point	1"	12	IT Room to CCTV Access Points
Leased Line Communications	2"	2	IT Room to Communications Service Access Point
Exterior Power Underground	2"	8	IT Room to North and South Bridge Towers (exterior)
Electronic Access Control	1"	2	IT Room to Electric Strike Lock and Door Card Reader
IT Room General	TBD	TBD	Electrical outlets, smoke detector, alarms, spare conduits, etc.

2.8 GROUNDING, BONDING LIGHTNING AND SURGE PROTECTION

2.8.1 General Requirements

The Design-Build Firm shall be responsible for providing all grounding, lighting, bonding and surge protection as described herein for the VSSIT components and IT Room per FDOT Standard Specifications for Road and Bridge Construction, FDOT Design Standards, NEC and all applicable standards. All grounding conductors shall be exothermically welded to the grounding rod.

Grounding and Surge Protective Device (SPD) shall be provide for all AC and DC voltages, communications data lines and PoE connections.
(Note to reviewer: This is required for the Ethernet connections – current scope is for conduit installation. The City will be responsible for this item.)

The Design-Build Firm shall be responsible for the design, furnishing, construction and installation of a lightning protection system for the VSSIT per NEC and applicable standards. The lighting protection system shall be grounded and bonded to the same grounding array for the Pedestrian Bridge facility.

2.8.2 Warranty

The grounding and Surge Protective Device (SPD) components shall include a minimum ten (10) year warranty commencing on the date of Final Acceptance. The Design-Build Firm shall provide the warranty documentation to City.

City of Doral

DESIGN-BUILD PROJECT FOR PEDESTRIAN BRIDGE OVER NW 41ST STREET AT HEFT
FINANCIAL PROJECT ID: 441642-1-58-01

ATTACHMENT A-16
Pedestrian Bridge Aesthetic Manual

Table of Contents

I. Design Concept

The new pedestrian bridge shall provide a live, work, learn, and play experience in a safe connective space over 41st Street. The neighboring communities consist of the bridge is mostly residential on the north side, and mostly commercial with corporate offices, two college campuses, parks, and restaurants on the south side. The design and material selections for the bridge shall be safe, simple, light, maintenance friendly, and reflective of the adjacent communities.

II. Design Criteria

All plans and documents prepared are to be in accordance with the City of Doral Code of Ordinances, City of Doral Master Plans, and applicable building codes and standards. All documents shall be accurate, legible, and complete in design and furnished in digital and reproducible as required. Final responsibility for compliance with all applicable codes and requirements rests with the designer of record and the Design-Build Firm. The designer of record shall be registered in the State of Florida. The designer of record shall not assume that the criteria presented herein in any way replaces the designer's professional duty to carefully review all existing conditions, coordinate the work of all disciplines and to provide a complete and thorough set of construction documents.

A. Protection for Occupants on Bridge

1. Environment
    a) Design structure and enclosure shall protect occupants from direct southern sun exposure and provide for indirect light.
    b) Roof shall be designed to fully protect occupants from inclement weather.
    c) Bridge enclosure shall incorporate natural ventilation and airflow to mitigate excessive heat gain.
    d) Considerations shall be made to minimize the impact that birds will have on the long-term maintenance of the bridge and occupant safety.

B. Protection for Vehicles and Pedestrians Below Bridge

1. Debris and projectiles
    a) Bridge shall be enclosed in such a way to mitigate the potential of debris and projectiles from affecting vehicles passing underneath

2. Gutters
    a) Provisions shall be made to address storm drainage from roof into gutters and downspouts designed inconspicuously into the structure and discharged away from pedestrians and vehicular circulation below.
    b) Further considerations shall be made for the roof design to minimize water intrusion into the enclosure.

3. Glare
    a) The design and materials shall be carefully consider glare and the effects on the vehicles passing below.

C. Materiality

1. Simplicity
    a) The design shall incorporate materials and systems that are simple to construct and are long-term maintenance friendly.

D. Character

1. Design
    a) The entire project including bridge, supporting structures, associated architectural components, landscaping, lighting, and site design shall be reflective of the neighboring community.

2. Signage
    a) Signage shall be integrated into the design for the bridge enclosure and central column to define the bridge as a landmark for vehicles entering and exiting the City of Doral

III. Finishes

A. Pedestrian Bridge

1. Enclosure:
    a) Prefabricated steel box truss structure
    b) Glazed railing system
        (1) Acid-etching to reflect the city's logo and mission
        (2) 42" height to align with adjacent stair guardrails
    c) Metal mesh system
        (1) Cambridge product as a minimum standard
        (2) Modular prefabricated structural support integral to finish system
        (3) System shall be installed and secured in accordance with the applicable codes for design pressures and wind loads

2. Floor:
    a) Hard durable surface such as sealed, broom finished concrete or tile
    b) ADA compliant and slip resistant

3. Roof:
    a) Roof membrane system to prevent enclosure from moisture intrusion
    b) Gutter and downspout system integral to design and with material and finish material to match metal mesh system
    c) Glazing to match towers, impact resistant and tinted

B. Stairs

1. Precast concrete
    a) Landings, Treads, and Risers
        (1) Stainless steel slip resistant nosings shall be cast full length into stair treads.

2. Metal railings
    a) Handrail height at 2'-8" – 2'-10"
        (1) Railing shall be securely mounted to structural elements.
    b) Guardrail height at 3'6"
    c) Factory finished aluminum or stainless steel

C. Towers and Columns

1. Glazing
    a) Insulated
    b) Impact Tested

c) Tinted & Low-E Coated

2. Storefront
   a) Insulated system
   b) Impact tested
   c) Factory finished and coordinated with all other material selections
3. Precast concrete
   a) Integral Color(s)
   b) Multiple cast textures allowable per design
   c) Reveals allowable per design

D. Elevator Cab

1. Stainless steel panels and rails
2. Durable, hard surface flooring such as tile
3. Stainless steel ceiling with LED lighting

IV. Codes and Standards

The project shall comply with the latest adopted edition of the following codes and standards:

A. Florida Building Code

B. Florida Building Code: Electrical

C. Florida Building Code: Plumbing

D. Florida Building Code: Mechanical

E. Florida Building Code: Energy Conservation

F. Florida Building Code: Accessibility

G. Florida Building Code: Test Protocols for High-Velocity Hurricane Zones

H. National Fire Protection Association: NFPA 1 Fire Code and NFPA 101 Life Safety Code

I. Florida Fire Prevention Code

1. Including the Florida-specific editions of NFPA

J. American Concrete Institute (ACI) Standards for Concrete

K. Precast/Prestressed Concrete Institute (PCI) Standards for Precast/Prestressed Concrete

L. National Roofing Contractors Association

M. Occupational Safety and Health Administration

N. All other applicable standards based on design progression

O. LRFD Guide Specifications for Design of Pedestrian Bridges

V. Elevator Criteria

The following criteria shall be provided at a minimum:

A. 5000 pound class hydraulic twin post

B. 5'-8" wide by 8'-4" deep minimum clear cab dimensions with ability to accommodate a stretcher and emergency personnel

1. Dimensions shall be coordinated based on manufacturer/product selection.

C. 4'-0" pit depth with sufficient, integral drainage system and approved waterproofing system

D. Include provisions for steel hoist beam as required and height coordinated with overall design

E. Include provisions for elevator equipment as required per manufacturer/product selection.

VI. Lighting Criteria

A. Lighting Levels

1. The Design-Build Firm shall evaluate and provide lighting for underside of the bridge, ramps and include as part of the design and construction. The vertical lighting requirements for the walkway will be in accordance with ANSI/IESNA RP-8-14, American National Standard Practice for Roadway Lighting and the horizontal lighting requirements will be in accordance with AASHTO Roadway Lighting Design Guide. From RP-8-14 Table 4 the recommended illuminance values for high pedestrian conflict areas are as follows:
   a) Per AASHTO, the Average Horizontal Illuminance at Facilities Separated from the Roadway (e.g., Sidewalks and Shared Use Paths) is 2.5 f.c with uniformity ratios of 4:1 (avg./min.) and 10:1 (max./min.).
   b) From RP-8-14 Table 4, the recommended Minimum Vertical Illuminance at 1.5m (4.9 ft.) above bridge walkway measured in both directions parallel to the main pedestrian flow is 10.0/1.0
   c) Uniformity Ratio Eavg/Emin (Horizontal only) is 4.0

B. Lighting Power Density

1. Lighting power density installed in accordance with the following 2017 Florida Building Code – Energy conservation, Table c405.5.1(2)
   a) Walkways less than 10 feet wide – 1.0 W/linear ft.
   b) Stairways – 1.0 W/sqft
   c) Walkways 10 feet wide or greater – 0.2 W/sqft

C. Lighting Color Temperature

1. Lighting color temperature shall 4000K

D. Dark Sky Requirements and light Trespass

1. In with the City of Doral, Miami-Dade County, and the state of Florida
   a) Lighting shall be deflected, shaded and focused away from such adjacent property
   b) Light shall not be allowed to cause glare affecting motorists, bicyclists, or other users of roads, driveways and bicycle paths.
   c) Lighting shall not exceed 1 fc at adjacent property lines

E. Controls

1. Lighting controls shall follow in accordance with the 2017 Florida Building Code C405.2.5 as follows:
   a) Time clock shall provide 'off' control of lighting at a pre-determined time.

b) Photocell and integral motion sensors shall be used for partial dimming.
c) When the time clock is in the 'off' setting, the photocell shall override the time clock and turn the lights 'on' to 100% output when presence is detected by the integral motion sensors.
d) Exterior lighting shall automatically turn off when daylight is detected.

