

EXHIBIT A



Hallandale Beach
PROGRESS. INNOVATION. OPPORTUNITY.

**INVITATION TO BID
THREE ISLAND REUSE IRRIGATION PROJECT
TECHNICAL SPECIFICATIONS AND GENERAL REQUIREMENTS**

**PREPARED BY:
CITY OF HALLANDALE BEACH
PUBLIC WORKS DEPARTMENT
EAC CONSULTING, INC.
AND PROCUREMENT DEPARTMENT**

**CITY OF HALLANDALE BEACH
DEPARTMENT OF PUBLIC WORKS**

630 NW 2nd Street, Hallandale Beach, FL 33009



TECHNICAL SPECIFICATIONS

For

THREE ISLAND REUSE IRRIGATION PROJECT

**100% Phase Submittal
January 2016**

Prepare By:



EAC Consulting, Inc.
5100 NW 33rd Avenue, Suite 243
Fort Lauderdale, FL 33309
CA # 7011
EAC No. 14045.SD01

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SUMMARY OF WORK

PART 1 -- GENERAL

1.01 THE REQUIREMENT

- A. The work to be performed under this Contract shall consist of furnishing all tools, equipment, materials, supplies, and manufactured articles and for furnishing all transportation and services, including fuel, power, water, and essential communications, and for the performance of all labor, work, or other operations required for the fulfillment of the Contract in strict accordance with the Contract Documents. The work shall be complete, and all work, materials, and services not expressly shown or called for in the Contract documents which may be necessary for the complete and proper construction of the work in good faith shall be performed, furnished, and installed by the CONTRACTOR as though originally so specified or shown, at no increase in cost to the CITY.
- B. Prior to construction, the CONTRACTOR shall verify all existing utilities identified on the Drawings and locate all other potential utilities in their working area that may not be shown on the Drawings. The utility verifications consist of excavation to verify tie-in points and to locate potential conflicts that may affect the work as shown on the Drawings. The CONTRACTOR shall be responsible for the coordination of this work with the associated utility owners and permitting agencies having jurisdiction over the specific locations to be verified.

1.02 SCOPE

- A. The work to be performed includes site and civil work associated with the construction of approximately 3775 LF of new pressurized reuse irrigation main, out of which 3175 LF will be 8" PVC C-900 and the remaining 600 LF will be 10" DIPS HDPE DR 9 to be installed via Horizontal Directional Drilling crossing underneath the DeSoto Waterway Canal. The project begins from the intersection of Wiley Street and Diplomat Parkway, running south along Diplomat Parkway and heading East on Atlantic Shores Blvd where the main will cross underneath the DeSoto Waterway Canal, and then continue east until south of the intersection of Three Island Blvd and Atlantic Shores Blvd. The project ends at the southwest corner of the Joseph Scavo Park. This project also consists of the installation of irrigation service lines, storage tanks, and the construction of a pump station.

Some of the key construction activities include survey, permitting, clearing and grubbing, locating and protection existing utilities, preparation and submittal of shop drawings, installing storm water pollution prevention systems, maintenance of traffic, piping trench excavation, horizontal directional drilling, structures installation, piping with valves and fitting installation, backfill, density test, pressure test, trench restoration, infiltration trench, pavement marking restoration, milling and resurfacing, etc.

- B. It is the intent of the CITY to obtain a complete and working installation under this contract and any items of labor, materials or equipment, which may reasonably be assumed as necessary to accomplish this end, should be supplied whether or not specifically shown on the plans or described herein. Maintenance of the existing utility systems is mandated throughout the construction period.

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SUMMARY OF WORK

1.03 WORK BY OTHERS

- A. The CONTRACTOR shall cooperate fully with all utility forces of the CITY, or other public or private agencies engaged in the relocation, altering, or otherwise rearranging any facilities which interfere with the progress of the work, and shall schedule the work so as to minimize interference with said relocation, altering, or rearranging of facilities.
- B. When two or more contracts are being executed at one time on the same or adjacent land in such manner that Work on one contract may interfere with that on another, the CITY shall determine the sequence and order of the Work. When the territory of one contract is the necessary or convenient means of access for the execution of another contractor, such privilege of access or any other reasonable privilege may be granted by the CITY to CONTRACTOR.

1.04 LOCATION OF THE PROJECT

- A. The project begins at the intersection of Wiley Street and Diplomat Parkway in the City of Hollywood and ends at the southwest corner of the Joseph Scavo Park, south of the intersection of Diplomat Parkway and Three Island Blvd in the City of Hallandale Beach.

1.05 CONTRACT DRAWINGS

- A. The work to be performed is shown on the set of Contract Drawings entitled "Three Island Reuse Irrigation Project".

1.06 CONTRACTOR FURNISHED MATERIAL AND EQUIPMENT

- A. All equipment, materials, or devices incorporated in this project shall be new and unused, unless indicated otherwise in the Contract Documents and shall be the products of reliable manufacturers who, unless otherwise specified, have been regularly engaged in the manufacture of such material and equipment for at least five (5) years. Procedures and additional requirements regarding manufacturer's experience and substitutions are included in Section 01300 - Submittals.

1.07 DRAWINGS OF EXISTING FACILITIES

- A. The CONTRACTOR shall contact representatives for other utilities, facilities in proximity of the work and Sunshine State One Call Inc., to obtain the as-built information from them directly. The utilities shown on Drawings are based upon available records supplied from various sources. The CITY makes no guarantee, either expressed or implied, as to their accuracy or completeness.

1.08 ITEMS SPECIFIED ON DRAWINGS

- A. Certain items of material and/or equipment, and their installation may be specified on the Drawings and not mentioned in the Specifications. Such items are to be considered as both shown on the Drawings and noted in the Specifications and be provided by the CONTRACTOR in accordance with the Specification on the Drawings.

1.09 FIELD LAYOUT OF WORK

Three Island Reuse Irrigation Project
City of Hallandale Beach

Summary of Work

SECTION 01010

SUMMARY OF WORK

- A. All work under this Contract shall be constructed in accordance with the Contract Drawings or as directed by the ENGINEER. Elevations of existing ground, structures and appurtenances are believed to be reasonably correct but are not guaranteed to be absolute and therefore are presented only as an approximation. Any error or apparent discrepancy in the data shown or omissions of data required for accurately accomplishing the stake-out survey shall be referred immediately to the ENGINEER for interpretation or correction.
- A. All survey work for construction control purposes shall be made by the CONTRACTOR at his expense.
- C. The CONTRACTOR shall establish all base lines for the location of the principal component parts of the work together with benchmarks and batter boards adjacent to the work. Based upon the information provided by the Contract Drawings, the CONTRACTOR shall develop and make all detail surveys necessary for construction. The CITY will furnish information and location of existing benchmarks.
- D. The CONTRACTOR shall have the responsibility to carefully preserve the benchmarks, reference points and stakes. In case of destruction thereof by the CONTRACTOR or resulting from his negligence, he shall be held liable for any expense and damage resulting therefrom and shall be responsible for any mistakes that may be caused by the unnecessary loss or disturbance of such bench marks, reference points and stakes.
- E. Existing or new control points, property markers, and monuments that will be established or are destroyed during the normal causes of construction shall be re-established by the CONTRACTOR; and all reference ties recorded therefore shall be furnished to the ENGINEER. All computations necessary to establish the exact position of the work shall be made and preserved by the CONTRACTOR.
- F. The ENGINEER may check all or any portion of the work, and the CONTRACTOR shall afford all necessary assistance to the ENGINEER in carrying out such checks. Any necessary corrections to the work shall be performed immediately by the CONTRACTOR and he shall accept all responsibility for the accuracy and completeness of his work.

PART 2 -- PRODUCTS (Not Used)

PART 3 -- EXECUTION (Not Used)

- END OF SECTION -

SECTION 01025

MEASUREMENTS AND PAYMENT

PART 1 – GENERAL

1.1 GENERAL

- A. The CONTRACTOR shall receive and accept the compensation provided in the Proposal and the Contract as full payment for furnishing all materials, labor, tools and equipment, for performing all operations necessary to complete the work under the Contract, and also in full payment for all loss or damages arising from the nature of the work, or from any discrepancy between the actual quantities of work and quantities herein estimated by the ENGINEER, or from the action of the elements or from any unforeseen difficulties which may be encountered during the prosecution of the work until final acceptance by the CITY.
- B. The prices stated in the proposal include all costs and expenses for taxes, labor, equipment, materials, commissions, transportation charges and expenses, patent fees and royalties, labor for handling materials during inspection, together with any and all other costs and expenses for performing and completing the work as shown on the details and specified herein. The basis of payment for an item at the unit price shown in the proposal shall be in accordance with the description of that item in this Section.
- C. The CONTRACTOR's attention is again called to the fact that the, quotations for the various items of work are intended to establish a total price for completing the work in its entirety. Should the CONTRACTOR feel that the cost for any item of work has not been established by the Bid Form or Payment Items, he shall include the cost for that work in some other applicable bid item, so that his proposal for the project does reflect his total price for completing the work in its entirety.

PART 2 – MEASUREMENT

2.1 MEASUREMENT

- A. The quantities for payment under this Contract shall be determined for those completed items, in place, ready for service and accepted by the CITY, in accordance with the applicable method of measurement therefore contained herein. A representative of the CONTRACTOR shall witness any field measurements.

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MEASUREMENTS AND PAYMENT

PART 3 – PAYMENT ITEMS

3.1 PAYMENT ITEMS

Item No. 1 - Clearing and Grubbing:

Measurement and payment of individual items for Clearing and Grubbing will not be made; rather, all items shall be included in the lump sum price.

Payment for Clearing and Grubbing will be made at the Contract lump sum price, which price and payment shall be full compensation for complete removal, replacement and disposal of all vegetation, debris, or any other obstruction in all areas where excavation is to be done. This payment also includes the removal of pavement markings by grinding method, removal and replacement of the existing fence in conflict with the proposed pipe installation.

Item No. 2 - Sod – Saint Augustine:

The quantity of sod to be paid will be by the square yard as bid unless modified as necessary in the field.

Payment for the sod will be made at the contract unit price per square yard, which price shall be full compensation for all labor, material, transportation, installation, and replacement of any material which does not survive for a period of thirty days from substantial completion, and all incidentals necessary to complete the item in place including topsoil.

Item No. 3 – Irrigation Service Lines:

The irrigation service reconnections to the Joseph Scavo Park and the three existing medians within the intersection of Atlantic Shores Blvd and Three Islands Blvd will be paid as a lump sum price.

Payment includes design, permitting, coordination, removal and reconnection of the irrigation service lines with City of Hallandale Beach and the Joseph Scavo Park. The price bid shall be full compensation for a complete irrigation service reconnection and shall include but not limited to, determining best route for service pipe, furnishing and installing 2-inches or less service pipe, meters and all other materials to install the services described above in accordance with the Florida Building Code and permit requirements; furnishing and installing pipe bedding; furnishing and installing valve box; restoration of sod, landscaping, pavers, stamped concrete, bricks, concrete, fences, driveways, slabs and any other structure damaged as a necessary part of the irrigation service installation to equal or better condition; locating any potential underground utilities;

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MEASUREMENTS AND PAYMENT

excavation; demolition and modification work; cut and plug existing water services previously serving the existing irrigation system, placing and compacting backfill; furnishing all materials and equipment necessary to clean and test the service connections; restoring miscellaneous items and property damaged by the construction to original locations and to equal or better than original conditions.

Item No. 4 – Pump Station & Electrical Control Panel:

Payment for all labor, equipment, materials, delivery, testing and commissioning for all work necessary and required to install the pump station as described on the contract documents. The work shall include but is not limited to: the concrete pump station structure sized for both phases, manhole cover, two (2) 10HP pumps, excavation, cost for dewatering and associated permits, backfill, 6' chain link fence with black vinyl coating, 6' cocoplum hedge, electrical control panel, conduits, strut support, antenna, FPL cost of service, material and installation, and associated appurtenances.

Since this item is bid as an aggregate sum, no other special provisions for measurement will be necessary.

Item No. 5 – Underground Storage Tank:

Payment for all labor, equipment, materials, delivery, testing and commissioning for all work necessary and required to install a 20,000 Gallons Storage Tank for Phase 1. The work shall include but is not limited to: excavation and backfill, valves, fittings, appurtenance, float/alarms, 12-inch PVC pipes, 12-inch caps, cost for dewatering and associated permits, and as described on the approved contract documents.

Since this item is bid as an aggregate sum, no other special provisions for measurement will be necessary.

Item No. 6 – 8-inch PVC (C-900) Pipe and DI Fitting:

Payment for all labor, equipment, materials, delivery, testing and commissioning for all work necessary and required to install new 8-inch PVC (C-900) pipe with D.I. fittings (polyethylene encasement) via open cut installation. This work shall include but is not be limited to: survey, locating and protection of all existing utilities, preparation and submittal of shop drawings, installing storm water pollution prevention devices, cost for dewatering and associated permits, pipe and all DI fittings/appurtenances, geotextile wrap, restraint joints, protection of guard booth and gate arms, trench excavation, pipe bedding, backfilling material, testing, trench restoration, 12-inch subgrade, 12-inch limerock base and 3-inch asphaltic concrete pavement, prime and tack

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coat, requirements associated with the complete installation of the 8-inch PVC (C-900) pipe and DI fittings.

The quantity of 8-inch pipe to be paid for will be by the linear foot as bid unless modified in the field.