F. Fixtures

1. Lighting fixtures chosen shall be harmonious with finished material elements and design concept intention.

2. All fixtures shall be LED

VII. Landscape Criteria

All plans and documents prepared are to be in accordance with the City of Doral Code of Ordinances, City of Doral Master Plans, Florida Department of Transportation (FDOT) Design Standards, FDOT Design Manual, and shall be accurate, legible, and complete in design and furnished in digital and reproducible as required. The Landscape Architect of Record (LA) shall be registered in the State of Florida. Final responsibility for compliance with all applicable codes and requirements rests with the Landscape Architect of Record. The LA shall not assume that the criteria presented herein in any way replaces the LA's professional duty to carefully review all existing conditions, coordinate the work of all disciplines and to provide a complete and thorough set of construction documents.

The landscape design shall account for the mitigation of removal or relocation of any existing trees and palms according to applicable City of Doral Code of Ordinances and Miami-Dade County Code of Ordinances. Existing vegetation shall be evaluated for preservation or relocation. The site contains trees and palms that shall be evaluated for preservation, relocation and potential use within the new landscape design. There should be an attempt to preserve all or portions of the existing trees and palms.

All invasive exotics throughout the project site shall be eradicated. Refer to the Florida Exotic Pest Plant Council's most recent list of Invasive Plant Species to determine species to be eradicated.

The intent of the landscape design is primarily to reduce the impact of the extensive impervious surfaces and building coverage (inclusive of all structures) on the site while providing a healthy environment conducive to safe pedestrian activities both within the site and from the adjacent sidewalks. A healthy environment shall include a landscape design that creates native plant community themes appropriate to the ecoregion of the site and that provide shading to the paved surfaces to reduce heat island effect. The communities should be determined based on the site's natural history and the plant communities that surrounded it.

The LA shall be responsible for resolving conflicts between landscape, site lighting, CCTV coverage, and utility components. CCTV viewing angles shall not be obstructed by tree canopies.

The LA shall design areas where mowing can be kept to a minimum or conducted on a periodic basis to meet the City's maintenance cycles. A graphic depicting these areas shall be included as a submittal along with a long-term Maintenance Manual. The Maintenance Manual shall include instructions for the maintaining agency showing mowing, fertilizing, pruning, mulching frequencies on an annual basis. The objective is to reduce the frequency of required maintenance as much as possible allowing the carefully selected plant species to grow to their natural shape and size with minimal interference.

Drought tolerant, native and exotic plants which can survive long term without an irrigation system shall be selected for this project. There will be no irrigation system included for this project. The following is a list of alternatives for potential plant community groups typically present in this region. Any substitutions to the suggested plant materials list shall be drought tolerant and appropriate for the location and submitted for approval.

A. Vegetation shall include trees within the following Landscape Communities:

1. Pineland Community (Common Name; Scientific Name)
    a) South Florida Slash Pine; Pinus elliottii var. densa
    b) Saw Palmetto; Serenoa repens
    c) Locustberry; Byrsonima lucida
    d) Wild Sage; Lantana involucrata
    e) Silver Saw Palmetto; Serenoa repens Silver Form
    f) Coontie; Zamia pumila
    g) Pineland Croton; Croton linearis
    h) Muhly Grass; Muhlenbergia capillaris
    i) Tickseed Coreopsis; leavenworthii Seeding

2. Hammock Community (Common Name; Scientific Name)

    a) Live Oak; Quercus virginiana
    b) Wild Tamarind; Lysiloma latisiliquum
    c) Gumbo Limbo; Bursera simaruba
    d) Satinleaf; Chrysophyllum oliviforme
    e) Pigeon Plum; Coccoloba diversifolia
    f) Jamaican Caper Capparis cynophallophora
    g) Dwarf Firebush; Hamelia patens ‘Compacta’
    h) Simpson’s Stopper; Myrcianthes fragrans
    i) Bahama Wild Coffee; Psychotria ligustrifolia
    j) Shinyleaf Wild Coffee; Psychotria nervosa
    k) Sword Fern; Nephrolepis exaltata

3. Hydric Community (Common Name; Scientific Name)

    a) Pond Cypress; Taxodium ascendens
    b) Bald Cypress; Taxodium distichum
    c) Wax Myrtle; Myrica cerifera
    d) Coastal Plain Willow; Salix caroliniana
    e) Red Tip Cocoplum; Chrysobalanus icaco ‘Red Tip’
    f) Dwarf Fakahatchee Grass; Tripsacum floridanum
    g) Leather Fern; Acrostichum danaeifolium
    h) Alligator Flag; Thalia geniculata
    i) Lance-Leaf Arrowhead; Sagittaria lancifolia
    j) Sword Fern; Nephrolepis exaltata
    k) Cabbage Palm; Sabal palmetto
    l) Silver Buttonwood; Conocarpus e. ‘Sericeus’
    m) Muhly Grass; Muhlenbergia capillaris

B. Palm varieties shall include: (Common Name; Scientific Name)

1. Royal Palm; Roystonea elata
2. Cabbage Palm; Sabal palmetto
3. Saw Palmetto; Serenoa repens

C. Sod shall be: (Common Name; Scientific Name)

1. Bahia Sod; Paspalum notatum
2. Mix: Paspalum notatum, Coreopsis leavenworthii, Coreopsis basalis, Mimosa strigillosa

* All plant material must be approved by the LA prior to delivery to the project site. All plant material must meet the Florida Fancy grading of the latest Florida Grades and Standards for Nursery Plants.*

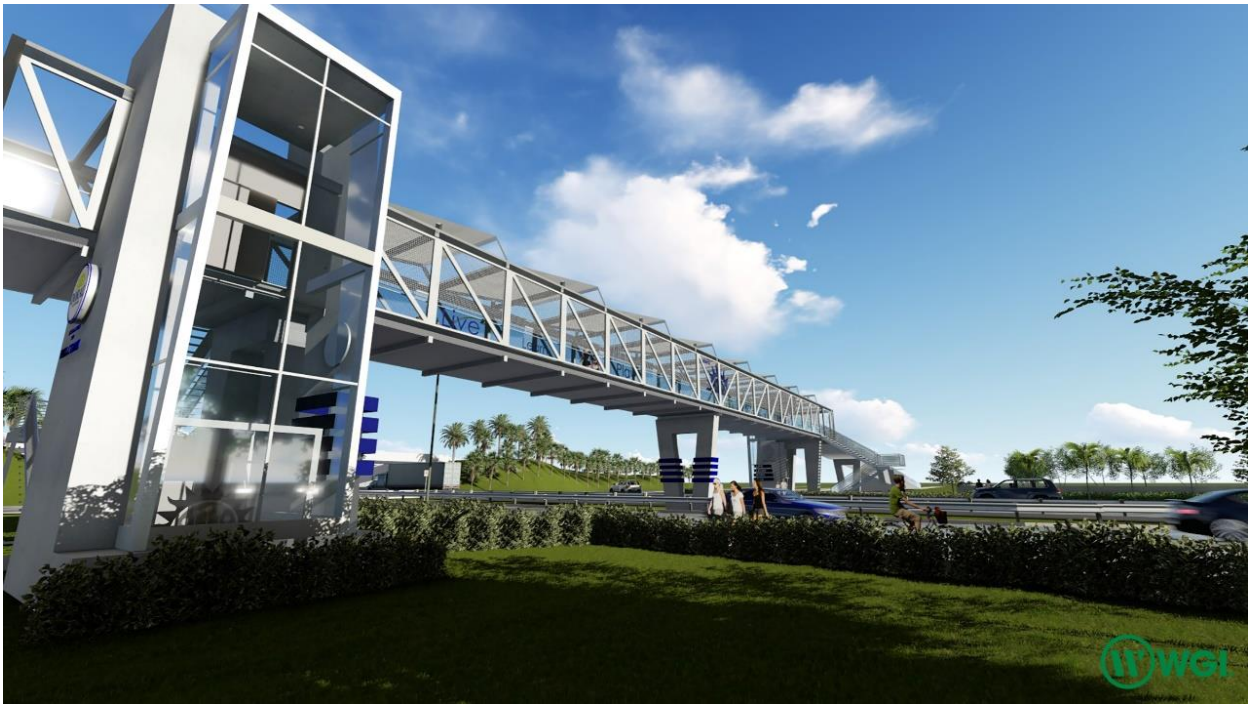
VIII. Appendix

A. Preferred Rendering Concept 1:

B. Preferred Rendering Concept 2:

C. Preferred Rendering Concept 3:

D. Preferred Rendering Concept 4:



City of Doral

DESIGN-BUILD PROJECT FOR PEDESTRIAN BRIDGE OVER NW 41ST STREET AT HEFT
FINANCIAL PROJECT ID: 441642-1-58-01

ATTACHMENT A-17
City of Doral Lighting Master Plan

CITY OF DORAL LIGHTING MASTER PLAN

Dressel's Dairy Trail

Turnpike Trail

Beacon Trail

Park and Greenway Trail

NW 104th Avenue Trail

Southern Command Trail

NW 41st Street Trail

Prepared For:
City of Doral
8401 NW 53rd Terrace
Doral, FL 33166

Prepared by:
H.W. Lochner, Inc.
8750 NW 36th Street, Suite 360
Miami, FL 33178
Phone: (305) 503-9873

July 8, 2020

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Alejandro Gari, P.E.
License No. 79281

_____

Date

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY

The City of Doral (The City) has asked H.W. Lochner Inc. (Lochner) to develop a Lighting Master Plan report to analyze and compare various lighting improvements along several shared use path trails throughout Doral totaling to approximately 7 miles. The City will use this report and its recommendations as a guide for implementation of the proposed lighting improvements. The goal for these improvements is to enhance pedestrian safety and security, while providing an aesthetically pleasing, energy efficient pedestrian lighting system.

The proposed design will maximize the available resources while reducing operating costs of the new lighting system by operating at full capacity only when needed. The goal of the trail lighting master plan is to: improve public safety and security, provide day and nighttime aesthetics, consider environmental issues, identify the nature of the site (residential, commercial, or industrial), use energy efficiently, control sky glow and light trespass, implementing lighting curfews, standardizing design choices, simplify maintenance.

While beautification, safety, and security are the top priorities, the City of Doral is ambitious in moving towards a more efficient and green lighting system by being one of the leaders within Miami-Dade County in adopting adaptive lighting controls which will reduce energy consumption significantly.

The latest version of the AGi32 lighting analysis software was used to test each luminaire's photometric performance. Three types of light fixtures from three different brands have been analyzed and compared to help determine the fixture which will accomplish The City's goals. The recommended fixtures for each category are summarized in the table below.

Recommended Luminaires		
Parking Lot/Area	**Trail/Shared Use Path**	**Bollard**
Lithonian Radian Arm Mount	Lithonian Radian Post Mount	Amerilux Lunetta

2.0 PROJECT DESCRIPTION

The City of Doral (The City) has asked H.W. Lochner Inc. (Lochner) to develop a Lighting Master Plan report to analyze and compare various lighting improvements along several shared use path trails throughout Doral totaling to approximately 7 miles. The City will use this report and its recommendations as a guide for implementation of the proposed lighting improvements. The goal for these improvements is to enhance pedestrian safety and security, while providing an aesthetically pleasing, energy efficient pedestrian lighting system at the locations listed below and highlighted in Figure 1.

- Beacon Trail along NW 25th Street from NW 117th Avenue to west of NW 107th Avenue
- Turnpike Trail along NW 117th Avenue from NW 25th Street to NW 58th Street
- Dressel's Dairy Trail along NW 58th Street from NW 117th Avenue to NW 107th Avenue
- NW 104th Ave Future Trail from NW 33rd Street to NW 41st Street
- NW 50th St Trail from NW 114th Avenue to NW 107th Avenue
- Southern Command Trail
- NW 41st Street Trail from NW 87th Avenue to NW 82nd Avenue

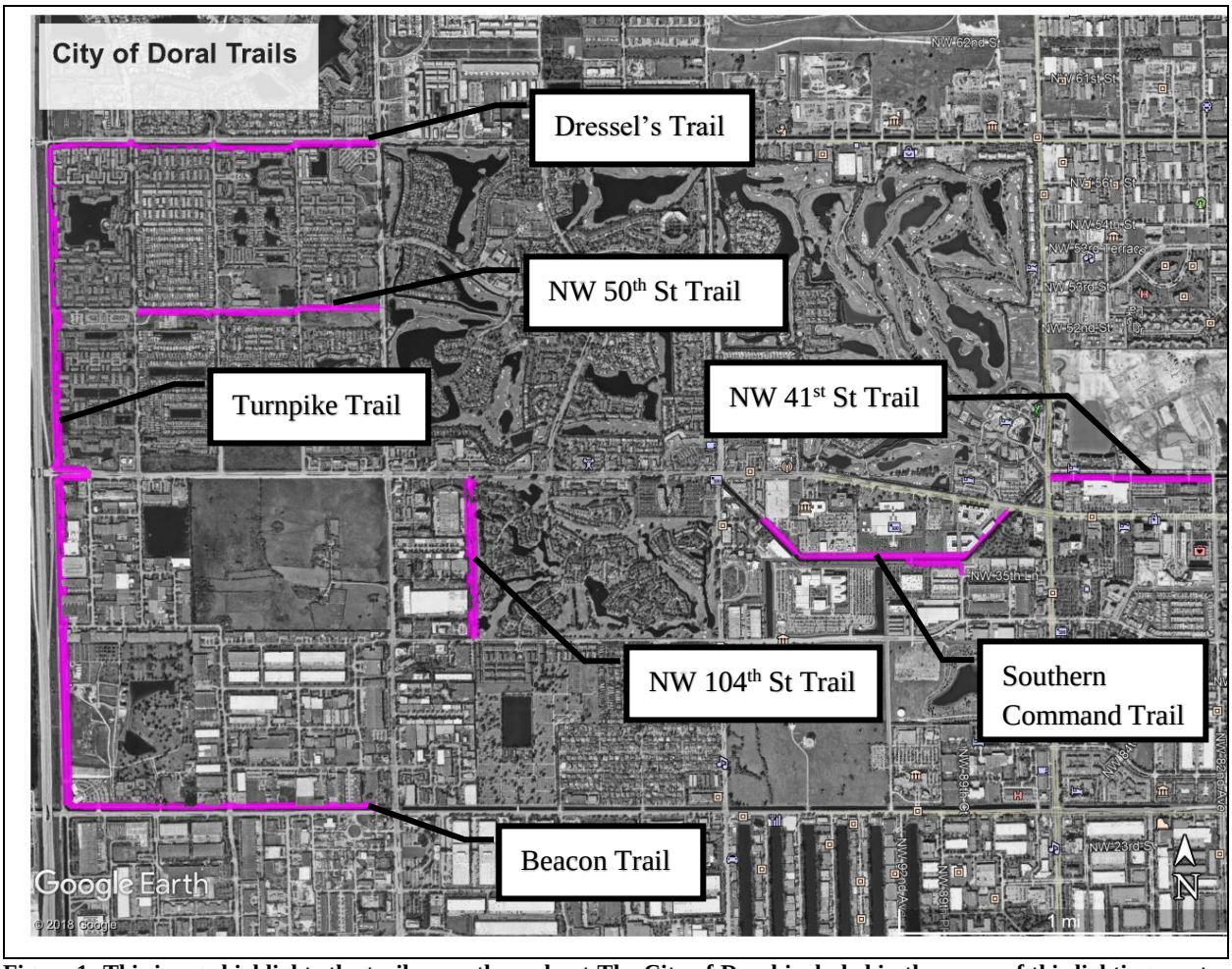

Figure 1: This image highlights the trail areas throughout The City of Doral included in the scope of this lighting master plan report.

In addition to the above trails, lighting improvements will be made to Trails and Tails Park located at 11645 NW50th Street and will include modifications to the existing parking lot, small dog play area, large dog play area, children's playground, and Greenway Trail.

This Lighting Master Plan report describes each trail's existing conditions and prioritizes the improvements for each trail based on the current average illumination levels. Trails with lower illumination levels will be prioritized before trails with higher illumination levels. Lochner, in conjunction with the City, has reviewed and selected several light fixtures for comparison. These fixtures have been compared based off of their maximum light pole spacing, light spillage and dark sky compliance, costs, efficiency, and aesthetics.

A rapid growth in technology over recent years has allowed for many advancements in the lighting industry including, Light Emitting Diodes (LED), security cameras, internet connectivity, adaptive controls, and Internet of Things (IoT) sensors for remote control and asset management of the entire pedestrian lighting infrastructure. Using a combination of these technologies provides The City with an opportunity for connecting their lighting system and making them "smart" by creating a multiservice platform for driving energy efficiency, sustainability, and a reduction in operating and maintenance costs.

3.0 EXISTING CONDITIONS

A walkthrough of each trail has been performed to assess the existing conditions such as overhead utility lines, location of existing and proposed light poles, adjacent residential properties, vegetation which may obscure light, environmental issues, and existing illumination levels. Illumination measurements in footcandles (fc), were taken using a calibrated Dr. Meter LX 1330B digital light meter with the resulting data shown in Table 1 below. The footcandle unit is the measurement of light intensity on a surface at a given point.