Item No. 7 – 10-inch (DIPS) HDPE (DR 9) Pipe and DI Fitting:

Payment for all labor, equipment, materials, delivery, testing and commissioning for all work necessary and required to install new 10-inch HDPE pipe with D.I. fittings (polyethylene encasement) via horizontal directional drill (HDD) installation butt fusion method. This work shall include but not be limited to: survey, locating and protection of all existing utilities, preparation and submittal of shop drawings, installing storm water pollution prevention devices, cost for dewatering and associated permits, pipe and all DI fittings/appurtenances, adapters, pits, fluids, bedding, backfilling, testing requirements for a complete HDD installation.

The quantity of 10-inch pipe to be paid for will be by the linear foot from entry to exit pits as bid unless modified in the field.

Item No. 8 – 24"x8" Tapping Sleeve and 8" Tapping Valve:

Payment for all labor, equipment, materials, delivery, testing and commissioning for all work necessary and required to install each live tap connection to existing 24-inch reuse main including 24"x8" tapping sleeve and 8-inch tapping valve. This work shall include but not be limited to, survey, locating and protection of all existing utilities, polyethylene encasement, preparation and submittal of shop drawings, installing storm water pollution prevention devices, cost for dewatering and associated permits, restraint joints, trench excavation, pipe bedding, backfilling material, testing, trench restoration, 12-inch subgrade, 12-inch limerock base and 3-inch asphaltic concrete pavement, prime and tack coat, requirements associated with the complete installation of the tapping sleeve and valve.

Item No. 9 – 8"x8" Tee:

Payment for all labor, equipment, materials, delivery, testing and commissioning for all work necessary and required to install each 8"x8" Tee. This work shall include but not be limited to, survey, locating and protection of all existing utilities, polyethylene encasement, preparation and submittal of shop drawings, installing storm water pollution prevention devices, cost for dewatering and associated permits, restraint joints, trench excavation, pipe bedding, backfilling material, testing, trench restoration, 12-inch subgrade, 12-

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inch limerock base and 3-inch asphaltic concrete pavement, prime and tack coat, requirements associated with the complete installation of the tees.

Item No. 10 – 8” Gate Valve:

Payment for all labor, equipment, materials, delivery, testing and commissioning for all work necessary and required to install each 8-inch Gate Valve. This work shall include but not be limited to, survey, locating and protection of all existing utilities, polyethylene encasement, preparation and submittal of shop drawings, installing storm water pollution prevention devices, cost for dewatering and associated permits, restraint joints, trench excavation, pipe bedding, backfilling material, testing, trench restoration, 12-inch subgrade, 12-inch limerock base and 3-inch asphaltic concrete pavement, prime and tack coat, requirements associated with the complete installation of the gate valves.

Item No. 11 – 8” Flow Control Valve & Electrical Control Panel:

Payment for all labor, equipment, materials, delivery, testing, excavation and backfill, and commissioning for all work necessary and required to install an 8-inch Flow Control Valve. This work shall include but not be limited to, survey, locating and protection of all existing utilities, preparation and submittal of shop drawings, installing storm water pollution prevention devices, electrical control panel, FPL cost of service, cost for dewatering and associated permits, trench excavation, pipe bedding, backfilling material, testing, trench restoration, 12-inch subgrade, 12-inch limerock base and 3-inch asphaltic concrete pavement, prime and tack coat, requirements associated with the complete installation of the flow control valve.

Measurement and payment of individual items for 8” Flow Control Valve and Electrical Control Panel will not be made; rather, all items shall be included in the lump sum price.

Item No. 12 – Air Release Valve:

Payment for all labor, equipment, materials, delivery, testing, excavation and backfill, and commissioning for all work necessary and required to install each air release valve. This work shall include but not be limited to, survey, locating and protection of all existing utilities, polyethylene encasement, preparation and submittal of shop drawings, installing storm water pollution prevention devices, cost for dewatering and associated permits, restraint joints, trench excavation, pipe bedding, backfilling material, testing, trench restoration, 12-inch subgrade, 12-inch limerock base and 3-inch asphaltic concrete pavement, prime and tack

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coat, requirements associated with the complete installation of the air release valve.

Item No. 13 – 8” Cap:

Payment for all labor, equipment, materials, delivery, testing, excavation and backfill, and commissioning for all work necessary and required to install each 8” Cap. This work shall include but not be limited to, survey, locating and protection of all existing utilities, polyethylene encasement, preparation and submittal of shop drawings, installing storm water pollution prevention devices, cost for dewatering and associated permits, restraint joints, trench excavation, pipe bedding, backfilling material, testing, trench restoration, 12-inch subgrade, 12-inch limerock base and 3-inch asphaltic concrete pavement, prime and tack coat, requirements associated with the complete installation of a Cap.

Item No. 14 – 8” Cap with 2” FVO:

Payment for all labor, equipment, materials, delivery, testing, excavation and backfill, and commissioning for all work necessary and required to install each 8” Cap with 2” FVO. This work shall include but not be limited to, survey, locating and protection of all existing utilities, polyethylene encasement, preparation and submittal of shop drawings, installing storm water pollution prevention devices, cost for dewatering and associated permits, restraint joints, trench excavation, pipe bedding, backfilling material, testing, trench restoration, 12-inch subgrade, 12-inch limerock base and 3-inch asphaltic concrete pavement, prime and tack coat, requirements associated with the complete installation of the 8” Cap and 2” FVO.

Item No. 15 – 1” Milling:

Payment for all labor and equipment for all work necessary and required to mill 1” of existing asphalt pavement for a full lane as indicated on the Contract Documents.

The quantity of asphalt milling to be paid for will be by the linear foot as bid unless modified in the field.

Item No. 16 – 1” Asphalt Pavement (SP 9.5):

Payment of all labor, equipment, materials, testing and delivery for all work necessary and required to pave 1” of asphalt pavement, Type SP 9.5 structural course per current FDOT standards. In addition, payment also includes but is not limited to tack coat, and other asphalt related items.

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The quantity of asphalt pavement (SP 9.5) to be paid for will be by the TNs as bid unless modified in the field.

Item No. 17 – 8” Electromagnetic Flowmeter:

Payment for all labor, equipment, materials, delivery, testing excavation and backfill, and commissioning for all work necessary and required to install an 8” Electromagnetic Flowmeter by ABB Manufacturer. This work shall include but not be limited to, survey, locating and protection of all existing utilities, polyethylene encasement, preparation and submittal of shop drawings, installing storm water pollution prevention devices, cost for dewatering and associated permits, restraint joints, trench excavation, pipe bedding, backfilling material, testing, trench restoration, 12-inch subgrade, 12-inch limerock base and 3-inch asphaltic concrete pavement, requirements associated with the installation of the 8” Cap and 2” FVO.

Measurement and payment of individual items for 8” Electromagnetic Flowmeter will not be made; rather, all items shall be included in the lump sum price.

Item No. 18-25 – Thermoplastic Pavement Markings:

Payment for all labor, equipment, materials, delivery, testing, temporary paint striping, and commissioning for all work necessary to furnish and install the following pavement markings:

- 18: Thermoplastic 6-inch White Skip 10-30
- 19: Thermoplastic 6-inch Solid White Stripe
- 20: Thermoplastic 8-inch Solid White Stripe
- 21: Thermoplastic 12-inch Solid White Stripe
- 22: Thermoplastic 28-inch Solid White Stripe
- 23: Thermoplastic 24-inch Solid White Stripe
- 24: Thermoplastic 6-inch Yellow Skip 10-30
- 25: Thermoplastic 6-inch Solid Yellow Stripe

Payment for standard solid stripe markings will be made at the Contract unit price per linear foot, which price shall be full compensation for materials, tools, equipment, labor and work necessary to complete the item. It also includes the RPM (Reflective Pavement Markers). Temporary paint striping prior to installation of Thermoplastic Striping shall be included in the cost for Thermoplastic Pavement Markings.

Payment for standard skip stripes will be made at the contract unit price per gross miles, which price shall be full compensation for all labor, materials and equipment necessary to complete the item. Payment includes the gross miles

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from the beginning of the first strip to the end of the last stripe. It also includes the RPM (Reflective Pavement Markers). Temporary paint striping prior to installation of Thermoplastic Striping shall be included in the cost for Thermoplastic Pavement Markings.

Item No. 26 – Accessible Space & Aisle:

Payment for all labor, equipment, materials, delivery, testing and commissioning to install an accessible space and aisle at the unit price for each per current FDOT's Design Standard.

Item No. 27 – Speed Hump:

Payment for all labor, equipment, materials, delivery, testing and commissioning to install speed humps at unit price for each per current FDOT's Design Standard.

Item No. 28 – Pavement Message:

Payment for all labor, equipment, materials, delivery, testing and commissioning to install a pavement message at unit price for each per current FDOT's Design Standard.

Item No. 29 – Single Sign Post:

Payment for all labor, equipment, materials, delivery, testing and commissioning to install single sign post at unit price for each per current FDOT's Design Standard and as indicated on Contract Documents.

Item No. 30 – Sign Removal:

Payment for all labor, equipment, materials, delivery, testing and commissioning to remove single sign post at unit price for each per current FDOT's Design Standard and as indicated on Contract Documents.

Item No. 31 – Concrete Curb and Gutter/Drop Curb:

Payment for all labor, equipment, materials, delivery, testing and commissioning for all work necessary and required to install concrete curb and gutter and/or drop curb as shown on Contract Documents.

The quantity of concrete curb and gutter and/or drop curb to be paid for will be by the linear foot as bid unless modified in the field.

Item No. 32 – 6" Thick Concrete Sidewalk/Driveway:

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Payment for all labor, equipment, materials, delivery, testing for all work necessary and required to install the 6" thick concrete sidewalk and/or driveway.

The quantity of 6" thick concrete sidewalk and/or driveway to be paid for will be by the square foot as bid unless modified in the field.

Item No. 33 – SCADA System:

Payment for all labor, equipment, materials, delivery, testing for all work necessary and required to install the SCADA system.

Measurement and payment of individual items for the SCADA system will not be made; rather, all items shall be included in the lump sum price.

Item No. 34 – Mobilization:

The lump sum price bid for this item shall be full compensation for all mobilization and demobilization activities, including but not limited to bonds, insurance, scheduling, project meetings, submittals, and other permit package, temporary facilities, audio-video documentation of the existing site, any space required for staging, laydown, storage, parking, finish grading, site clearing, utility relocation coordination and location adjustment of existing utility per approved Contract Documents and all other activities necessary to prepare, execute and complete the contract work. The permit fees will be refunded to the CONTRACTOR by the CITY at the exact amount.

Measurement and payment of individual items for Mobilization will not be made; rather, all items shall be included in the lump sum price.

Item No. 35 – Maintenance of Traffic:

Payment for all labor, equipment, material, delivery, design and permitting for all work necessary and required to maintain traffic within the limits of the project for the duration of the construction period, including any temporary suspensions of the work and closure notifications to the CITY as well as residents. This includes resources required to create, modify and permit MOT plans with the CITY and all applicable jurisdictional agencies as well as to construct and maintain detours. Provide facilities needed to maintain access to residences, businesses, etc., within the project limits. MOT includes all facilities, temporary asphalt, temporary striping, devices and operations as required for the safety and convenience of the public within construction related areas at all times.

Measurement and payment of individual items for Maintenance of Traffic will not be made; rather, all items shall be included in the lump sum price.

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Item No. 36 – Permit Allowance:

The allowance indicated for this item is to pay for all permit fees required of the CONTRACTOR per the approved Contract Documents. The allowance shown on the schedule of Bid Prices is an estimate of fees required. Payment will be based on the actual permit fee paid directly to the Agency documented by paid receipts, specifically excluding any labor, mark-up, overhead and profit, administration and other costs involved in obtaining the permits. Fees specifically excluded from this allowance include but are not limited to expired permit fees.

- END OF SECTION -

SECTION 01200

PROJECT MEETINGS

Part 1 - GENERAL

1.01 PRECONSTRUCTION

A. A mandatory preconstruction meeting will be held to acquaint representatives of the CITY and various other agencies with those in responsible charge of the CONTRACTOR's activities for the project. Unless otherwise directed by the CITY, no construction activities relating to this contract shall commence until after the pre-construction meeting has adjourned, and until any pending business from the meeting has been addressed by the CONTRACTOR to the satisfaction of the CITY and ENGINEER. The meeting will cover such subjects as the following:

1. Insurance certificates
2. Permits and licenses
3. Construction schedules
4. Cost breakdown and applications for payment
5. Material deliveries, storage and payments
6. Shop drawings and submittals
7. Job-site inspection by the ENGINEER
8. Safety and emergency action procedures
9. Operations of the existing utilities
10. Field offices, security and other housekeeping procedures
11. List of subcontractors
12. Liquidated damages
13. Communications
14. Coordinating
15. All other appropriate matters.

1.02 PROGRESS

A. Progress meetings shall be held every two weeks for the purpose of coordinating and expediting the work. The CONTRACTOR, as a part of his obligations under the Contract, shall attend in person or by an authorized representative to attend and to act on his behalf. The ENGINEER will conduct such meetings and as necessary, with the CONTRACTOR's input, issue an agenda.

B. In addition, the ENGINEER or CONTRACTOR may call for special job site meetings for the purpose of resolving unforeseen problems or conflicts which may impede the construction schedule. The ENGINEER will prepare a brief

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summary report of the decisions or understandings concerning each of the items discussed at the meeting.

- C. At progress meetings, the CONTRACTOR shall submit to the ENGINEER for review a current two (2) week progress schedule. This schedule submission shall include a two week look ahead schedule and reflect status of the work performed during the preceding week.