Trail	Approximate Length of Trail (mi)	Average Illuminance (fc)	Existing Condition Characteristics
Beacon	**1.0 miles**	**0.93**	• Low levels of illumination were experienced from NW 107 Avenue to NW 109 Avenue. This area is mostly industrial. The trail width was approximately 10 feet. • Approaching Doral Academy, illumination levels increased; in particular, near the soccer and football fields, the trail was well lit up. However, a second field review at approximately 9:30 PM showed that the sports field lighting was turned off at this time. The measurements used along this portion of the trail for the average lighting were taken during the second field review when the lights were turned off. • The trail portion from west of NW 112th Avenue to east of NW 117th Avenue experienced low illumination

Trail	Approximate Length of Trail (mi)	Average Illuminance (fc)	Existing Condition Characteristics
			levels. From NW 112th Avenue to about NW 114th Avenue, trees located on the north side of the trail, behind the walls of the cemetery, cause shadows and dark spots that further lower the illumination levels along the trail.
Turnpike	**2.0 miles**	**1.69**	• The southernmost 0.5 miles of trail received low levels of illumination along the church and cemetery. The trail width was approximately 10 feet. • Just south of NW 34th Street, levels of light begin to rise as the east side of the trail began to consist of industrial warehouses and the Miami-Dade College. However there were still some low lighting areas within this portion of the trail, particularly near the parking lots. • Approaching NW 41st Street from the south side illumination levels appeared to increase, likely due to surrounding lighting such as roadway, commercial, and residential lighting within the surrounding complexes. • The trail section north of NW 41st Street experienced low illumination levels, there were trees along the East of the road that further obstructed illumination. Additionally near NW 50th Street, lighting along Turnpike was turned off causing the trail illumination to be even lower
Dressel's Dairy	**0.75 miles**	**2.54**	• The segment from NW 107 Avenue to NW 109 Avenue was well illuminated and high pedestrian activity was experienced. • West of NW 109th Avenue significantly lower illumination levels occurred and pedestrian activity seemed to be significantly lower. This section of the trail was residential, going parallel to an apartment complex on the south side of the trail. • The trail was closed off from NW 112th Avenue to NW 114th Avenue, forcing pedestrians to cross to the north sidewalk and then cross back over at NW 114th Avenue.

Trail	Approximate Length of Trail (mi)	Average Illuminance (fc)	Existing Condition Characteristics
			• The trail resumed west of NW 114th Avenue to NW 117th Avenue where illumination levels were low overall. Trees along the south of the trail obstructed lighting from residential complexes on the south side
NW 104th Ave	N/A	N/A	• Not yet constructed.-
NW 50th St	**0.75 miles**	**7.49**	• Overall, the 10 foot wide trail was well illuminated from NW 114th Avenue to NW 102th Avenue. Pedestrian activity was experienced, consisting mostly of dog-walkers. • East of NW 109th Avenue, illumination levels dropped significantly. There were lighting poles along the trail, however east of NW 109th Avenue a significant portion of these light posts were turned off, then cross back over at NW 114th Avenue. • The immediate south side of the trail consists of undeveloped land, however, the north segment is mostly residential, but also contains a middle school, located from NW 112th Avenue to NW 109th Avenue.
Southern Command	**1.00 miles**	**4.86**	• Approximately the first 600 feet of the trail consisted of a 26 foot wide dirt trail with low illumination levels. • The trail then consisted of a 10 foot wide path along the canal with significantly higher illumination levels. The first portion of the trail runs parallel to construction site, construction debris can be noticed throughout this portion. • At approximately 91st Avenue, a pedestrian bridges crosses the trail over to the south side of the canal. This portion of the trail experienced inconsistent lighting ranging from 0.7 to 5.8 FCs. • The trail east of the bridge was overall well illuminated, however the apartment buildings near the trail casted lighting, making the lighting along the trail inconsistent.
NW 41st St	**0.5 miles**	**3.10**	• The trail was approximately 10 foot wide. Although overall, the trail experienced high illumination levels, the lighting along the trail was inconsistent with

Trail	Approximate Length of Trail (mi)	Average Illuminance (fc)	Existing Condition Characteristics
			lighting measurements ranging from 0.5 FC to 13.70 FC.

Table 1. This table details the existing lighting conditions along with other characteristics for each trail.

Understanding these existing conditions will help anticipate possible project issues and allow for adjustments in design to better suit the trail stakeholders and participants.

Coordination was done with the Southern Command Center and Federal Reserve to ensure that any proposed lighting along the adjacent trails would not conflict with security measures. All coordination and correspondence can be found in Appendix G.

4.0 PROPOSED LIGHTING MASTER PLAN

The proposed design will maximize the available resources while reducing operating costs of the new lighting system by operating at full capacity only when needed. The goal of the trail lighting master plan is to:

- improve public safety and security
- provide day and nighttime aesthetics
- consider environmental issues
- identify the nature of the site (residential, commercial, or industrial)
- use energy efficiently
- control sky glow and light trespass
- implementing lighting curfews
- standardizing design choices
- simplify maintenance

Advancements in technology have provided many options for lighting systems such as LED luminaires, adaptive controls, Internet of Things (IoT) sensors, and wireless communication which when combined, create a smart and efficient pedestrian lighting system. This report compares and contrasts these technologies from various manufacturers which were invited by Lochner and The City to present a few of their LED luminaires, poles, sensors, controls, monitoring systems, and smart city products. One product from each representative was chosen to be included within this report's assessment.

4.1 Illumination Design Criteria

The *AASHTO Roadway Lighting Design Guide, Seventh Edition* describes two methods, illuminance and luminance, for performing photometric calculations. The illuminance method is used in this report and is congruent with FDOT methods. The level, and uniformity of a lighting system depends on several factors, including the lumen output of the light source, luminaire distribution, mounting height, luminaire position/setback, pole spacing and pole arrangement. Below is a description of terms needed to better understand the design criteria:

- **average initial illuminance** – the average level of horizontal illuminance on the pavement area of a traveled way at the time the lighting system is installed (when lamps are new and luminaires are clean); expressed in average footcandles (fc) for the pavement area.
- **average maintained illuminance** – the average level of horizontal illuminance on the roadway pavement when the output of the lamp and luminaire is diminished by the maintenance factors (light loss factors); expressed in average footcandles (fc) for the pavement area.
- **uniformity ratio** – falls under two categories and is the ratio between the maximum to minimum points and the ratio between the average to minimum points.

The latest version of the AGi32 software shall be used to perform photometric calculations to facilitate choosing the correct lumen output, distribution, mounting height, position/setback, pole spacing, and pole arrangement for the most cost effective and efficient lighting system.

Trails which are adjacent to a state road, such as the Turnpike Trail and Beacon Trail, will use FDOT criteria and all other trails will use the AASHTO criteria. The Miami Dade County Ordinance Section 8C-3 was reviewed and determined its requirements apply to open parking lots. The table below summarizes the minimum lighting design criteria recommendations which will be applied to the City of Doral.

Illumination Design Criteria			
Roadway and Walkway Classification	**Average Illuminance (fc)**	**Illuminance Uniformity Ratio**	
		(Avg./Min.)	**(Max./Min.)**
AASHTO Illuminance Design Values			
Pedestrian Ways and Bicycle Way/Trails	2.0[1]	3:1	N/A
Major Activity Areas	1.0[1]	4:1	N/A
Minor Activity Areas	0.5[1]	6:1	N/A
FDOT 2019 Florida Design Manual			
Sidewalks and Shared Use Paths/Trails	2.5[2]	4:1 or less	10:1 or less
Miami Dade County Ordinance Section 8C-3			
Parking Lots	1.0[1]	N/A	12:1

[1] Average maintained illuminance value.
[2] Average initial illuminance value.

Table 2. Shows the design criteria used for determining the lighting system

The activity areas are those designed for pedestrian use and are broken down into major and minor activity areas. The major activity areas are those which include such facilities as rest rooms, information centers, etc., as well as the walkways to and from these locations and to the parking area. The minor activity areas

are those which include picnic tables, playgrounds, dog walks, etc., and there associated walkways and facilities.

Pedestrian safety, security, and presence can change through the night and influence the lighting levels required to maintain safety. The *FHWA Design Criteria for Adaptive Roadway Lighting* and *AASHTO Roadway Lighting Design Guide, Seventh Edition* does not specifically have a dimming level or curfew recommendation and state that each "roadway" must be evaluated separately. Although this is not a roadway, these organizations' publications were reviewed for guidance.

The trails throughout the City do not have a great amount of night time pedestrian traffic. As a result, it has been determined that the lights shall be dimmed to 30% power from 10:00pm to sunrise. The lighting system shall also be capable of dimming up to 100% power when a pedestrian is detected. In addition, parking lot facilities shall be dimmed to 50% power during non-business/park hours. The Trails and Tails dog park and playground areas will be switched off manually by staff upon park closing.

4.2 Adaptive Lighting Controls

Adaptive lighting is the adjustment of lighting based on the current conditions of the area being lit. For an adaptive lighting solution to produce a financial benefit, the lighting system must have the following components:

- Dimmable-controls-ready luminaire.
- Control system, either central or localized on each luminaire.
- Localized metering.
- Luminaire monitoring.

4.3 Electrical Service System

The electrical system shall be 120/240V, single phase, 3 wire with a service rated distribution panel/lighting control cabinet in a NEMA 4X enclosure. A 240/480 voltage system can be used for longer distance trails to compensate for voltage drop on branch circuit feeders. Along with dimming controls, the lighting control cabinet shall be equipped with a hand-off-auto switch with the auto function controlled via an adjustable photocell sensor. Due to the energy savings produced by the dimming capabilities, it is recommended to use a metered electrical service in lieu of a negotiated rate.

5.0 LIGHTING EQUIPMENT SPECIFICATIONS

The equipment specifications are ordered by area of interest. The 3 areas of interest are parking lots/open areas, shared use paths/trails and bollard path lighting. The specs from 3 separate manufacturers were used to provide 3 fixture options for each of the 3 areas of interest. Some fixtures come with a range of performance packages that will cause fixture spacing to vary based off of brightness levels (lumens).

5.1 Parking Lot/Area Lighting

Holophane Mongoose Medium LED

Lumens – Multiple performance packages ranging from 15,000 lumens to 43,000 lumens. FAO Feature permits running the fixtures at controlled outputs, lowering operating temps and slowing depreciation rates on electronic components.

Wattages – Multiple performance ranges from 105 watts to 280 watts. Equivalent to 150-400 watts HID.

Lumens per Watt – Up to 168 L/W, making it a DesignLights Consortium (DLC) QPL qualified product.

Mounting Heights – 25' Height. 3G vibration rated per ANSI 136.31. Adjustable fixture tilt from 0° to 45°. Universal mount compatible with most manufactured pole insert patterns.

Poles & Bracket – Rounded, Straight Aluminum Pole (25 ft.). No bracket/arm needed.

Spacing – Dependent on mounting height, lumen package and selected distribution.

Distribution Types – IP66 rated borosilicate glass optics. Prismatic glass refractor for visual comfort. Area, Forward Throw, Medium Roadway, Narrow Roadway and Wide Roadway types (types II – V).

BUG Ratings – B3-U2-G2 or B3-U0-G2

Dark Sky Compliance – Compliant

FDOT APL Listed / MDC Approved – Yes

Color Temperature – standard 3000K, 4000K and 5000K CCT

Material – Rugged grade A360 die-cast aluminum (<1% copper). Rigorous 5-stage pretreatment polyester topcoat to ensure maximum durability that achieves a scribe creepage rating of 8 after 5,000 hours of salt spray. Corrosion resistant stainless-steel latches.

Efficiency – Up to 77% Energy Savings and a minimum of 50% reduction in maintenance costs when compared to traditional High-pressure Sodium (HPS) lighting.

Useful Life – LED light engines are rated for over 100,000 hours (Electronic driver has an expected life of more than 100,000 hours) Rated for -40°C / (-40°F) minimum ambient temp. Standard surge protection is 20kV/10kA "Extreme Level" per ANSI C136.2. Field Adjustable Option (AO) Feature permits running the fixtures at less than 100% light output, lowering operating temps and slowing depreciation rates on electronic components.

Maintenance – Tool-less access with stainless steel corrosion resistant latches and removable "power tray" facilitates maintenance and ensures secure closure over the long fixture life. If a fixture or component is

malfunctioning, please contact a local Holophane/AEL/Cyclone office. 1-5 fixtures can be replaced for new units. If more than 5 fixtures are in need of replacement, a company field service technician can evaluate fixture conditions on-site and advise how to proceed to honor item warranty.

Budgetary Cost for 25 ft SSA pole/fixture assembly with nLight control – $2,100/each

Warranty – 5-year limited warranty. Optional 10 year warranty upon customer request. Complete warranty terms available at:

www.acuitybrands.com/support/customer-support/termsand-conditions.

Ordering Lead Times – Standard 4-6 weeks terms apply. In-factory rush available upon request.

Product Manufactured – USA /CSA Certified to US and Canadian standards. Made in the USA

Control System – nLight wireless smart controls embedded in Mongoose Led fixture.

Lithonia Radean Arm Mount (RAD1 LED)

Lumens – Multiple performance packages ranging from 3,362 lumens to 17,126 lumens. "nLight" wireless controls and scheduled dimming with motion sensor overrides help control outputs based on timed schedules and motion/activity, lowering operating temps and slowing depreciation rates on electronic components.

Wattages – Multiple performance ranges from 25 watts to 122 watts.

Lumens per Watt – Multiple performance ranges from 132 L/W to 140 L/W, making it a DesignLights Consortium (DLC) QPL qualified product.

Mounting Heights – 25' Height

Poles & Bracket – Arm mounted with direct buried, 25' round, tapered aluminum (RTA) pole.

Spacing – Dependent on mounting height, lumen package and selected distribution.

Distribution Types – SYM Symmetric type V, ASY Asymmetric type IV and PATH Pathway type III

BUG Ratings – B1-U0-G1, B2-U0-G1, B2-U0-G2, B3-U0-G1, B3-U0-G2, B3-U0-G3, B4-U0-G3 and B4-U0-G4 (depending on performance package).

Dark Sky Compliance – Compliant

Color Temperature – standard 2700K, 3000K, 3500K, 4000K and 5000K CCT

Material – Single-piece die-cast aluminum housing with nominal wall thickness of 0.125" on a 6mm thick acrylic waveguide is fully gasketed with a single piece tubular silicone gasket.

Exterior parts are protected by a zinc-infused Super Durable TGIC thermoset powder coat finish that provides resistance to corrosion and weathering. Coatings have a controlled minimum thickness for a finish that can withstand extreme climate changes without cracking or peeling. Standard colors include dark bronze, black, natural aluminum and white. Available in textured and non-textured finishes.

Efficiency – Up to 40% Energy Savings and a reduction in maintenance costs when using scheduled dimming with motion sensor overrides.

Useful Life – LED light engines are rated for over 100,000 hours

Maintenance –The driver and light engine are accessible with a screwdriver and an allen wrench. If a fixture or component is malfunctioning, please contact a warranty specialist through the website URL below

(in the warranty section). The strong warranty program provides the costumer with the option of completely replacing the fixture with a new one.

Budgetary Cost for 25ft RTA pole/fixture Assembly with nLight Control – $2,750/each

Warranty – 5-year limited warranty. Complete warranty terms located at

Ordering Lead Times – Standard 2-6 weeks terms apply. In-factory rush available upon request.

Product Manufactured –Made in the USA

Control System – nLight wireless smart controls embedded, optional scheduled dimming and motion sensor overrides.

Pemco Enterprise 31 Post Top

Lumens – 4000 lumens.

Wattages – 42 watts.

Lumens per Watt – 113 L/W, making it a DesignLights Consortium (DLC) QPL qualified product.

Mounting Heights – 25' Height

Poles & Bracket – 4" round aluminum pole

Spacing – Dependent on mounting height, lumen package and selected distribution.

Distribution Types – standard IES distributions types II, III, IV, & V available

BUG Ratings – B3-U0-G1

FDOT APL Listed / MDC Approved – MDC Compliant

Color Temperature – 3000K, 4000K and 5000K

Efficiency –Dimmable, motion sensor capable and remote controlled to maximize efficiency.

Budgetary Cost for 25 ft pole/fixture assembly– $1,100 each not including installation

Warranty – Pemco Lighting Products warrants to its End Customers that its products shall be free from defects in material and workmanship (excluding ballasts and photoelectric controls, see below) for a period of one (1) year from the date of shipment. 5-year Limited Warranty. Visit URL below for warranty terms:

https://irp-cdn.multiscreensite.com/d3e4881b/files/uploaded/terms.pdf

Ordering Lead Times – Fixtures require 4-8 weeks, poles require 4 to 6 weeks. .

Product Manufactured –Made in the USA

Control System – Dimmable, motion sensor capable and remote controlled

5.2 Trail/Shared Use Path Lighting

Cyclone Levanto (Azalea) Post Top

Lumens – Multiple performance packages ranging from 2,300 to 15,400 lumens.

Wattages – Multiple performance ranged from 20 to 140W. Equivalent to 50-300W HID

Lumens per Watt – Up to 106 L/W, making it a DesignLights Consortium (DLC) QPL qualified product.

Mounting heights – Ranging between 12 ft. to 25 ft. All heights are 1.5G vibration rated per ANSI 136.3.

Poles & Bracket – Decorative Round aluminum pole with Holophane Oslow base.

Spacing – Dependent on mounting height, lumen package and selected distribution.

Distribution Types - Type 2, 3, 3M (wide), 4 & 5 Roadway optics available. Flat Clear Glass (FGC) provides 98% transmissivity for highest efficiency and performance. Flat Clear Frost (FGF) for reduced glare with increased uniformity. The Galaxy Light engine unit is a custom designed, modular system that combines state-of-the-art optics, LEDs and thermal management

BUG ratings – B1-U0-G1

Dark sky compliance – Compliant.

Color Temperature - 3000K and 4000K CCT

Material – Sturdy die-cast aluminum housing with integrated driver compartment. Certified IP67 optical system. Silicone gasket and stainless steel hardware with JS1500TM coating. Durable exterior polyester powder coating meets AAMA 2604 requirements (5 years South Florida exposure). Marine Grade (MG) pre-finish is available to meet ASTM G7, B117, D1654 and D2247 requirements (salt spray, corrosion and humidity resistance).

Efficiency – 60% energy savings and more than 50% savings in maintenance costs when compared to traditional High-pressure Sodium (HPS) lighting.

Useful Life – LED GALAXY engines are tested & designed for a lifespan of over 100,000 hours. Calculated L70 is over 363,000 hours. Heat sink designed and tested for optimal thermal management performance in all-weather from - 40C/-40F to 50C/122F

Maintenance –Utility Fitter for easy, tool-free access to all electrical components. If a fixture or component is malfunctioning, please contact a local Holophane/AEL/Cyclone office. 1-5 fixtures can be replaced for a new units. If more than 5 fixtures are in need of replacement, a company field service technician can evaluate fixture conditions on-site and advise how to proceed to honor item warranty.

Budgetary Cost for fixture/Oslow Aluminum Pole assembly and nLight control – $2,300/each

Warranty - 5-year limited warranty. Optional 10 year warranty upon customer request. Complete warranty terms available at:

www.acuitybrands.com/support/customer-support/termsand-conditions.