Part 2 - PART 2 -- PRODUCTS (Not Used)

Part 3 - PART 3 -- EXECUTION (Not Used)

– END OF SECTION –

SECTION 01300

SUBMITTALS

Part 1 - GENERAL

1.01 THE REQUIREMENT

A. This section specifies the means of all submittals. All submittals, whether their final destination is to the CITY, ENGINEER, or other representatives of the CITY, shall be directed through the ENGINEER. A summary of the key types of submittals and the number of copies required is as follows:

<u>Copies to Engineer</u>	<u>Type of Submittal</u>
2	Construction schedule
2	Schedule of payment items
1	Audio visual preconstruction record (CD)
2	Progress estimates
3	Shop drawings
2	Certificates of compliance
2	Warranties
1	Product samples
2	Record drawings/As-built
2	Final Record Drawings/As-built

*Unless otherwise required in the specific Section where requested.

1.02 SUBMITTAL PROCEDURES

- A. Transmit each submittal with a form acceptable to the ENGINEER, clearly identifying the project, CONTRACTOR, the enclosed material and other pertinent information specified in other parts of this section. Identify variations from Contract Documents and Product or system limitations which may be detrimental to successful performance of the completed work.
- B. Revise and resubmit submittals as required, identify all changes made since previous submittals. Resubmittals shall be noted as such.
- C. Distribute copies of reviewed submittals to concerned parties. Instruct parties to promptly report any inability to comply with provisions.

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1.03 CONSTRUCTION PROGRESS SCHEDULE

- A. The CONTRACTOR shall have the capability of preparing and utilizing the specified construction progress scheduling techniques. A statement of capability shall be submitted in writing to the ENGINEER with the return of the executed Agreement to the CITY and will verify that either the CONTRACTOR's organization has in-house capability qualified to use the technique or that the CONTRACTOR employs a consultant who is so qualified. Capability shall be verified by description of the construction projects to which the CONTRACTOR or its consultant has successfully applied the scheduling technique and which were controlled throughout the duration of the project by means of systematic use and updating of the construction progress schedule, the network analysis and associated reports. The submittal shall include the name of the individual on the CONTRACTOR's staff who will be responsible for the construction progress schedule and associated reports and for providing the required updating information of same. The CONTRACTOR shall submit its proposed progress (baseline) schedule to the ENGINEER for review and comment within thirty days of the Notice to Proceed. The ENGINEER shall have the authority to determine acceptability/correctness of the schedule logic and activity interrelationships. The use of extraneous, nonworking activities and activities which add restraints to the construction schedule shall not be accepted. Baseline schedules that do not meet their contract completion dates shall not be accepted.
- B. In addition, each construction progress schedule, network analysis and report shall be prefaced with the following summary data:
1. Contract Name and Number
 2. CONTRACTOR's Name
 3. Contract Schedule
 4. The Effective or Starting Date of The Schedule (the date indicated in the Notice-to-Proceed)
- C. The work day to calendar date correlation shall be based on an 8-hour day and 40-hour week with adequate allowance for holidays and all other special requirements of the work.
- D. If the CONTRACTOR desires to make changes in its method of operating which affect the construction progress schedule and related items, the CONTRACTOR shall notify the ENGINEER in writing stating what changes are proposed and the reason for the change. If the ENGINEER accepts these changes, in writing, the CONTRACTOR shall revise and submit, without

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additional cost to the CITY, all of the affected portions of the construction progress schedule, and associated reports. The construction progress schedule and related items shall be adjusted by the CONTRACTOR only after prior acceptance, in writing by the ENGINEER. Adjustments may consist of changing portions of the activity sequence, activity durations, division of activities, or other adjustments as may be required. The addition of extraneous, nonworking activities and activities which add restraints to the construction progress schedule shall not be accepted.

- E. Except where earlier completions are specified, schedule dates which show completion of all work prior to the contract completion date shall, in no event, be the basis for claim for delay against the CITY by the CONTRACTOR.
- F. Construction progress schedules and related items which contain activities showing negative float or which extend beyond the contract completion date will not be accepted by the ENGINEER.
- G. Whenever it becomes apparent from the current construction progress schedule and associated reports that delays to the critical path have resulted and the contract completion date will not be met, or when so directed by the ENGINEER, the CONTRACTOR shall take some or all of the following actions at no additional cost to the CITY. They shall submit to the ENGINEER for approval, a written statement of the steps they intend to take to remove or arrest the delay to the critical path in the current construction progress schedule, including a computer generated schedule revision to reflect proposed actions.
 - 1. Increase construction manpower in such quantities and crafts as will substantially eliminate the backlog of work.
 - 2. Increase the number of working hours per shift, shifts per day, working days per week, the amount of construction equipment, or any combination of the foregoing, sufficiently to substantially eliminate the backlog of work.
 - 3. Reschedule activities to achieve maximum practical concurrency of accomplishment of activities, and comply with the revised schedule.
- H. If when so requested by the ENGINEER, the CONTRACTOR should fail to submit a written statement of the steps they intend to take or should fail to take such steps as reviewed and accepted in writing by the ENGINEER, the ENGINEER may direct the CONTRACTOR to increase the level of effort in manpower (trades), equipment and work schedule (overtime, weekend and holiday work, etc.) to be employed by the CONTRACTOR in order to remove or arrest the delay to the critical path in the current construction progress schedule, and the CONTRACTOR shall promptly provide such level of effort at no additional cost to the CITY.

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- I. If the completion of any activity, whether or not critical, falls more than 100 percent behind its previously scheduled and accepted duration, the CONTRACTOR shall submit for approval a schedule adjustment showing each such activity divided into two activities reflecting completed versus uncompleted work.
- J. Shop drawings which are not approved on the first submittal or within the time scheduled, and equipment which does not pass the specified tests and certifications shall be immediately rescheduled.
- K. The contract time will be adjusted only in accordance with the General Requirements and other portions of the Contract Documents as may be applicable. If the ENGINEER finds that the CONTRACTOR is entitled to any extension of the contract completion date, the ENGINEER's determination as to the total number of days extension shall be based upon the current construction progress schedule and on all data relevant to the extension. Such data shall be included in the next updating of the schedule and related items. Actual delays in activities which, according to the construction progress schedule, do not affect any contract completion date will not be the basis for a change therein.
- L. From time to time it may be necessary for the contract schedule of completion time to be adjusted by the CITY in accordance with the General Requirements and other portions of the Contract Documents as may be applicable. Under such conditions, the ENGINEER will direct the CONTRACTOR to reschedule the work or contract completion time to reflect the changed conditions, and the CONTRACTOR shall revise the construction progress schedule and related items accordingly, at no additional cost to the CITY.
- M. Available float time may be used by the CITY through the CITY's ENGINEER.
- N. The CITY controls the float time and, therefore, without obligation to extend either the overall completion date or any intermediate completion dates, the CITY may initiate changes that absorb float time only. CITY initiated changes that affect the critical path on the network diagram shall be the sole grounds for extending the completion dates. CONTRACTOR initiated changes that encroach on the float time may be accomplished only with the CITY's concurrence. Such changes, however, shall give way to CITY initiated changes competing for the same float time.
- O. To the extent that the construction project schedule, or associated report or any revision thereof shows anything not jointly agreed upon or fails to show anything jointly agreed upon, it shall not be deemed to have been accepted by the ENGINEER. Failure to include on a schedule any element of work required for the performance of this Contract shall not excuse the CONTRACTOR from completing all work required within any applicable

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completion date, notwithstanding the review of the schedule by the ENGINEER.

- P. Review and acceptance of the construction progress schedule, and related reports, by the ENGINEER is advisory only and shall not relieve the CONTRACTOR of the responsibility for accomplishing the work within the contract completion date. Omissions and errors in the construction progress schedule, and related reports shall not excuse performance less than that required by the Contract and in no way make the ENGINEER an insurer of the CONTRACTOR's success or liable for time or cost overruns flowing from any shortcomings in the construction progress schedule, and related reports.
- Q. The CONTRACTOR shall present and discuss the proposed schedule at the preconstruction conference.
- R. The construction progress schedule shall be based upon the precedence diagramming method of scheduling and shall be prepared in the form of a horizontal bar chart showing in detail the proposed sequence of the work and identifying all construction activities included but not limited to yard piping, all structures and treatment units and all related work specified herein to be performed under the Contract. The schedule shall be time scaled, identifying the first day of each week, with the estimated date of starting and completion of each stage of the work in order to complete the project within the contract time. The project critical path shall be clearly identified in color or by other means acceptable to the ENGINEER.
- S. The progress schedule shall be plotted on 11-inch by 17-inch paper and shall be revised and updated monthly, depicting progress through the last day of the current month and scheduled progress through completion. Two 11-inches by 17-inch, schedules, required schedule "sorts" (tabulations) and an electronic copy of the baseline schedule shall be submitted for review and acceptance. Two 11-inches x 17-inch up-to-date copies of the schedule and two copies of tabulations and an electronic copy shall be submitted along with the application for monthly progress payments for the same period.
- T. The construction progress schedule shall be developed and maintained using Primavera Sure Trak as manufactured by Primavera Systems, Inc., or equal.

1.04 SCHEDULE OF PAYMENT VALUES

- A. The CONTRACTOR shall submit a Schedule of Payment Values, in accordance with Section 01025, for all items in the proposal that are to be paid for as unit price and lump sum basis. The schedule shall contain the labor and material values of the component parts of work for the purpose of making progress payments during the construction period. The Schedule of Payment Values shall directly correlate on an item by item basis (unless otherwise

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accepted by the ENGINEER) to each individual activity detailed in the construction progress schedule.

- B. The schedule shall be given in sufficient detail for the proper identification of work accomplished. Each item shall include its proportional share of all costs including the Contractor's overhead, contingencies and profit. The sum of all scheduled items shall equal the total value of the Contract.
- C. The CONTRACTOR shall expand or modify the above schedule and materials listing as required by the ENGINEER's initial or subsequent reviews.
- D. The CONTRACTOR shall update the Schedule of Payment Values monthly for reviewing by the ENGINEER. The payment applications shall be reviewed by the ENGINEER in accordance with the updated Schedule of Payment Values.

1.05 SHOP DRAWINGS, PROJECT DATA AND SAMPLES

- A. General: A Shop Drawing Submittal Schedule shall be provided by the CONTRACTOR within thirty (30) days of the Notice to Proceed.
- B. The CONTRACTOR shall furnish for review three (3) copies of shop drawings, project data, samples and other submittal items required by the Contract Documents. Two (2) copies shall be returned to the CONTRACTOR stamped "Furnish as Submitted" or "Furnish as Corrected". Where major corrections are indicated, two (2) copies will be returned stamped "Revise and Resubmit" and a new submittal is required (2 copies).
- C. The review of the CONTRACTOR's submissions shall in no way relieve the CONTRACTOR of any of his responsibilities under the Contract. An acceptance of a submission shall be interpreted to mean that there are no specific objections to the submitted material, subject to conformance with the Contract Drawings and Specifications.
- D. All submissions shall be dated and properly referenced to the specifications section and Contract Drawing number. The submittal number shall match the following submittal numbering system (or an equivalent system as approved by the ENGINEER):

Submittal Numbering System

- 1. Package ID: The package number will reflect the CSI (specification) section number as it appears in the specifications.
- 2. Subgroup ID: The submittal number will include the CSI number followed by two additional codes. The first will define the type of submittal as follows:

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- 01 - Product Data, Specifications, Cut Sheets, Manufacturers certification or approval letters.
- 02 - Shop Drawings
- 03 - Product Samples and Mock-Ups
- 04 - Special requirements as required in the contract documents
- 05 - As-Built Drawings
- 06 - Warranties
- 07 - O&M
- 08 - Spare Parts

The second code will identify individual submittals within that submittal type. The number to the left of the decimal represents the submittal number and the number to the right of the decimal represents the revision number.

Example:

<u>Package</u>	<u>Submittal</u>	<u>Description</u>
03300	03300-01-1.1	Concrete Admixture A, First Submittal
06400	06400-01-1.2	← Re-submittal
		← First Submittal
		← Product Data
		← Finish Carpentry

By the following this code system, all submittals may be entered into the Document Tracking System prior to receipt of submittals. When a particular submittal is received, locate the entry in the Document Tracking project file; add the appropriate information and process. The Document Tracking System will provide the next sequence number.

- E. Shop Drawings and Project Data within practical limits shall be submitted as a single complete package for any operating system and shall include all items of equipment and mechanical units involved in the functioning of such system. Where applicable, the submission shall include elementary wiring diagrams showing circuit functioning and necessary interconnection wiring diagrams for construction.

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- F. All submissions shall bear the CONTRACTOR's stamp certifying that they have been checked for conformance and accuracy. Submissions without the CONTRACTOR's stamp of approval will not be reviewed by the ENGINEER and will be returned to the CONTRACTOR.
- G. For any submission containing any departure from the Contract Documents and the CONTRACTOR shall include proper explanation in his letter of submittal.
- H. Work on fabricated or special items shall not be commenced until the required submission information has been reviewed and accepted.
- I. Standard items shall not be assembled or shipped until the required submission information has been reviewed and accepted.
- J. Prior review actions shall not relieve the CONTRACTOR of the responsibility for correcting errors, deviations, and/or omissions discovered at a later date.
- K. Shop Drawings: Shop Drawings include, but are not limited to, layout drawings, installation drawings, construction drawings, certified and interconnecting wiring diagrams, etc. The CONTRACTOR shall be responsible for security of all the information, details, dimension, drawings, etc. necessary to prepare submission drawings required and necessary under this Contract and to fulfill all other requirements of his Contract. The CONTRACTOR shall secure such information, details, drawings, etc. from all possible sources including the Contract Drawings, drawings prepared by subcontractors, Engineer, manufacturers, Contractors, etc.
- L. Submission drawings shall accurately and clearly present the following:
 - 1. All working and installation dimensions.
 - 2. Arrangement and sectional views.
 - 3. Units of equipment in the proposed position for installation, details of required attachments and connections and dimensioned locations between units and in relation to the structures.
 - 4. Necessary details and information for making connections between the various trades including but not limited to, power supplies and interconnection wiring between units, accessories, appurtenances, etc.
- M. Product Data: Where manufacturer's publications in the form of catalogs, brochures, illustrations, or other data sheets are submitted in lieu of prepared shop drawings, such submission shall specifically indicate the particular item offered. Identification of such items and relative pertinent information shall be made with indelible ink. Submissions showing only general information will not be accepted.
- N. Product data shall include materials of construction, dimensions, performance characteristics, capacities, wiring diagrams, piping and controls, etc.

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- O. Samples: CONTRACTOR shall furnish for review all samples as required by the Contract Documents or requested by the ENGINEER.
- P. Samples shall be of sufficient size or quantity to clearly illustrate the quality, type, range of color, finish or texture and shall be properly labeled to show the nature of the work where the material represented by the sample will be used.
- Q. Samples shall be checked by the CONTRACTOR for conformance to the Contract Documents before being submitted to the ENGINEER and shall bear the CONTRACTOR's stamp certifying that they have been so checked. Transportation charges on samples submitted to the Engineer shall be prepaid by the CONTRACTOR.
- R. ENGINEER's review will be for compliance with the Contract Documents, and his comments will be transmitted to the CONTRACTOR with reasonable promptness.
- S. Accepted samples will establish the standards by which the completed work will be judged.

1.06 OPERATION AND MAINTENANCE INSTRUCTIONS (MANUALS)

- A. Individual Instructions: The CONTRACTOR, through manufacturer's representatives or other qualified individuals, shall provide instruction of designated employees of the OWNER in the operation and care of all equipment furnished.
- B. Written Instructions: The CONTRACTOR shall furnish and deliver to the ENGINEER, prior to the fifty percent completion point of construction, and no later than thirty (30) days prior to operator training, two (2) complete sets of instructions, technical bulletins, and any other printed matter such as diagrams, prints or drawings, containing full information required for the proper operation, maintenance, and repair of the equipment. As a minimum, the following shall be included in this submittal:
 - 1. Operating Instructions
 - 2. Troubleshooting Information
 - 3. Maintenance Schedule(s)
 - 4. Lubrication Schedule
 - 5. Location of Service Centers
 - 6. Parts Diagram and List
 - 7. Spare Parts List (spare parts furnished shall be defined)
 - 8. Special Tools List
 - 9. Installation Instructions
 - 10. Assembly & Erection Drawings
 - 11. Dimensional Drawings

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12. Wiring Diagram(s)
 13. Storage Instructions
- C. These requirements are a prerequisite to the operation and acceptance of equipment. Each set of instructions shall be bound together in appropriate three-ring binders. A detailed Table of Contents shall be provided for each set. Written operation and maintenance instructions shall be required for all equipment items supplied for this project. The amount of detail shall be commensurate with the complexity of the equipment item. Submittal shall be made for all mechanical and electrical equipment included but not limited to pumps, valves, gates, etc.
 - D. Information not applicable to the specific piece of equipment installed on this project shall be struck from the submission. Information provided shall include a source of replacement parts and names of service representatives, including address and telephone number.
 - E. Extensive pictorial cuts of equipment are required for operator reference in servicing.
 - F. When written instructions include shop drawings and other information previously reviewed by the ENGINEER, only those editions thereof which were accepted by the ENGINEER, and which accurately depict the equipment installed, shall be incorporated in the instructions.

1.07 RECORD DRAWINGS

- A. The CONTRACTOR shall keep and maintain, at the job site, one record set of Drawings. On these, it shall mark all project conditions, locations, configurations, and any other changes or deviations which may vary from the details represented on the original Contract Drawings, including buried or concealed construction and utility features which are revealed during the course of construction. Special attention shall be given to recording the horizontal and vertical location of all buried utilities that differ from the locations indicated, or which were not indicated on the Drawings. As-Built furnished grade information shall be included on the record drawings. Said record drawings shall be supplemented by detailed sketches as necessary or directed to indicate, fully, the Work as actually constructed. These master record drawings of the CONTRACTOR's representation of as-build conditions, including all revisions made necessary by addenda and change orders shall be maintained up-to-date during the progress of work.
- B. The record drawings shall be received on the 20th working day of every third month after the month in which the final notice to proceed is given as well as on completion of work. Failure to maintain the record drawings up-to-date

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shall be grounds of withholding monthly progress payments until such time as the record drawings are brought up-to-date.

- C. In the case of those drawings which depict the detail requirement for equipment to be assembled and wired in the factory, such as motor control centers and the like, the record drawing shall be updated by indicating those portions which are superseded by change order drawings or final shop drawings, and by including appropriate reference information describing the change orders by number and the shop drawings by manufacturer, drawing, and revision numbers.
- D. Record drawings shall be accessible to the ENGINEER at all times during the construction period.
- E. Upon substantial completion of the work and prior to final acceptance, the CONTRACTOR shall finalize and deliver a complete set of final record drawings/as-builts to the ENGINEER for transmittal to the CITY, conforming to the construction records of the CONTRACTOR. This set of drawings shall consist of corrected drawings showing the reported location of the work. The information submitted by the CONTRACTOR and incorporated in the Final Record Drawings will be assumed to be correct, and the ENGINEER will not be responsible for the accuracy of such information, and for any errors or omissions which may appear on the Final Record Drawings as a result.
- F. The information submitted by the CONTRACTOR in the Final Record Drawings shall be certified by a land surveyor registered in the State of Florida. For clarity, Final Record Drawings need to be redrawn and clearly labeled as "Record Drawings". Notations indicated in the drawings shall be legible and printed in black ink. No handwritten notes are allowed.
- G. Final payment will not be acted upon until the ENGINEER certifies the record drawings as required by the agencies having jurisdiction. Said up-to-date record drawings shall be in the form of a set of prints with carefully plotted information.
- H. All final record drawings shall be certified by the ENGINEER of Record. Such certification shall evidence that ENGINEER has reviewed the information, finds it in substantial accordance with the design; and where deviations from the design exist, that said deviations are not to the detriment of the system. ENGINEER's certification shall read as follows:

"I HEREBY NOTIFY THE OWNER OF THE COMPLETION OF CONSTRUCTION OF ALL THE COMPONENTS OF THE REUSE IRRIGATION FOR THE ABOVE REFERENCED PROJECT AND CERTIFY THAT THEY HAVE BEEN CONSTRUCTED IN SUBSTANTIAL CONFORMANCE WITH THE PLANS AND SPECIFICATIONS PERMITTED BY THE AGENCIES HAVING JURISDICTION"

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- I. The CONTRACTOR shall submit all electronic media files of the plans, reports, other supporting information, and the final version of as-builts drawings shall be submitted to the ENGINEER's office. The information provided shall contain an index file with a brief description of the electronic filing contents, and shall be labeled with project name, company name, and point of contact. Documents and spreadsheets shall be submitted in either MS Word, Word Perfect, Excel, or other format approved by the ENGINEER. Drawings shall be submitted in AutoCad or other format approved by the ENGINEER.
- J. Final Record Drawings submitted to the CITY as part of the project acceptance shall contain at least the following information:
 1. Drawings shall be legibly marked to record actual construction.
 2. Drawings shall show actual location of all underground and above ground piping and related appurtenances. All changes to piping location including horizontal and vertical locations of utilities and appurtenances shall be clearly shown and referenced to permanent surface improvements. Drawings shall also show actual installed pipe material, class, etc. Profile sheets shall be updated to include all field measurements and elevations taken during construction.
 3. Drawings shall clearly show all field changes of dimension and detail including changes made by field order or by change order.
 4. Drawings shall clearly show all details not on original contract drawings but constructed in the field. All equipment and piping relocation shall be clearly shown.
 5. Location of all manholes, tees, reducers, crosses, valves, and valve boxes shall be shown. All tees, reducers, crosses, and valves shall be referenced from at least two (2) and preferably three (3) permanent points such as building corners and roadway intersections.
 6. Dimensions between all manholes shall be field verified and shown. The rim, inverts and grade elevations of all manholes shall be shown.

1.08 WARRANTIES

- A. Original warranties, called for in the Contract Documents, shall be submitted to the CITY through the ENGINEER. When warranties are required, they shall be submitted prior to request for payment.

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- B. When advance copies of warranties are requested, they shall be submitted with, and considered as shop drawings.
- C. The CONTRACTOR shall warrant to the CITY that all material and labor used in the construction are covered by his warrantee for a minimum of a one year period upon approval and acceptance by the CITY. The CONTRACTOR shall replace or repair defects at no cost to the CITY during the warrantee period. No visible or potential leakage shall be allowed during the warrantee period.

1.09 CERTIFICATES

- A. Copies of certificates of compliance and test reports shall be submitted for requested items to the ENGINEER prior to request for payment.

1.10 AUDIO-VISUAL PRECONSTRUCTION RECORD

- A. General: Prior to commencing work, the CONTRACTOR shall have a continuous color audio-video DVD recording taken of the entire Project, including existing areas that will be disturbed by the CONTRACTOR's operations, to serve as a record of preconstruction conditions. No construction shall begin prior to review and acceptance of the tapes covering the respective, affected construction area by the ENGINEER. The ENGINEER shall have the authority to reject all or any portion of the video DVD not conforming to the specifications and order that it be redone at no additional charge. The CONTRACTOR shall reschedule unacceptable coverage within five days after being notified. The ENGINEER shall designate those areas, if any, to be omitted from or added to the audio-video coverage. Audio-video recordings shall not be performed more than ninety days prior to construction in any area. All DVDs and written records shall become property of the CITY.
- B. Services: The CONTRACTOR shall engage the services of a professional electrographer. The color audio-video tapes shall be prepared by a responsible commercial firm known to be skilled and regularly engaged in the business of preconstruction color audio-video tape documentation. The electrographer shall furnish to the ENGINEER a list of all equipment to be used for the audio-video taping, i.e., manufacturer's name, model number, specifications and other pertinent information. Additional information to be furnished by the electrographer is the names and addresses of two references that the electrographer has performed color audio-video taping for on projects of a similar nature within the last twelve months.
- C. Audio-Video DVDs: Audio-video DVDs shall be new. The DVDs shall be compatible for with a standard player-receiver.

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- D. Equipment: All equipment, accessories, materials and labor to perform this service shall be furnished by the CONTRACTOR.
1. The total audio-video system shall reproduce bright, sharp, clear pictures with accurate colors and shall be free from distortion, tearing, rolls or any other form of imperfection. The audio portion of the recording shall reproduce the commentary of the camera operator with proper volume and clarity, and be free from distortion and interruptions.
 2. When conventional wheeled vehicles are used, the distance from the camera lens to the ground shall not be less than twelve feet. In some instances, audio-video tape coverage may be required in areas not accessible by conventional wheeled vehicles. Such coverage shall be obtained by walking or special conveyance acceptable to the ENGINEER.
 3. The color video camera used in the recording system shall have a horizontal resolution of 300 lines at center, a luminance signal to noise ratio of 45 dB and a minimum illumination requirement of twenty-five foot-candles.
- E. Recorded Information - Audio: Each tape shall begin with the current date, project name and municipality and be followed by the general location; i.e., process structure, or area, viewing side and direction of progress. The audio track shall consist of an original live recording. The recording shall contain the narrative commentary of the electrographer, recorded simultaneously with his fixed elevation video record of the zone of influence of construction.
- F. Recorded Information - Video: All video recordings must, by electronic means, display continuously and simultaneously, generated with the actual taping, transparent digital information to include the date and time of recording. The date information shall contain the month, day and year. The time information shall contain the hours, minutes, and seconds. Additional information shall be displayed periodically. Such information shall include, but not be limited to, project name, bid package number, process structure or area, and the viewing side. This transparent information shall appear on the extreme upper left hand third of the screen.
- G. Conditions for Taping: All taping shall be done during times of good visibility. No taping shall be done during precipitation, mist or fog. The recording shall only be done when sufficient sunlight is present to properly illuminate the subjects of recordings and to produce bright, sharp video recordings of those subjects.
- H. Tape Coverage: Tape coverage shall include all surface features located within the zone of influence of construction supported by appropriate audio coverage. Such coverage shall include, but not be limited to, existing road,

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driveways, sidewalks, curbs, pavement, landscaping, fences, signs and interior and exterior of existing structures affected by the work and the exteriors of structures adjacent to the work, and any other on-site area that will be occupied or impacted by the CONTRACTOR or any of his subcontractors or suppliers within the area covered.