Ordering Lead times – Standard 8-10 weeks terms apply. In-factory rush available upon request.

Product manufactured – C/UL/US Certified to US and Canadian standards. Made in Canada

Control System – nLight wireless Controls

Lithonia Radean Post Top

Lumens – Multiple performance packages ranging from 3,168 lumens to 16,293 lumens. "nLight" wireless controls and scheduled dimming with motion sensor overrides help control outputs based on timed schedules and motion/activity, lowering operating temps and slowing depreciation rates on electronic components.

Wattages – Multiple performance ranges from 25 watts to 123 watts.

Lumens per Watt – Multiple performance ranges from 125 L/W to 133 L/W, making it a DesignLights Consortium (DLC) QPL qualified product.

Mounting Heights – Ranging between 10 ft. to 25 ft.

Poles & Bracket – Decorative round Aluminum pole.

Spacing – Dependent on mounting height, lumen package and selected distribution.

Distribution Types – SYM Symmetric type V, ASY Asymmetric type IV and PATH Pathway type III

BUG Ratings – B2-U2-G2, B2-U1-G1, B3-U2-G3, B3-U2-G1, B3-U2-G2, B4-U2-G4, B4-U3-G4 and B4-U2-G3 (depending on performance package).

Dark Sky Compliance – Compliant

FDOT APL Listed / MDC Approved – _____

Color Temperature – standard 2700K, 3000K, 3500K, 4000K and 5000K CCT

Material – Single-piece die-cast aluminum housing with nominal wall thickness of 0.125" on a 6mm thick acrylic waveguide is fully gasketed with a single piece tubular silicone gasket.

Exterior parts are protected by a zinc-infused Super Durable TGIC thermoset powder coat finish that provides resistance to corrosion and weathering. Coatings have a controlled minimum thickness for a finish that can withstand extreme climate changes without cracking or peeling. Standard colors include dark bronze, black, natural aluminum and white. Available in textured and non-textured finishes.

Efficiency – Up to 40% Energy Savings and a reduction in maintenance costs when using scheduled dimming with motion sensor overrides.

Useful Life – LED light engines are rated for over 100,000

Maintenance –The driver and light engine are accessible with a screwdriver and an allen wrench. If a fixture or component is malfunctioning, please contact a warranty specialist through the website URL below (in the warranty section).

Budgetary Cost for pole/fixture Assembly with nLight Control – $2,500/each

Warranty – 5-year limited warranty. Optional 10-year warranty upon customer request.Complete warranty terms located at

https://www.acuitybrands.com/support/customer-support/warranty

Ordering Lead Times – Luminaires take a standard 2-6 weeks, poles take 8 weeks. In-factory rush available upon request.

Product Manufactured –Made in the USA

Control System – nLight wireless smart controls embedded, optional scheduled dimming and motion sensor overrides.

Heper Oliva 2 Module

Lumens – 4000 lumens.

Wattages – 35 watts.

Lumens per Watt – 114 L/W, making it a DesignLights Consortium (DLC) QPL qualified product.

Mounting Heights – 14 ft.

Poles & Bracket – 3.5" round aluminum pole with 2 arm mounting options.

Spacing – Dependent on mounting height, lumen package and selected distribution.

Distribution Types – standard IES distributions types II, III, IV, & V available

BUG Ratings – B2-U0-G1

FDOT APL Listed / MDC Approved – MDC Compliant

Color Temperature – 2700K, 3000K and 4000K

Material – Corrosion resistant die-cast aluminum housing (marine grade) with electrostatic powder coating (Black, Doral Blue, & Hunter Green available).

Efficiency –Dimmable, motion sensor capable and remote controlled to maximize efficiency.

Budgetary Cost for 14 ft pole/fixture assembly– $2,000 each not including installation

Warranty – 5-year limited warranty. Complete warranty terms located at

https://www.heperlighting.com/uploads/docs/1569509421_warranty.pdf

Ordering Lead Times – Fixtures require 6 to 10 weeks, poles require 4 to 6 weeks. .

Product Manufactured –Made in the USA

Control System – Dimmable, motion sensor capable and remote controlled

Holophane Mongoose Medium LED

Lumens – Multiple performance packages ranging from 15,000 lumens to 43,000 lumens. FAO Feature permits running the fixtures at controlled outputs, lowering operating temps and slowing depreciation rates on electronic components.

Wattages – Multiple performance ranges from 105 watts to 280 watts. Equivalent to 150-400 watts HID.

Lumens per Watt – Up to 168 L/W, making it a DesignLights Consortium (DLC) QPL qualified product.

Mounting Heights – 14' Height. 3G vibration rated per ANSI 136.31. Adjustable fixture tilt from 0° to 45°. Universal mount compatible with most manufactured pole insert patterns.

Poles & Bracket – Rounded, Straight Aluminum Pole (14 ft.). No bracket/arm needed.

Spacing – Dependent on mounting height, lumen package and selected distribution.

Distribution Types – IP66 rated borosilicate glass optics. Prismatic glass refractor for visual comfort. Area, Forward Throw, Medium Roadway, Narrow Roadway and Wide Roadway types (types II – V).

BUG Ratings – B3-U2-G2 or B3-U0-G2

Dark Sky Compliance – Compliant

FDOT APL Listed / MDC Approved – Yes

Color Temperature – standard 3000K, 4000K and 5000K CCT

Material – Rugged grade A360 die-cast aluminum (<1% copper). Rigorous 5-stage pretreatment polyester topcoat to ensure maximum durability that achieves a scribe creepage rating of 8 after 5,000 hours of salt spray. Corrosion resistant stainless-steel latches.

Efficiency – Up to 77% Energy Savings and a minimum of 50% reduction in maintenance costs when compared to traditional High-pressure Sodium (HPS) lighting.

Useful Life – LED light engines are rated for over 100,000 hours (Electronic driver has an expected life of more than 100,000 hours) Rated for -40°C / (-40°F) minimum ambient temp. Standard surge protection is 20kV/10kA "Extreme Level" per ANSI C136.2. Field Adjustable Option (AO) Feature permits running the fixtures at less than 100% light output, lowering operating temps and slowing depreciation rates on electronic components.

Maintenance – Tool-less access with stainless steel corrosion resistant latches and removable "power tray" facilitates maintenance and ensures secure closure over the long fixture life. If a fixture or component is malfunctioning, please contact a local Holophane/AEL/Cyclone office. 1-5 fixtures can be replaced for new

units. If more than 5 fixtures are in need of replacement, a company field service technician can evaluate fixture conditions on-site and advise how to proceed to honor item warranty.

Budgetary Cost for 14 ft OSA pole/fixture assembly with nLight control – $2,450/each

Warranty – 5-year limited warranty. Optional 10 year warranty upon customer request. Complete warranty terms available at:

www.acuitybrands.com/support/customer-support/termsand-conditions.

Ordering Lead Times – Standard 4-6 weeks terms apply. In-factory rush available upon request.

Product Manufactured – USA /CSA Certified to US and Canadian standards. Made in the USA

Control System – nLight wireless smart controls embedded in Mongoose Led fixture.

5.3 Bollard Lighting

Cyclone Clio

Lumens – Multiple performance packages ranging from 921 to 2,720 lumens.

Wattages – Multiple performance ranges from 15 watts to 35 watts.

Lumens per Watt – Up to 65 L/W

Mounting heights – 45 inches

Spacing – Type 3 (Low glare): For a street with a width up to 2 times the mounting height and a spacing up to 6 times the mounting height.

Distribution Types - Type 3 (Low glare) or 5 optics. Flat lightly frosted lens for perfectly diffused illumination. Class 2 electrical system with an aluminum core LED engine.

BUG ratings – B0-U0-G0

Dark sky compliance - Compliant.

Color Temperature - 3000K and 4000K CCT

Material – All Cyclone bollards are manufactured with an extrusion base and permanent cast aluminum head module including a water tight certified IP67 light engine. Durable exterior polyester powder coating meets AAMA 2604 requirements (5 years South Florida exposure). For added protection a Marine Grade (MG) pre-finish is available to meet ASTM G7, B117, D1654 and D2247 requirements (salt spray, corrosion and humidity resistance). Tamper proof, stainless & black oxide hardware.

Efficiency – 60% energy savings and more than 50% savings in maintenance costs when compared to traditional High-pressure Sodium (HPS) lighting.

Useful Life - Copernic engines are tested & designed for a lifespan of over 100,000 hours. System wattage includes the LED and the Driver. Calculated L70 is over 363,000 hours

Maintenance - Bollards are durable and are delivered with tamper-proof hardware allowing ease of maintenance while protecting against vandalism. If a fixture malfunctions, contact the local Holophane/AEL/Cyclone representative. 1-5 fixtures can be replaced for a new units. If more than 5 fixtures are in need of replacement, a company field service technician can evaluate fixture conditions on-site and advise how to proceed to honor item warranty.

Budgetary Cost – $1,200.00

Warranty 5-year limited warranty. Optional 10 year warranty upon customer request. Complete warranty terms available at:

www.acuitybrands.com/support/customer-support/termsand-conditions.

Ordering Lead times – Standard 8-10 weeks terms apply. In-factory rush available upon request.