Part 2 - PRODUCTS (Not Used)

Part 3 - EXECUTION (Not Used)

- END OF SECTION –

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TRAFFIC REGULATIONS AND MAINTENANCE OF TRAFFIC

PART 1 – GENERAL

1.01 TRAFFIC CONTROL

- A. CONTRACTOR shall obey all traffic laws and comply with all the requirements, rules and regulations of the State of Florida Department of Transportation (FDOT), the City of Hallandale Beach, City of Hollywood, Broward County and other local authorities having jurisdiction, to maintain adequate warning signs, lights, barriers, etc., for the protection of traffic on public roadways.
- B. The CONTRACTOR shall maintain traffic and protect the public from all damage to persons and property within the Contract Limits, in accordance with the Contract Documents and all applicable state, city and local regulations. The CONTRACTOR shall conduct its construction operations so as to maintain and protect access, for vehicular and pedestrian traffic, to and from all properties and business establishments adjoining or adjacent to those streets affected by his operations, and to subject the public to a minimum of delay and inconvenience. Suitable signs, barricades, railing, etc. shall be erected and the work outlined by adequate lighting at night. Danger lights shall be provided as required. Watchmen, flagmen, and crossing guards shall be provided as may be necessary for the protection of traffic. Traffic Control and Maintenance of traffic during construction shall be included in the CONTRACTOR's bid and no additional payment shall be requested to the City for these activities
- C. For the protection of traffic in public or private streets and alleyways, the CONTRACTOR shall provide, place, and maintain all necessary barricades, traffic cones, warning signs, lights, and other safety devices in accordance with the requirements of the "Manual of Uniform Traffic Control Devices (MUTCD), Part VI, Traffic Controls for Street and Highway Construction and Maintenance Operations", published by U.S. Department of Transportation, Federal Highway Administration (ANSI D6.1).
- D. The CONTRACTOR shall submit a Maintenance of Traffic (MOT) Plan for ENGINEER and/or CITY approval at least 60 days prior to construction work.
- E. All signs, signals, and barricades shall conform to the requirements of Subpart G, Part 1926, of the OSHA Safety and Health Standards for Construction.
- F. All dirt spilled from the CONTRACTOR'S trucks on existing pavements shall be removed by the CONTRACTOR immediately and whenever in the opinion of the CITY the accumulation is sufficient to cause the formation of mud, dust, interference with traffic or create a traffic hazard.
- G. Areas designated by the Broward County Traffic Engineering Division as "Safe Walk Routes" shall adhere to the requirements of the Broward County Maintenance of Traffic School/Pedestrian.

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- H. Temporary paint striping prior to installation of Thermoplastic Striping shall be included in the cost for Thermoplastic Pavement Markings.

1.02 TEMPORARY CROSSINGS

- A. General: Wherever necessary or required for the convenience of the public or individual residents at street or highway crossings, private driveways, or elsewhere, the CONTRACTOR shall provide suitable temporary bridges over unfilled excavations, except in such cases as the CONTRACTOR shall secure the written consent of the individuals or authorities concerned to omit such temporary bridges, which written consent shall be delivered to the CITY prior to excavation. All such bridges shall be maintained in service until access is provided across the backfilled excavation. Temporary bridges for street and highway crossing shall conform to the requirements of the authority having jurisdiction in each case, and the CONTRACTOR shall adopt designs furnished by said authority for such bridges, or shall submit designs to said authority for approval, as may be required.
- B. Street Use: Nothing herein shall be construed to entitle the CONTRACTOR to the exclusive use of any public street, alleyway, or parking area during the performance of work hereunder, and it shall so conduct its operations as not to interfere unnecessarily with the authorized work of utility companies or other agencies in such streets, alleyways, or parking areas. No street shall be closed to the public without first obtaining permission of the CITY and proper governmental authority. Where excavation is being performed in primary streets or highways, one lane in each direction shall be kept open to traffic at all times unless otherwise provided or shown. Toe boards shall be provided to retain excavated material if required by the CITY or the agency having jurisdiction over the street or highway. Fire hydrants on or adjacent to the work shall be kept accessible to fire-fighting equipment at all times. Temporary provisions shall be made by the CONTRACTOR to assure the use of sidewalks and the proper functioning of all gutters, sewer inlets, and other drainage facilities.
- C. The CONTRACTOR shall take all necessary precautions for the protection of the Work and the safety of the public. All barricades and obstructions shall be illuminated at night, and all lights shall be kept burning from sunset until sunrise. The CONTRACTOR shall station such guards or flaggers and shall conform to such special safety regulations relating to traffic control as may be required by the public authorities within their respective jurisdictions. All signs, signals, and barricades shall conform to the requirements of Subpart G, Part 1926, of the OSHA Safety and Health Standards for Construction.
- D. The CONTRACTOR shall remove traffic control devices when no longer needed, repair all damage caused by installation of the devices, and shall remove post settings and backfill the resulting holes to match grade.

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TRAFFIC REGULATIONS AND MAINTENANCE OF TRAFFIC

- E. Temporary Street Closure: If closure of any street is required during construction, a formal application for a street closure shall be made to the authority having jurisdiction at least 30 days prior to the required street closure in order to determine necessary sign and detour requirements. Detour signs shall be provided, installed prior to street closure, and removed after construction by the CONTRACTOR.
- F. Temporary Driveway Closure: The CONTRACTOR shall notify the CITY or occupant (if not owner-occupied) of closure of driveways to be closed more than one eight-hour work day, at least three working days prior to the closure. The CONTRACTOR shall minimize the inconvenience and minimize the time period that the driveways will be closed. The CONTRACTOR shall fully explain to the owner/occupant how long the work will take and when closure is to start.
- G. Temporary Bridges: Whenever necessary, the CONTRACTOR shall provide suitable temporary bridges or steel plates over unfilled excavations, except in such cases as the CONTRACTOR shall secure the written consent of the individuals or authorities concerned to omit such temporary bridges or steel plates, which written consent shall be delivered to the ENGINEER prior to excavation. All such bridges or steel plates shall be maintained in service until access is provided across the backfilled excavation. Temporary bridges or steel plates for street and highway crossing shall conform to the requirements of the authority having jurisdiction in each case, and the CONTRACTOR shall adopt designs furnished by said authority for such bridges or steel plates, or shall submit designs to said authority for approval, as may be required.

1.03 CONTRACTOR PARKING

- A. The CONTRACTOR shall obtain off-site parking for all personnel vehicles as required.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

- END OF SECTION -

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PROJECT CLOSEOUT

PART 1 -- GENERAL

1.01 PROJECT CLOSEOUT

- A. As construction of the project enters the final stages of completion, the CONTRACTOR shall, in accordance with the requirements set forth in the Contract Documents, attend to or have already completed the following items:
1. Scheduling start-up and initial operation.
 2. Correcting or replacing defective work, including completion of items previously overlooked or work which remains incomplete, all as evidenced by the CITY's "Punch" lists.
 3. Make final submittals.
 4. Attend to any other items listed herein or brought to the CONTRACTOR's attention by the CITY.

1.02 CLOSEOUT TIMETABLE

- A. The CONTRACTOR shall establish dates for equipment testing, acceptance periods, and on-site instructional periods (as required under the Contract). Such dates shall be established not less than one week prior to beginning any of the foregoing items, to allow the CITY, the ENGINEER, and their authorized representatives sufficient time to schedule attendance at such activities.

1.03 FINAL SUBMITTALS

- A. Before the acceptance of the project major milestones for substantial completion, the CONTRACTOR shall submit to the ENGINEER (or to the CITY if indicated) certain records, certifications, etc., which are specified elsewhere in the Contract Documents. Missing, incomplete or unacceptable items, as determined by the ENGINEER or the CITY, shall indicate non-compliance with substantial completion major milestone dates. A partial list of such items appears below, but it shall be the CONTRACTOR'S responsibility to submit any other items which are required in the Contract Documents:
1. Written Test results of project components.
 2. Performance affidavits for equipment and materials.
 3. Operation and Maintenance Manuals for equipment.
 4. As-Built Drawings: During the entire construction operation, the CONTRACTOR shall maintain records of all deviations from the Drawings and Specifications and shall prepare therefrom as-built drawings showing correctly and accurately all changes and deviations from the Work made during construction to reflect the Work as it was actually constructed. These drawings shall conform to recognized standards of drafting, shall be

SECTION 01700

PROJECT CLOSEOUT

neat, legible, and in Auto CAD acceptable to the ENGINEER. The as-built drawings shall be submitted on CD and in hard paper copies, signed and sealed by a professional land surveyor registered in the State of Florida.

5. Written guarantees, where required.
6. Certificates of inspection and acceptance by local governing agencies having jurisdiction.
7. Releases from all parties who are entitled to claims against the subject project, property, or improvement pursuant to the provisions of law.

1.04 PUNCH LISTS

- A. Final cleaning and repairing shall be scheduled upon completion of the project.
- B. The ENGINEER will make his final inspection whenever the CONTRACTOR has notified the ENGINEER that the work is ready for the inspection. Any work not found acceptable and requiring cleaning, repair and/or replacement will be noted on the "Punch" list. Work that has been inspected and accepted by the ENGINEER shall be maintained by the CONTRACTOR, until final acceptance of the entire project.
- C. Whenever the CONTRACTOR has completed the items on the punch list, he shall again notify the ENGINEER that it is ready for final inspection. This procedure will continue until the entire project is accepted by the ENGINEER. The "Final Payment" will not be processed until the entire project has been accepted by the ENGINEER and all of the requirements in previous Article 1.03 "Final Submittals" have been satisfied.

1.05 MAINTENANCE AND GUARANTEE

- A. The CONTRACTOR shall comply with all maintenance and guarantee requirements of the Contract Documents.
- B. Replacement of earth fill or backfill, where it has settled below the required finish elevations, shall be considered as a part of such required repair work, and any repair or resurfacing constructed by the CONTRACTOR which becomes necessary by reason of such settlement shall likewise be considered as a part of such required repair work unless the CONTRACTOR shall have obtained a statement in writing from the affected private CITY or public agency releasing the CITY from further responsibility in connection with such repair or resurfacing.
- C. The CONTRACTOR shall make all repairs and replacements promptly upon receipt of written order from the CITY. If the CONTRACTOR fails to make such repairs or replacements promptly, the CITY reserves the right to do the Work and the CONTRACTOR and his surety shall be liable to the CITY for the cost thereof.

1.06 FINAL CLEANUP

- A. The CONTRACTOR shall promptly remove from the vicinity of the completed Work, all rubbish, unused materials, concrete forms, construction equipment, and temporary structures

SECTION 01700

PROJECT CLOSEOUT

and facilities used during construction. Final acceptance of the Work by the CITY will be withheld until the CONTRACTOR has satisfactorily complied with the foregoing requirements for final cleanup of the project site.

PART 2 -- PRODUCTS (Not Used)

PART 3 -- EXECUTION (Not Used)

- END OF SECTION -

SECTION 01740

PERMITS

Part 1 - GENERAL

1.01 General:

- A. The CONTRACTOR shall obtain and pay for all permits and fees in connection with the work. The CITY will refund the actual permit fees to the CONTRACTOR.
- B. The CONTRACTOR shall familiarize himself with, and comply with, all requirements of required permits governing all work under this Contract. The CONTRACTOR's particular attention is called to any Special Conditions of the permits relating to construction procedures, excavation and backfill requirements, open trench restrictions, turbidity control, traffic control, pavement restoration and all other general and special conditions. In the event any of the conditions of the permits are in conflict with the requirements of these Specifications, the most stringent conditions shall take precedence.
- C. Any deviations from the Plans, Specifications or required permits, must first be approved by the CITY even if approval for the change has been given by the permitting agency.
- D. The CONTRACTOR shall fully assume all obligations and responsibilities, monetary and otherwise, imposed by the permits throughout the life of the project, including but not limited to:
 1. Proper maintenance of permit documentation and field records.
 2. Proper maintenance of all permit-required field controls, including but not limited to the following:
 - (a) Chemical spill prevention
 - (b) Erosion, sedimentation, turbidity and dust retention
 - (c) Protection of storm drainage facilities
 - (d) Temporary vehicular and pedestrian traffic controls
 3. Payment of fines resulting from permit non-compliance
 4. Maintaining active permits and obtaining permit extensions when needed
 5. Providing certifications of all materials and equipment installed
 6. Performing successful inspections and tests required by the permits.
 7. Correcting any work that is not in compliance with permits.
 8. Performing successful equipment start-ups.

SECTION 01740

PERMITS

9. Providing Operation and Maintenance (O&M) manuals for installed equipment as required by permits.
10. Repair of any permanent traffic controls impacted by CONTRACTOR
11. Close-out of all permits.

E. All surveying required by the project permits will be done by the CONTRACTOR's Florida registered Land Surveyor. This includes staking out limits of construction.

Part 2 - PRODUCTS

(Not Used)

Part 3 - EXECUTION

(Not Used)

END OF SECTION

SECTION 02100

CLEARING AND GRUBBING

Part 1 - GENERAL

1.01 THE REQUIREMENT

- A. The CONTRACTOR shall furnish all materials, equipment and labor necessary to complete all clearing and grubbing as specified herein and in accordance with the Drawings.
- B. The CONTRACTOR shall protect all trees, shrubs, lawns, and the like where to be preserved.
- C. The CONTRACTOR shall remove and replace existing fence in conflict with proposed work.
- D. The CONTRACTOR shall remove existing pavement markings as indicated in the plans by grinding method to be reviewed and approved by the ENGINEER.

1.02 STANDARDS AND REGULATIONS

- A. The CONTRACTOR shall comply with all state, county and local regulations regarding disposal of debris resulting from the clearing and grubbing operation.
- B. The CONTRACTOR shall dispose of debris resulting from the clearing and grubbing operation at off-site locations in a lawful manner.

1.03 PROTECTION OF PERSONS AND PROPERTY

- A. All work shall be performed in such a manner to protect all personnel, workmen, pedestrians, and adjacent property and structures from possible injury or damage.

Part 2 - PRODUCTS (Not Used)

Part 3 - EXECUTION

3.01 GENERAL

- A. The work specified in this section consists of clearing and grubbing within the areas required in the easements and right-of-ways to install the pipeline and appurtenances. The work shall include the disposal of the resultant products and debris in areas provided by the CONTRACTOR unless noted otherwise.
- B. Standard clearing and grubbing shall consist of the complete removal and disposal of all trees, shrubs, timber, brush, stumps, roots, grass, weeds,

SECTION 02100

CLEARING AND GRUBBING

rubbish and other obstructions resting on or protruding through the surface of the existing ground and the surface of excavated areas.

- C. Excavation resulting from the removal of trees, roots, and the like shall be filled with suitable material, as approved by the ENGINEER, and thoroughly compacted per the requirements contained in Section 02222 – Excavation and Backfill for Utilities.

3.02 DISPOSAL OF MATERIALS

- A. Timber, stumps, muck, brush, roots, rubbish and other objectionable material resulting from clearing and grubbing shall be disposed of in a lawful manner, off site by the CONTRACTOR.
- B. Burning of any debris resulting from the clearing and grubbing work will not be permitted at the site.

- END OF SECTION -

SECTION 02140

DEWATERING

Part 1 - GENERAL

1.01 DESCRIPTION

- A. Design, furnish, operate, maintain, and remove temporary dewatering systems to control groundwater and surface water to maintain stable, undisturbed subgrades, and permit work to be performed under dry and stable conditions. Work to be done as part of dewatering includes, but is not limited to:
1. Lower the groundwater level
 2. Lower hydrostatic pressure.
 3. Prevent surface water from entering the excavation during construction.
 4. Implement erosion control measures for disposing of discharge water.
- B. Groundwater within the excavation area shall be lowered to at least 1 foot below the lowest excavation levels as specified and as indicated.
- C. Common groundwater recharge methods include, but are not limited to, deep wells, large sumps or any combination thereof.
- D. The CONTRACTOR shall obtain the required permits for discharge from the Contractor's dewatering systems in accordance with Broward County Water Management Division and South Florida Water Management District (SFWMD) requirements. The CONTRACTOR shall conform to all permit requirements.

1.02 RELATED WORK

- A. Section 02210 - Earth Excavation, Backfill, Fill and Grading
B. Section 02222 – Excavation and Backfill for Utilities.

1.03 SUBMITTALS

- A. Submit the following:
1. Qualification of the CONTRACTOR's dewatering specialist's or firm's qualifications a minimum of four (4) weeks prior to execution of any dewatering. The submittal shall include, but not be limited to:
 - (a) Qualifications of specialist's or firm's Registered Professional Engineer as specified in Paragraph 1.04 B.
 - (b) Qualifications of specialist's or firm's field representative, as specified in paragraph 1.04 B, who shall oversee the installation, operation and maintenance of the dewatering system.

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DEWATERING

2. Submit a dewatering plan at least two weeks prior to start of any dewatering operation. Do not submit design calculations. The review will be only for the information of the CITY and third parties for an overall understanding of the project relating to access, maintenance of existing facilities and proper utilization of the site. The CONTRACTOR shall remain responsible for the adequacy and safety of the means, methods and sequencing of construction. The plan shall include the following items as a minimum:
 - (a) Dewatering plan and details stamped and signed by a Registered Professional Engineer.
 - (b) Certificate of Design: Refer to Section 01300, "Submittals"
 - (c) A list of equipment including, but not limited to, pumps, prime movers, and standby equipment.
 - (d) Detailed description of dewatering, maintenance, and system removal procedures.
 - (e) Monitoring plan and details, including, but not limited to, number and locations of observation wells, and geotechnical instruments such as settlement markers and piezometers, and frequency of reading the monitoring devices.
 - (f) Erosion/sedimentation control measures, and methods of disposal of pumped water.
 - (g) List of all applicable laws, regulations, rules, and codes to which dewatering design conforms.
 - (h) List of assumptions made for design of dewatering and for groundwater recharge systems, including but not limited to groundwater levels, soil profile, permeability, and duration of pumping and or recharge.
 - (i) Turbidity measurements in receiving waters as required by the permit. A turbidity control and monitoring where discharge is to a body of water.
3. Measurement records consisting of observation well groundwater records and the geotechnical instrumentation readings within one day of monitoring.
4. A modified dewatering plan within 24 hours, if open pumping from sumps and ditches results in boils, loss of fines, sinkholes or softening of the ground.

1.04 QUALITY ASSURANCE

SECTION 02140

DEWATERING

- A. Employ the services of a dewatering specialist or firm having the following qualifications:
 - 1. Have completed at least five (5) successful dewatering projects of equal size and complexity and with equal systems within the last five (5) years.
 - 2. Retain the services of a Florida Registered Professional Engineer having a minimum of five (5) years of experience in the design of well points, deep wells, or equal systems.
 - 3. Retain the services of a field representative having a minimum of five (5) years of experience in installation of well points, deep wells, or equal systems.
- B. If subgrade soils are disturbed or become unstable due to dewatering operation or an inadequate dewatering system, notify the ENGINEER, stabilize the subgrade, and modify system to perform as specified at no additional cost to the CITY.
- C. Notify the ENGINEER immediately if any settlement or movement is detected on structures. If the settlement or movement is deemed by the ENGINEER to be related to the dewatering, take actions to protect the adjacent structures and submit a modified dewatering plan to the ENGINEER within 24 hours. Implement the modified plan and repair any damage incurred to the adjacent structures at no additional cost to the CITY.
- D. If oil and/or other hazardous materials are encountered after dewatering begins, immediately notify the ENGINEER.

1.05 PROJECT/SITE CONDITIONS

- A. Subsurface Conditions: Refer to Geotechnical Report provided specifically for the project. The CONTRACTOR is responsible for investigating existing soil conditions as the Geotechnical Report does not assure all subsurface site conditions are represented.

Part 2 - PRODUCTS

2.01 MATERIALS

- A. Provide settlement markers, observation wells, piezometers and/or any other geotechnical instruments in accordance with the submitted dewatering plan.
- B. Provide casings, well screens, piping, fittings, pumps, power and other items required for dewatering system.

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DEWATERING

- C. Provide sand and gravel filter around the well screen. Wrapping geotextile fabric directly around the well screen shall not be allowed.
- D. When deep wells, well points, or vacuum well points are used, provide pumping units capable of maintaining high vacuum and handling large volumes of air and water at the same time.
- E. Provide and store auxiliary dewatering equipment, consisting of pumps and hoses on the site in the event of breakdown, at least one (1) pump for every five (5) used.
- F. Provide and maintain erosion/sedimentation control devices as indicated or specified and in accordance with the dewatering plan.
- G. Provide temporary pipes, hoses, flumes, or channels for the transport of discharge water to the discharge location.
- H. Provide cement grout having a water cement ratio of 1 to 1 by volume.

Part 3 - EXECUTION

3.01 EXECUTION

- A. Execution of any earth excavation, installing earth retention systems, and dewatering shall not commence until the related submittals have been reviewed by the ENGINEER, comments satisfactorily addressed and the geotechnical instrumentation has been installed.
- B. Furnish, install and maintain dewatering system in accordance with the dewatering plan.
- C. Carry out dewatering program in such a manner as to prevent undermining or disturbing foundations of existing structures or of work ongoing or previously completed.
- D. Do not excavate until the dewatering system is operational.
- E. Unless otherwise specified, continue dewatering uninterrupted until all structures, pipes, and appurtenances below groundwater level have been completed such that they will not be floated or otherwise damaged by an increase in groundwater elevation.
- F. Discontinue open pumping from sumps and ditches, if such pumping is resulting in boils, loss of fines, softening of the ground, or instability of the slopes. Modify dewatering plan and submit to the ENGINEER at no additional cost to the CITY.
- G. Where subgrade materials are disturbed or become unstable due to dewatering operations, remove and replace the materials in accordance with Section 02210 – Earth Excavation, Backfill, Fill and Grading at no additional cost to the CITY.
- H. Dewatering Discharge:

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DEWATERING

1. Install and monitor recharge systems when specified and/or indicated and in accordance with the submitted dewatering plan.
 2. Install sand and gravel filters in conjunction with well points and deep wells to prevent the migration of fines from the existing soil during the dewatering operation.
 3. Transport pumped or drained water to discharge location without interference to other work, damage to pavement, other surfaces, or property.
 4. Provide separately controllable pumping lines.
 5. The ENGINEER reserves the right to sample discharge water at any time.
 6. Immediately notify the ENGINEER if suspected contaminated groundwater is encountered. Do not pump water found to be contaminated with oil or other hazardous material to the discharge locations.
- I. Monitoring Devices and Records:
1. Install, maintain, monitor and take readings from the observation wells and geotechnical instruments in accordance with the dewatering plan.
 2. Install settlement markers on structures within the zone of influence for dewatering a distance equal to twice the depth of the excavation, from the closest edge of the excavation. Conduct and report settlement surveys to 0.01 feet.
 3. For large rectangular, square or circular mass excavations the zone of influence shall be defined by the actual cone of watering influence corresponding to a 10% increase in effective vertical stress.
- J. Install and maintain erosion/sedimentation control devices at the point of discharge as indicated or specified during the pre-construction meeting and in accordance with the dewatering plan.
- K. Removal:
1. Do not remove dewatering system without written approval from the Engineer.
 2. Backfill and compact sumps or ditches with clean fill in accordance with Section 02210 – Earth Excavation, Backfill, Fill and Grading.
 3. All dewatering wells shall be abandoned upon completion of the work, and completely backfilled with cement grout.

- END OF SECTION -

SECTION 02210

EARTH EXCAVATION, BACKFILL, FILL AND GRADING

Part 1 - GENERAL

1.01 DESCRIPTION

- A. Perform the following earth excavation, backfill, fill and grading as indicated or specified:
1. Make excavations to accommodate foundations and other structures.
 2. Provide materials for backfilling excavations and constructing embankments and fills as indicated and specified.
 3. Construct embankments of compacted materials.
 4. Grade surfaces to meet finished grades indicated.
 5. Immediately notify the ENGINEER if suspected hazardous materials are encountered and cease operations in that part of work.
 6. Immediately stop work and notify the ENGINEER if historical artifacts or human remains are encountered.
 7. Remove boulders within the excavation limits.

1.02 RELATED WORK

- A. Section 02100 - Clearing and Grubbing
B. Section 02222 – Excavation and backfill for Utilities
C. Section 03300 - Cast in Place Concrete, Reinforcing and Formwork

1.03 REFERENCES

- A. American Society for Testing and Materials (ASTM) Publications:
1. C33: Specification for Concrete Aggregates.
 2. C136: Sieve Analysis of Fine and Coarse Aggregates.
 3. D421: Practice for Dry Preparation of Soil Samples for Particle Size Analysis and Determination of Soil Constants.
 4. D422: Test Method for Particle-Size Analysis of Soils.
 5. D1140: Test Method for Amount of Material in Soils Finer than the No. 200 (75 Fm) Sieve.
 6. D1556: Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
 7. D1557: Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/ft³ (600 kN-m/m³)).

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EARTH EXCAVATION, BACKFILL, FILL AND GRADING

8. D2167: Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
9. D2922: Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods. (Shallow Depth).
10. D3017: Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
11. D4318: Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
12. D4718: Practice for Correction of Unit Weight and Water Content for Soils Containing Oversized Particles.
13. D4944: Test Method for Field Determination of Water (Moisture) Content of Soil by the Calcium Carbide Pressure Tester Method.
14. D4959: Test Method for Field Determination of Water (Moisture) Content of Soil by Direct Heating Method.
15. D5080: Test Method for Rapid Determination of Percent Compaction.

- B. Occupational Safety and Health Administration (OSHA) Standards and Regulations contained in Title 29: Subpart P - Excavations, Trenching and Shoring

1.04 DEFINITIONS

- A. Percentage of compaction is defined as the ratio of the field dry density, as determined by ASTM D1556 to the maximum dry density determined by ASTM D1557 Procedure C, multiplied by 100.
- B. Proof Roll: Compaction with a minimum of 4 passes of a vibratory steel drum or rubber tire roller. Vibratory plate compactors shall be used in small areas where vibratory steel drum or rubber tire roller cannot be used.
- C. Acceptable Material: Material which does not contain organic silt or organic clay, peat, vegetation, wood or roots, stones or rock fragments over 6-inch [15 cm] in diameter, porous biodegradable matter, loose or soft fill, excavated pavement, construction debris, or refuse. Stones or rock fragments shall not exceed 40 percent by weight of the backfill material.
- D. Unacceptable Materials: Materials that do not comply with the requirements for the acceptable material or which cannot be compacted to the specified or indicated density.

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EARTH EXCAVATION, BACKFILL, FILL AND GRADING

1.05 SUBMITTALS

A. Submit the following:

1. Qualifications of the CONTRACTOR's Independent Testing Laboratory as specified in Paragraph 1.06 I, four (4) weeks prior to the execution of any earth excavation, backfilling, filling, or compaction process.
2. Submit an excavation, backfilling, and filling plan at least two weeks prior to start of any earth moving activities. The review will be only for the information of the CITY and third parties for an overall understanding of the project relating to access, maintenance of existing facilities and proper utilization of the site. The CONTRACTOR shall remain responsible for the adequacy and safety of the means, methods and sequencing of construction. The Earthwork plan shall include, but not be limited to the following items:
 - (a) Detailed sequence of work.
 - (b) General description of construction methods.
 - (c) Numbers, types, and sizes of equipment proposed to perform excavation and compaction.
 - (d) Details of dust control measures.
 - (e) Proposed locations of stockpiled excavation and/or backfill materials.
 - (f) Proposed surplus excavated material off-site disposal areas and required permits.
 - (g) Details of erosion and sedimentation control measures which will prevent erosion and sedimentation during the earth moving activities.
3. Laboratory testing results of gradation and moisture-density relationship. Submittal shall include specific location of the source and the date when sample was taken.
4. During Construction, submit written confirmation of fill lift thickness, in-place soil moisture content, and percentage of compaction to the ENGINEER before placing the next lift or constructing foundations.