Product manufactured – C/UL/US Certified to US and Canadian standards. Made in Canada

Lithonia Radean Bollard

Lumens – Multiple performance packages ranging from 380 lumens to 1,459 lumens. "nLight" wireless controls and scheduled dimming with motion sensor overrides help control outputs based on timed schedules and motion/activity, lowering operating temps and slowing depreciation rates on electronic components.

Wattages – Multiple performance ranges from 5 watts to 19 watts.

Lumens per Watt – Multiple performance ranges from 73 L/W to 78 L/W

Mounting Heights – Ranging between 24", 30", 36" and 42"

Spacing – Dependent on mounting height, lumen package and selected distribution.

Distribution Types – ASY Asymmetric and SYM Symmetric

BUG Ratings – B0-U1-G0 and B1-U1-G0 (depending on performance package).

Dark Sky Compliance – Compliant

Color Temperature – standard 2700K, 3000K, 3500K, 4000K and 5000K CCT

Material – One-piece extruded aluminum shaft with thick side walls for extreme durability, and die-cast reflector and top cap. Four 3/8" x 16" anchor bolts with double nuts and washers and 5-2/3" maximum bolt circle template ensure stability. Overall height is 42" standard.

Exterior parts are protected by a zinc-infused durable TGIC thermoset powder coat finish that provides superior resistance to corrosion and weathering for maximum retention of gloss and luster. A tightly controlled multi-stage process ensures a minimum controlled thickness for a finish that can withstand the elements without cracking or peeling. Available in both textured and non-textured finishes.

Efficiency – Up to 40% Energy Savings and a reduction in maintenance costs when using scheduled dimming with motion sensor overrides.

Useful Life – LED light engines are rated for over 100,000

Maintenance –Electrical components mounted on removable power tray. If a fixture or component is malfunctioning, please contact a warranty specialist through the website URL below (in the warranty section).

Budgetary Cost– $850/each

Warranty – 5-year limited warranty. Optional 10-year warranty upon customer request.

Complete warranty terms located at

https://www.acuitybrands.com/support/customer-support/warranty

Ordering Lead Times – Luminaires take a standard 2-6 weeks

Product Manufactured –Made in the USA

Control System – nLight wireless smart controls embedded, optional scheduled dimming and motion sensor overrides

Amerlux Lunetta LED Walkway Bollard

Lumens – 1420 lumens.

Wattages – 16 watts.

Lumens per Watt – 90 L/W

Mounting Heights – 3 ft. (36 inch)

Poles & Bracket – 2.6" diameter, round aluminum pole

Spacing – Dependent on mounting height, lumen package and selected distribution.

Distribution Types – Standard IES distribution type V

BUG Ratings – B1-U0-G1

Color Temperature – 3000K, 3500k, 4000K and 5000K

Material - Cast aluminum housing for wet locations, surge suppression and glare controlled optics for "cleaner" lighting. Colors include gray, bronze, satin black and stardust silver.

Efficiency –Dimmable and remote controlled for optimized efficiency.

Maintenance – Subterranean junction box for access to wiring. No visible fasteners or hardware.

Budgetary Cost– Contractor net price: $995.00 each, approximately $180.00 per node, $2,500.00 per site controller, plus set-up fee (commissioning) approx. $5000.00 which includes (2) days factory tech training (does not include installation).

Warranty – All outdoors fixtures are backed up by an Amerlux 5-year manufacturer limited warranty. Completer terms can be located at https://www.amerlux.com/Warranty

Ordering Lead Times – Fixtures require 6-8 weeks, controls require 4 to 6 weeks.

Product Manufactured –Made in the USA.

Control System – Dimmable and remote controlled.

6.0 PHOTOMETRIC ANALYSIS

The latest version of the AGi32 lighting analysis software was used to test each luminaire's photometric performance. This section will describe the variables and processes used to compare each luminaire by function. Although the photometric results are summarized below, more details can be found in Appendix E.

6.1 Parking Lot/Area Lighting

The parking lot/area luminaires were compared by using a 60 ft. x 60 ft. point by point calculation grid area. The area size was based on the dimensions of a typical parking lot which consists of two 18 ft. vehicle parking spaces, and a 24 ft. two-way driving aisle. A Type V distribution was used for each luminaire and placed at each corner of the calculation area. The Type V will produce a circular distribution that has the same intensity at all lateral angles. A parking lot typical mounting height is 25 ft. and was used as the basis of this analysis. This mounting height would be used throughout the City's parking lots with the exception of Trails and Tails Park which is restricted to a 14ft mounting height due to the FPL overhead transmission lines.

A light loss factor was considered for the Mongoose Medium LED, Radian LED Arm Mount, and Enterprise 32 LED, which was 0.25, 0.82, and 0.96 respectively. Light loss factors address losses that result in direct changes to lamp lumens including lamp lumen depreciation (LLD) and/or a user defined factor (UDF). The LLD was based on the predicted performance of the luminaire at 100,000 hours or end of useful life. The reason the Mongoose Medium LED LLF is 0.25 is because it considers a LLD of 0.96, and a UDF of 0.26. The UDF is used to consider the fixture dimming capabilities. The luminaire is equipped with a field adjustable dimming setting which provides a high range of lumen out puts for various applications. For the parking lot/area lighting application, at a mounting height of 25 ft., an output setting of 26% produced the best results.

The table below summarizes the performance of each luminaire with respect to design criteria for parking lots. Each luminaire complied with Miami-Dade County's parking lot design criteria. The results were virtually identical for the Mongoose Medium LED and Enterprise 32 LED, with the Radian LED Arm Mount luminaire performing slightly better on the uniformity ratio criteria. The lower the uniformity ratio the more uniform the parking lot/area illumination will appear.

Parking Lot/Area Photometric Results			
	Mongoose Medium LED	**Lithonia Radean Arm Mount**	**Pemco Enterprise 31 Post Top**
Average Maintained Illuminance (fc.)	1.0	1.0	1.0
Uniformity Ratio (Max. / Min.)	1.4	1.1	1.4

6.2 Trail/Shared Use Path Lighting

The luminaires for the trail/shared use paths were compared using the roadway optimizer tool within the AGi32 software. This tool provides the maximum spacing possible while complying with the user defined lighting criteria.

The typical trail width of 10 ft. was used with a light pole setback of 2.5 ft. The spacing result will help determine an approximate number of light poles needed along the trail. Each fixture was placed at a 14 ft. mounting height, which was coordinated by the City of Doral and Florida Power & Light to help avoid overhead conflicts during construction. The chosen height is mostly due to the transmission lines located at Trails and Tails Park and along NW 50th Street. Other trails may not have the 14 ft. mounting restriction but is recommended for consistency throughout the City of Doral.

As described in the previous section, a light loss factor of 0.95, 0.82, and 0.285 was applied to the Cyclone Levanto (Azalea) Post Top, Lithonia Radian Post Top, and the Heper Olivia 2 Module respectively to consider luminaire performance. The Heper Olivia2 Module's LLF was a combination of a 0.95 LLD and a 0.30 UDF. The UDF is the application of a 30% dimming setting internal to the fixture. The application of permanent dimming on a luminaire will decrease the required maintenance while increasing its lifespan.

The table below summarizes the performance of each luminaire with respect to the design criteria. When evaluating the spacing of the light poles, the Lithonia and Heper luminaires similarly outperform the Cyclone. A one foot difference in spacing between the Lithonia and Heper fixtures is insignificant when it relates to project costs. What makes the Lithonia luminaire stand out amongst the competition is its low uniformity ratio which is approximately half of the other luminaires. This will provide a more even distribution of illuminance along the trail/shared use path.

Trail/Shared Use Path Photometric Results				
	Cyclone Levanto (Azalea) Post Top	**Mongoose Medium LED**	**Lithonia Radean Post Top**	**Heper Oliva 2 Module**
Average Maintained Illuminance (fc.)	2.0	2.1	2.0	2.0
Uniformity Ratio (Avg. / Min.)	2	3	1	2
Maximum spacing for a 10 ft trail/path (ft.)	50	66	54	55

As requested by the City of Doral, the same Mongoose Medium LED fixture shown for the parking lot application has been added as a forth option for the Trail/Shared Use Path application. This fixture is mainly

used for roadway/area lighting but was tested for the Trail/Shared Use Path application. The minimum lumen package with a house side shield is 10,883 lumens which is too high for a low mounting application. Therefore, the fixture will require a special driver installed by the factory to lower the lumens output by 26% or 2,830 lumens. The house side shield is recommended to avoid backlight and light spillage onto adjacent properties. For the photometric testing, a light loss factor of .25 was used which includes a 0.96 LLD and a 0.26 UDF. Although the uniformity ratio is higher than the other fixtures, it still complies with criteria while its maximum spacing significantly exceeds the other fixtures. It was later determined by the manufacturer that the mongoose fixture could not be dimmed further than the 26% lumen output requirement. This will not allow the fixtures to be dimmed more during off peak hours. Therefore the mongoose fixture is rejected as a shared use path option.

6.3 Bollard Lighting

Similar to the trail/shared use path lighting, the bollards were compared using the roadway optimizer tool using the following characteristics: a sidewalk/path width of 6 ft., a light pole setback of 1 ft., and the bollard heights as per fixture dimensions. In addition, a light loss factor of 0.95, 0.80, and 0.95 was applied to the Cyclone Clio, Lithonia Radean, and Amerilux Lunetta LED bollards respectively.

The table below summarizes the performance of each bollard with respect to the design criteria for minor activity areas. It is obvious from the spacing metric, that the Amerilux Lunetta bollard far outperforms the other two bollards with as much as twice the spacing.

Bollard Photometric Results			
	Cyclone Clio	**Lithonia Radean**	**Amerilux Lunetta**
Average Maintained Illuminance (fc.)	4.2	1.7	1.4
Uniformity Ratio (Avg. / Min.)	6	4	5
Maximum spacing for a 6 ft sidewalk (ft.)	17	12	35

7.0 COST ANALYSIS COMPARISON

Parking Lot/Area Lighting			
	Holophane Mongoose Medium LED	**Lithonia Radean Arm Mount**	**Pemco Enterprise 31 Post Top**
Luminaire/Motion Sensor/25 ft. Pole Assembly Cost ($)	$2,300.00	$2,750.00	$2,100.00
Approximate Quantity per Parking Lot	10	10	10
Watts	20	38	42
Energy Cost/Yr./Luminaire ($)	$28.50	$54.00	$59.70
Total Cost ($)	**$23,028.50**	**$27,554.00**	**$21,059.70**

Shared Use Path Lighting				
	Holophane Mongoose Medium LED	**Cyclone Levanto (Azalea) Post Top**	**Lithonia Radean Post Top**	**Heper Oliva 2 Module**
Photometric Spacing (ft)	66	50	54	55
Quantity per 7 miles:	560	740	685	672
Luminaire/ Motion Sensor/14 ft. Pole Assembly Unit Cost ($)	$2,450.00	$2,300.00	$2,500.00	$2,000.00
Watts	20	22	54	11
Energy Cost/Yr ($)	$1,592.36	$2314.61	$5259.05	$1,050.96
Total Cost ($)	**$1,372,000**	**$1,702,000**	**$1,712,500**	**$1,344,000**

Bollard Lighting			
	Cyclone Clio	**Lithonia Radean Bollard**	**Amerlux Lunetta LED Walkway Bollard**
Photometric Spacing (ft.)	17	12	36
Quantity per 500 ft.	30	42	28
Bollard/Sensor Cost ($)	$1,200.00	$850.00	$995.00
Watts	18	5	16
Energy Cost/Yr($)	$2.56	$0.71	$2.28
Total Cost ($):	**$36,000**	**$35,700**	**$27,860**

Notes:

1. Each manufacturer will have a control system commissioning fee of about $5,000.00.
2. Central control system for each luminaire is about $2,500.00 per zone coverage.
3. The kilowatt hour rate for energy cost used was $0.03246 kWh.
4. Total Cost does not include Energy Yearly Cost and is shown for informational purposes only.

A cost estimate was performed to compare procurement of the Mongoose and Beacon Trails as a sole project, as part of all the trails, and as part of the Pedestrian Bridge Project. These cost estimate comparison tables can be found in Appendix G.

8.0 RECOMMENDATION

The City of Doral is a developing city which strives to separate itself from the rest of South Florida. To accomplish this, Doral recognizes that it must choose quality infrastructure which will perform as designed while providing a unique experience and appearance. The safety and security of its residents and visitors using facilities such as parking lots, public parks, pedestrian path ways and trails is of up most importance. The City of Doral wants to send a message to its residents and visitors, that they are invited to enjoy its facilities and assure that safety is their top priority. One way of accomplishing these goals is by providing sufficient lighting at these facilities.

Three types of light fixtures from three different brands have been analyzed and compared to help determine the fixture which will accomplish The City's goals. While beautification, safety, and security are the top priorities, the City of Doral is ambitious in moving towards a more efficient and green lighting system by being one of the leaders in adopting adaptive lighting controls which will reduce energy consumption significantly.

The recommendations provided below are based on (in order of importance) photometric uniformity ratio performance, dark sky compliance, light spillage, energy efficiency, aesthetics, uniqueness, and cost being the least important. The purpose of this report is to provide a recommendation based on the best performing assembly. For that reason cost is last on the list. The controls for each lighting system have no effect on the recommendations as each system provides the same function at a similar cost.

One must understand that the luminaires analyzed in this report have many different characteristics such as, lumen output, distribution types, wattages, color temperatures, voltage ranges etc. Although this report analyzed one luminaire type for each category, an emphasis was made to compare apples to apples between brands. ~~The luminaires detailed as parking lot/area lighting can also be used for the trail lighting application.~~ The City of Doral has the ultimate choice in choosing the luminaire, pole, and control system which meets their goals. The recommendations below have been provided from a performance and engineering perspective. In keeping with the City of Doral branding, all light pole assemblies shall be painted blue. Recommended light poles have been included in the appendices and are shown in the cut sheets directly after the respective luminaire cut sheet. Keep in mind that the luminaires chosen can mount on almost any manufactured pole the City desires.

8.1 Parking Lot/Area Lighting

The **Lithonia Radian Arm Mount** is the recommended luminaire for the Parking Lot/Area lighting with a 10 year warranty option at a 10% adder fee. This fixture resulted in the lowest uniformity ratio when tested within a 60 ft. x 60 ft. area. This means that, the light within the parking lot will be more evenly distributed throughout the parking lot/area than its competitors. It has an up light rating of 0 which minimizes light pollution towards the sky. By choosing this fixture as your parking lot/area lighting, you

will be sure to have a quality product from a known brand. This fixture is unique, and not used anywhere else within Miami-Dade County.

The recommended pole for this fixture would be the round straight aluminum pole (RSA) by Hapco which includes a lifetime warranty. This pole assembly can be mounted at 14ft for parking lot areas in conflict with overhead utility lines, and at the recommended 25 ft for parking lot areas free of obstruction. In addition Hapco manufactures a matching multi-chambered pole for use when an additional electronic device such as a camera, license plate reader, etc. are to be attached to the light pole assembly. All foundation for the parking lot application shall be be designed with a concrete base which protrudes the finish grade by a minimum of 3ft and shall be analyzed by a structural engineer to comply with the latest Florida Building Code wind load requirements (170 MPH). The Hapco pole brochures can be found in Appendix A after the Lithonia Radian brochure.

8.2 Shared Use Path Lighting

Because of the amount of existing shared use path/trails located throughout the City of Doral, it is essential to choose a fixture which will provide the maximum spacing while meeting criteria. The recommendation for this application is **Lithonia Radian Post Top** with a 10 year warranty option at approximately 10% adder fee. Although the maximum spacing between poles is one foot less than the Heper Oliva 2 Module, the Lithonia Radian Post Top outperformed the competition in the uniformity metric. This benefits the City as this fixture will also match the fixture used for the parking lot/area lighting application and therefore provide the City with a consistent theme throughout. When these fixtures are installed adjacent to residents' homes, they shall be equipped with a house side shield to avoid light spillage onto their property.

For the shared use path application, a concrete base foundation is not needed for protection of the pole as is needed in the parking lot application. Because of the quantity of poles that will be installed throughout the City's trails, it is recommended to use Hapco's direct buried round tapered aluminum pole (RTA) which is a cost effective installation while complying with the latest Florida Building Code wind load requirements (170 MPH). This pole includes a 10 year warranty, and the brochure can be found in Appendix B after the Lithonia Radian brochure.

8.3 Control System

The recommended control system is the nLight Air which shall be used for the shared use path lighting only. This system uses the CL***AIR***ITY Pro Mobile App which can be used to adjust, from the ground, using a smartphone and allows the lighting to be "tuned" to the specific needs of the site. Approximately 128 devices can be connected to a single zone with a maximum line of site of 1000ft. When coupled with an nLight ECLYPSE and free SensorView software, the system capabilities expands to include time-based schedules, integrated site control and monitoring. To add motion sensing capabilities, the Lithonia Radian Post Top luminaire shall be equipped with an rSBOR motion sensor mounted externally near the top of the pole which will allow for communication and integration with the nLight Air system. To eliminate motion sensing blind spots, it is recommended to attach a motion sensor to every pole. The motion sensor coverage mounted at 14ft is approximately 30 ft on either side of the light pole assembly. Using the calculated spacing

of 54 ft, will provide an overlap between sensor readings and therefore eliminating any motion sensing blind spots along the shared use path.

8.4 Bollard Lighting

The **Amerlux Lunnetta LED Walkway Bollard** was by far the best technical option by outperforming its competition in the spacing metric by twice the distance. This will allow for fewer bollards needed per location thereby lowering the overall furnishing and installing costs. In addition, its sleek and modern architectural look and round top will match well with the two Lithonia fixtures.

8.5 Trail Prioritization

This section provides the City of Doral with a construction priority list for the seven trails analyzed as part of this report. The priority list is based off of existing ambient lighting within the trail from neighboring lighting systems, and whether or not the trail has been constructed as of present date. Field visits were performed and existing lighting measurements were documented, which can be seen in Appendix F. Although the Turnpike Trail has more ambient light than Beacon Trail, The City requested to raise the Turnpike trail priority due to the amount of residents utilizing this trail for exercise in the early morning and evening hours.

Trails Lighting Construction Priority List		
Priority	**Trail**	**Average Illumination (fc.)**
1	Turnpike	1.69
2	Beacon	0.93
3	Dressel's Dairy	2.54
4	NW 41st Street	3.10
5	Southern Commend	4.86
6	NW 50th Street	7.49
7	NW 104th Avenue	N/A