1.06 QUALITY ASSURANCE AND CONTROL

- ##### A. The CONTRACTOR shall be solely responsible for making all excavations in a safe manner. All excavation, trenching, and related sheeting, bracing, etc. shall comply with the requirements of OSHA excavation safety standards (29 CFR Part 1926 Subpart P) and State requirements. Where conflict between

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EARTH EXCAVATION, BACKFILL, FILL AND GRADING

OSHA and State regulations exists, the more stringent requirements shall apply.

- B. Do not excavate, construct embankments, or fill until all the required submittals have been reviewed by the ENGINEER.
- C. Formulate excavation, backfilling, and filling schedule and procedures to eliminate possibility of undermining or disturbing foundations of partially and completed structures, pipelines and embankments or existing structures and pipelines.
- D. Field Testing and Inspections:
 - 1. By CONTRACTOR's independent testing laboratory, acceptable to the ENGINEER, at CONTRACTOR's expense as specified in Paragraph 1.06 G.
 - 2. Location of tests mutually acceptable to testing laboratory and the ENGINEER or as directed by the ENGINEER.
 - 3. In the event compacted material does not meet specified in-place density, re-compact material and retest this area until specified results are obtained at no additional cost to the CITY.
 - 4. CONTRACTOR's independent testing laboratory to perform inspection at least once daily to confirm lift thickness and compaction effort for entire fill area.

E. Methods of Field Testing

- 1. In-Place Density: ASTM D1556, ASTM D2167, or ASTM D2922.
- 2. In-Place Moisture Content: ASTM D3017, ASTM D4944, or ASTM D4959.

F. Material Testing Frequency: The following testing frequencies are minimum required for all structural and non-structural fill, grading and embankment.

- 1. Field In-Place Density and Moisture Content - Screened gravel and crushed stone shall be compacted as specified and indicated. For other backfill and fill materials, minimum test frequency shall be as follows, and no less than one test per:
 - (a) Trenches under structures, foundation preparation, or roadways subbase: Every 500' lin. ft. per lift.
 - (b) Trenches in areas without structures or roadways: Every 1000 lin. ft. per alternate lift.
 - (c) Paved Roadways: Every 200 lin. ft. per lift.

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EARTH EXCAVATION, BACKFILL, FILL AND GRADING

- (d) Paved Areas: 3,500 sq. ft. per lift.
- (e) Under each structure: 1,000 sq. ft. per lift.
- (f) Around each structure: 1,500 sq. ft. per lift.
- (g) Embankment Fills: 10,000 sq. ft. per lift.

2. Moisture Density - One per source, except for screened gravel and crushed stone. Repeat the moisture density test for every 5,000 cubic yard of material use, and whenever visual inspection indicates a change in material gradation as determined by the ENGINEER.
3. Gradation Analysis - A minimum of one per source and for each moisture density test and whenever visual inspection indicates a change in material gradation.

G. Construction Tolerances

1. Construct finished surfaces to plus or minus 1 inch of the elevations indicated. Impervious surfaces shall be sloped such that following a rain event, water puddles shall be less than $\frac{1}{4}$ ".
2. Grade cut and fill areas to plus or minus 0.20 foot of the grades indicated.
3. Complete embankment edges to plus or minus 6 inches of the slope lines indicated.
4. Provide the ENGINEER with adequate survey information to verify compliance with above tolerances.

H. Cut pavement with a saw or pneumatic tools to prevent damage to remaining pavement without extra compensation. Where pavement is removed in large pieces, dispose of pieces before proceeding with excavation.

I. Pipes, drains, and other utilities may exist in certain locations not indicated on drawings. No attempt has been made to show all services. Completeness or accuracy of information given is not guaranteed. CONTRACTOR is to conform with all Sunshine One Call (811) requirements.

J. Dig test pits considered as incidental to the normal excavation as indicated and specified in this Section, at no additional compensation.

K. Carefully support and protect from damage, existing pipes, poles, wires, fences, curbing, property line markers, and other structures, which the ENGINEER determines must be preserved in place without being temporarily or permanently relocated. Should such items be damaged, restore without compensation therefore, to at least as good condition as that in which they were found immediately before the work was begun.

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EARTH EXCAVATION, BACKFILL, FILL AND GRADING

- L. Whenever certain existing structures, as described below, are encountered, and the ENGINEER so directs, change the location, remove and later restore, or replace such structures, or assist the CITY in doing so.
- M. In removing existing pipes or other structures, include for payment only those new materials which are necessary to replace those unavoidably damaged as determined by the ENGINEER.
- N. The preceding two paragraphs apply to pipes, wires, and other structures which meet the following: (a) are not indicated on the drawings or otherwise provided for, (b) encroach upon or are encountered near and substantially parallel to the edge of the excavation, and (c) in the opinion of the ENGINEER, will impede progress to such an extent that satisfactory construction cannot proceed until they have been changed in location, removed (to be later restored), or replaced.
- O. Restore existing property or structures as promptly as practicable.
- P. If material unacceptable for foundation (in the opinion of the ENGINEER) is found at or below the grade to which excavation would normally be carried in accordance with the drawings and/or specifications, remove such material to the required width and depth as directed by the ENGINEER and replace with material specified on Geotechnical Report.
- Q. Do not remove excavation materials from the site of the work or dispose of except as directed or permitted by the ENGINEER.
- R. Haul away and dispose of surplus excavated materials at locations directed by the ENGINEER at no additional cost to the CITY.
- S. During progress of work, conduct earth moving operations and maintain work site so as to minimize the creation and dispersion of dust. Furnish and spread calcium chloride if the ENGINEER decides that it is necessary for more effective dust control.
- T. Provide suitable and safe bridges and other crossings where required for accommodation of travel, and to provide access to private property during construction, and remove said structures thereafter.

1.07 SITE CONDITIONS:

- A. Subsurface Conditions: Refer to Geotechnical Report.

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EARTH EXCAVATION, BACKFILL, FILL AND GRADING

Part 2 - PRODUCTS

2.01 GENERAL

- A. Use only acceptable materials from excavations or borrows.
- B. Provide a minimum of 3,000 psi concrete.
- C. Provide Fine Aggregate conforming to ASTM C33.

2.02 EQUIPMENT

- A. The compaction equipment shall be selected by the CONTRACTOR, and shall be capable of consistently achieving the specified compaction requirements. The selected compaction equipment shall meet the following minimum requirements:
 - 1. Manually operated vibratory plate compactors weighing no less than 200 pounds with vibration frequency no less than 1600 cycles per minute.
 - 2. Vibratory steel drum or rubber tire roller weighing at least 12,000 pounds.

Part 3 - EXECUTION

3.01 EXCAVATION

- A. Execution of any earth excavation shall not commence until the related excavation support systems, and backfill and fill materials submittals are reviewed by the ENGINEER and all ENGINEER's comments satisfactorily addressed.
- B. Carry out program of excavation, and excavation support systems to eliminate possibility of undermining or disturbing foundations of existing structures or of work previously completed under this contract.
- C. Excavate to widths that give suitable room for building structures or laying and jointing piping.
- D. Do not plow, scrape or dig by machinery near to finished subgrade in a manner that would result in disturbance of subgrade.
- E. Excavate to lines and grades indicated in an orderly and continuous program.
- F. Establish limits of excavation to allow adequate working space for installing forms and for safety of personnel.
- G. Excavate to elevations indicated, or deeper, as directed by the ENGINEER, to remove unacceptable material.
- H. Exercise care to preserve material below and beyond the lines of excavations.

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- I. Place excavated material at the approved stockpile locations and in no case closer than 3 feet from edge of excavations to prevent cave-ins of bank slides.
- J. Regard small, less than one cubic yard, boulders, rock fragments, and concrete encountered during excavation as a normal part of in-place soils and not included for payment as rock.

3.02 SEPARATION OF EXCAVATED MATERIALS FOR REUSE

- A. Remove only existing pavement that is necessary for prosecution of work.
- B. Carefully remove loam and topsoil from excavated areas. Store separately for further use or furnish equivalent loam and topsoil as directed.
- C. Carefully remove acceptable material from excavated areas and store separately for further use as backfill material.

3.03 EXCAVATION NEAR EXISTING STRUCTURES

- A. Discontinue digging by machinery when excavation approaches pipes, conduits, or other underground structures. Continue excavation by use of hand tools. Include such manual excavation in work to be done when incidental to normal excavation and under items involving normal excavation.
- B. Excavate test pits when determination of exact location of pipe or other underground structure is necessary for doing work properly.

3.04 REMOVAL OF SUBSURFACE OBSTRUCTIONS

- A. Remove indicated subsurface structures and related obstructions to extent shown.
- B. Promptly notify the ENGINEER when any unexpected subsurface facilities are encountered during excavation such as utility lines and appurtenances, walls and foundations.

3.05 UNAUTHORIZED EXCAVATION

- A. When the bottom of any excavation for structures is taken out beyond limits indicated or specified, backfill, with screened gravel and crushed stone wrapped with non-woven geotextile fabric or with 1,500 psi concrete.

3.06 REUSE AND DISPOSAL OF SURPLUS EXCAVATED MATERIALS

- A. Reuse surplus acceptable excavated materials for backfill; deposit neatly and grade so as to make or widen fills, flatten side slopes, or fill depressions; or

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EARTH EXCAVATION, BACKFILL, FILL AND GRADING

legally dispose off-site; all as directed or permitted and without additional compensation.

3.07 SITE PREPARATION

- A. Site preparation in the pump station area will require excavation/replacement of the compressible stratum. The compressible stratum should be excavated to its full depth and to a horizontal distance of at least 5 feet beyond the outside edges of the pump station, where practical.

3.08 CARE AND RESTORATION OF PROPERTY

- A. Enclose uncut tree trunks adjacent to work in wooden boxes of such height as may be necessary for protection from injury from piled material, equipment, operations, or otherwise due to work. Operate excavating machinery and cranes of suitable type with care to prevent injury to trees not to be cut and particularly to overhanging branches and limbs.
- B. Cut all branches, limbs, and roots smoothly and neatly without splitting or crushing. Neatly trim, cut the injured portions and cover with an application of grafting wax or tree healing paint as directed.
- C. Protect cultivated hedges, shrubs, and plants which might be injured by the Contractor's operations by suitable means or dig up and temporarily replant and maintain. After construction operations have been substantially completed, replant in original positions and care for until growth is re-established. If cultivated hedges, shrubs, and plants are injured to such a degree as to affect their growth or diminish in their beauty or usefulness, replace by items of equal kind and quality existing at the start of the work.

3.09 BACKFILLING - GENERAL

- A. Do not placed, spread, roll or compact fill material during unfavorable weather conditions. If interrupted by heavy rain or other unfavorable conditions, do not resume until ascertaining that the moisture content and density of the previously placed soil are as specified.
- B. Do not use puddling, ponding or flooding as a means of compaction.

3.10 STRUCTURAL FILL AND BACKFILL UNDER STRUCTURES

- A. Compact fill and backfill under structures and pavements with screened gravel, crushed stone, select borrow, or fine aggregate as specified and indicated.

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EARTH EXCAVATION, BACKFILL, FILL AND GRADING

- B. Groundwater is expected to impact the replacement filling procedures. It is recommended that excavation/filling activities be done in the "wet".
- C. Fill material for use on this project should be composed of either clean sands or limerock. The fill should consist of an inorganic, non-plastic material, free of any man-made debris and limerock with a three inch maximum particle size. Proper control of the placement and compaction of new fills for the project should be exercised by a representative of the geotechnical engineer. The fill materials should be placed in lifts not exceeding 12 inches in loose thickness. Each lift should be compacted to at least 95 percent of the Modified Proctor maximum dry density near the optimum moisture content as determined by ASTM D-1557. Fill to be compacted with a vibratory plate tamper or a small walk behind vibratory roller should be placed in lifts not exceeding six inches in loose thickness. The fill material used both below the water table and to a height of one foot above it be as follows:
 - (a) The structural fill to be used above the water table should have a Unified Soil Classification System designation of GP, GW, SP, SW, GP-GM, GW-GM, SW-SM, or SP-SM containing less than 12 percent material passing the No. 200 sieve.
 - (b) The structural fill or backfill to be placed below the water table and to a height of one foot above it should consist of a combination of FDOT 57 Stone and structural fill material mixed in an approximate 50% proportion by volume. Density testing will not be required within this layer, however the subgrade preparation work should be observed by the ENGINEER to confirm that the material is in stable and unyielding condition.

3.11 COMPACTION CONTROL OF BACKFILL AND/OR FILL

- A. Compact to density specified and indicated for various types of material. Control moisture content of material being placed as specified or if not specified, at a level slightly lower than optimum.
- B. The soil testing laboratory shall provide inspection during filling or backfilling operations to ensure compaction of screened gravel or crushed stone and record compaction equipment in use.
- C. Moisture control may be required either at the stockpile area, pits, or on embankment or backfill. Increase moisture content when material is too dry by sprinkling or other means of wetting uniformly. Reduce moisture content when material is too wet by using ditches, pumps, drainage wells, or other devices

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EARTH EXCAVATION, BACKFILL, FILL AND GRADING

and by exposing the greatest possible area to sun and air in conjunction with harrowing, plowing, spreading of material or any other effective methods.

3.12 ALLOWANCE FOR SHRINKAGE

- A. Build embankments or backfill to a height above finished grade which will, in the opinion of the ENGINEER, allow for the shrinkage or consolidation of material. Initially, provide at all points, an excess of at least one percent of total height of backfill measured from stripped surface to top of finished surface.
- B. Supply specified materials and build up low places as directed, without additional cost if embankment or backfilling settles so as to be below the indicated level for proposed finished surface at any time before final acceptance of the work.

- END OF SECTION -

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EXCAVATION AND BACKFILL FOR UTILITIES

Part 1 - GENERAL

1.01 THE REQUIREMENT

- A. Excavate, grade and backfill as required for underground piping systems and appurtenances as shown on the Drawings and specified herein.
- B. Backfill from off-site sources shall be provided if the excavated material is unsuitable. Material/Soil with clay, muck, organic material, or rocks greater than ¾" are unsuitable for piping/conduit backfill.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Codes: All codes, as referenced herein, are specified in Section 01090, "Reference Standards".
- B. Commercial Standards:

ASTM C33	Standard Specification for Concrete Aggregates
ASTM D 422	Method for Particle-Size Analysis of Soils.
ASTM D 698	Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5-lb (2.49-kg) Rammer and 12-in (304.8-mm) Drop.
ASTM D 1556	Test Method for Density of Soil in Place by the Sand-Cone Method.
ASTM D 1557	Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in (457-mm) Drop.
ASTM D 2419	Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
ASTM D 2922	Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

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EXCAVATION AND BACKFILL FOR UTILITIES

1.03 SUBMITTALS

- A. General: Submit information and samples to the ENGINEER for review as specified herein.
- B. Dewatering: The CONTRACTOR shall submit to the ENGINEER its proposed methods of handling trench water and the locations at which the water will be disposed of. Methods shall be acceptable to the ENGINEER before starting the excavation.
- C. Bedding and Backfill Materials: The CONTRACTOR shall notify the ENGINEER of the off-site sources of bedding and backfill materials, and submit to the ENGINEER a representative sample weighing approximately 50 lbs. The sample shall be delivered to a location on site determined by the ENGINEER.
- D. Sheet Pile System: Drawings of the sheet pile system and design computations shall be submitted to the ENGINEER; however, the review of these drawings shall in no way relieve the CONTRACTOR of the responsibility to provide a safe and satisfactory sheet pile and shoring system. Sheet pile and shoring shall be designed by the CONTRACTOR, and the proposed design shall be sealed by a Professional ENGINEER registered in the State of Florida. If the ENGINEER is of the opinion that at any point sufficient or proper supports have not been provided, it may order additional supports put in at the CONTRACTOR's expense.
- E. Dewatering Permits: If the quantity or nature of water withdrawn requires approval/permits from regulatory agencies, the CONTRACTOR shall procure such permits at its expense and submit copies to the ENGINEER before commencing the work. The CONTRACTOR will not be granted contract time extensions due to dewatering permit processing delays.

1.04 QUALITY CONTROL

- A. The CONTRACTOR shall employ and pay for the services of an independent testing laboratory to perform specified testing. All testing shall be included as incidental cost to the appropriate pay item. The CONTRACTOR shall schedule its work so as to permit a reasonable time for testing before placing succeeding lifts and shall keep the laboratory informed of his progress. A minimum of 48 hours of notice shall be provided to the testing laboratory to mobilize its activities.

1.05 SUBSURFACE INFORMATION

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- A. The CONTRACTOR shall be responsible for anticipating groundwater conditions and shall provide positive control measures as required. Such measures shall ensure stability of excavations, groundwater pressure control, prevention of tanks, pipes, and other structures from being lifted by hydrostatic pressures, and avoiding the disturbance of subgrade bearing materials.

1.06 TRENCH SAFETY ACT COMPLIANCE

- A. The CONTRACTOR by signing and executing the contract is, in writing, assuring that it will perform any trench excavation in accordance with the Florida Trench Safety Act, Section 553.60 et. seq.. The CONTRACTOR has further identified the separate item(s) of cost of compliance with the applicable trench safety standards as well as the method of compliance as noted in the "Bid Forms" Section of the Contract front-end documents.
- B. The CONTRACTOR acknowledges that this cost is included in the applicable items of the Proposal and Contract and in the Grand Total Bid and Contract Price.
- C. The CONTRACTOR is, and the CITY and ENGINEER are not, responsible to review or assess the CONTRACTOR's safety precautions, programs or costs, or the means, methods, techniques or technique adequacy, reasonableness of cost, sequences or procedures of any safety precaution, program or cost, including but not limited to, compliance with any and all requirements of Florida Statute Section 553.60 et. seq. cited as the "Trench Safety Act". The CONTRACTOR is, and the CITY and ENGINEER are not, responsible to determine if any safety or safety related standards apply to the project, including but not limited to, the "Trench Safety Act".

1.07 PROTECTION OF PROPERTY AND STRUCTURES

- A. The CONTRACTOR shall, at its own expense, sustain in place and protect from direct or indirect injury, all pipes, poles, conduits, walls, buildings, and all other structures, utilities, and property in the vicinity of its Work. Such sustaining shall be done by the CONTRACTOR. The CONTRACTOR shall take all risks attending the presence or proximity of pipes, poles, conduits, walls, buildings, and all other structures, utilities, and its Work. It shall be responsible for all damage, and assume all expenses, for direct or indirect injury and damage, caused by its Work, to any such pipe, structures, etc., or to any person or property, by reason of injury to them, whether or not such structures, etc., are shown on the Drawings.
- B. Barriers shall be placed at each end of all excavations and at such places as may be necessary along excavations to warn all pedestrian and vehicular

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traffic of such excavations. Barricades with flashing lights shall also be placed along excavation from sunset each day to sunrise of the next day until such excavation is entirely refilled, compacted, and paved. All excavations shall be barricaded where required to meet OSHA, local and Federal Code requirements, in such a manner to prevent persons from falling or walking into any excavation within the site fenced property limits.

1.08 DEWATERING PERMITS

- A. The CONTRACTOR shall be responsible for obtaining all permits required for the dewatering operation.

Part 2 - PRODUCTS

2.01 BEDDING MATERIAL

- A. Bedding materials shall be furnished from acceptable off-site sources. The CONTRACTOR shall submit to the ENGINEER the sources of each material for review.
- B. Bottom of the trench to be over-excavated to provide a minimum depth of 6 inches of pipe bedding.
- C. Bedding material should consist of crushed stone (pea gravel) or No. 7 aggregate with not less than 95 percent passing the ½ inch and not less than 95 percent retained on a U.S. Standard No. 4 sieve. Alternatively, the use of FDOT 57 stone may also be acceptable.
- D. Bedding material should be stabilized so it is firm and unyielding prior to placement of the pipe.
- E. Place a geotextile wrap such as CONTECH C-60NW or its material equivalent to completely envelop the pipe and the bedding material. A Material property Data Sheet associated with geotextile C-60NW is included in the project's geotechnical report.

2.02 SELECT BACKFILL

- A. Compaction as per Typical Trench Backfill detail on Drawings.

2.03 GENERAL/SUITABLE BACKFILL

- A. All other backfill (general/suitable backfill) placed above the select backfill shall pass through a 6-inch ring. Suitable backfill placed and compacted to at least 100% of maximum density, 6" maximum size, 6" lifts, per AASHTO Spec No. T-99C General backfill used under roadways shall be compatible with the

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EXCAVATION AND BACKFILL FOR UTILITIES

materials and compaction specified under Section 02510 – Asphaltic Concrete Pavement and 02526 – Concrete Pavement, Curb and Walkway.

Part 3 - EXECUTION

3.01 EXCAVATION

- A. The CONTRACTOR shall perform all excavation of every description and of whatever substance encountered, to the dimensions, grades and depths shown on the Drawings, or as required for a proper installation. All excavations shall be made by open cut and in accordance with the Trench Safety Act. All existing utilities such as pipes, poles and structures shall be carefully located, supported and protected from injury; in case of damage, they shall be restored at the CONTRACTOR's expense.
- B. Pipe trenches for piping shall be excavated to a width within the limits of the top of the pipe and the trench bottom so as to provide a clearance on each side of the pipe barrel, measured to the face of the excavation, or sheeting if used, of 8 inches to 18 inches as defined on the Drawings. Where the pipe size exceeds 12 inches, the clearance shall be from 12 inches-to-18 inches. All pipe trenches shall be excavated to a level where suitable material is reached, a minimum of 8 inches below the pipe barrel or that will allow for a minimum of 36 inches of covering unless otherwise indicated on the Drawings.
- C. Ladders or steps shall be provided for and used by workmen to enter and leave trenches.
- D. Excavated unsuitable material shall be removed from the site and disposed of by the CONTRACTOR. Materials removed from the trenches shall be stored and in such a manner that will not interfere unduly with traffic on public roadways and sidewalks and shall not be placed on private property. In congested areas, such materials that cannot be stored adjacent to the trench or used immediately as backfill shall be removed to other convenient places of storage acceptable to the CITY at the CONTRACTOR's expense.
- E. Excavated material that is suitable for use as backfill shall be used in areas where sufficient material is not available from the excavation. Suitable material in excess of backfill requirements shall be disposed off-site at the CONTRACTOR's expense.

3.02 SHEETING AND BRACING

- A. The CONTRACTOR shall furnish, place and maintain sheeting and bracing to support sides of the excavation as necessary to provide safe working conditions in accordance with OSHA requirements, and to protect pipes,

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structures and other Work from possible damage. Where wood sheeting or certain designs of steel sheeting are used, the sheeting shall be cut off at a level of 2 feet above the top of the installed pipe and that portion below the level shall be left in place. If interlocking steel sheeting is used, it may be removed providing removal can be accomplished without disturbing the bedding, pipe or alignment of the pipe. Any damage to the pipe bedding, pipe or alignment of the constructed utility caused by the removal of sheeting shall be cause for rejection of the affected portion of the work. The CITY may permit sheeting to be left in place at the request and expense of the CONTRACTOR or the CITY may order him in writing to leave in place, for the preventing of damage to structures or property. Payment for sheeting ordered to remain in place shall be paid for at a negotiated price.

- B. If the ENGINEER is of the opinion that at any point sufficient or proper supports, have not be provided, he may order additional supports put in at the CONTRACTOR's expense. The CONTRACTOR shall be responsible for the adequacy of all sheeting used and for all damage resulting from sheeting and bracing failure or from placing, maintaining and removing it.

3.03 REMOVAL OF WATER

- A. General: It is a basic requirement of these Specifications unless otherwise authorized per Article 3.09 that excavations shall be free from water before pipe or structures are installed.
- B. The CONTRACTOR shall provide pumps, and other appurtenant equipment necessary to remove and maintain water at such a level as to permit construction in a dry condition. The CONTRACTOR shall continue dewatering operations until backfilling has progressed to a sufficient depth over the pipe to prevent flotation or movement of the pipe in the trench or so that it is above the water table. If at any point during the dewatering operation it is determined that fine material is being removed from the excavation sidewalls, the dewatering operation shall be stopped. If any of the subgrade or underlying material is disturbed by movement of groundwater, surface water, or any other reason, it shall be replaced at the CONTRACTOR's expense with crushed stone or gravel.
- C. The CONTRACTOR shall use dewatering systems that include automatic starting devices, and standby pumps that will ensure continuous dewatering in the event of an outage of one or more pumps.

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EXCAVATION AND BACKFILL FOR UTILITIES

- D. Disposal: Water from the trenches and excavation shall be disposed of in such a manner as will not cause injury to public health, to public or private property, to the Work completed or in progress, to the surface of the streets, cause any interference with the use of the same by the public, or cause pollution of any waterway or stream. The CONTRACTOR shall submit his proposed methods of handling trench water and locations at which the water will be disposed of to the ENGINEER for review and shall receive acceptance before starting the excavation. Disposal to any surface water body will require silt screens to prevent any degradation in the water body. The CONTRACTOR shall have responsibility for acquiring all necessary permits for disposal.

3.04 TRENCH STABILIZATION

- A. No claim for extras, or additional payment will be considered for cost incurred in the stabilization of trench bottoms which are rendered soft or unstable as a result of construction methods, such as improper or inadequate sheeting, dewatering or other causes. In no event shall pipe be installed when such conditions exist and the CONTRACTOR shall correct such conditions so as to provide proper bedding or foundations for the proposed installation at no additional cost to the CITY before placing the pipe or structures.

3.05 PIPE BEDDING IN DRY TRENCHES

- A. Pipe trenches shall be excavated as described in Article 3.01. The resulting excavation shall be backfilled with acceptable pipe bedding material, up to the level of the centerline of the proposed pipe barrel. This backfill shall be tamped and compacted to provide a proper bedding for the pipe and shall then be shaped to receive the pipe. Bedding shall be provided under the branch of all fittings to furnish adequate support and bearing under the fitting.
- B. Any over excavation below the levels required for installation of the pipe shall be backfilled with acceptable bedding material, tamped, compacted and shaped to provide proper support for the proposed pipe, at the CONTRACTOR's expense.
- C. Place a geotextile wrap such as CONTECH C-60NW or its material equivalent to completely envelop the pipe and the bedding material.

3.06 BACKFILL

- A. The CONTRACTOR shall not backfill trenches until the piping has been inspected and tested.

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EXCAVATION AND BACKFILL FOR UTILITIES

- B. Pipelines: Pipeline trenches shall be backfilled to a level 12 inches above the top of the pipe with select backfill. When placed in the dry, such material shall be placed in 6-inch layers, each compacted to the densities specified in Article 3.07. Only hand operated mechanical compacting equipment shall be used within six inches of the installed pipe.
- C. After the select backfill has been placed as specified above, and after all excess water has completely drained from the trench, general backfilling of the remainder of the trench may proceed. General backfill shall be placed in horizontal layers, the depth of which shall not exceed the ability of the compaction equipment employed, and in no event shall exceed a depth of 12 inches. Each layer shall be moistened, tamped, puddled, rolled or compacted to the densities specified in Article 3.07.

3.07 COMPACTION AND DENSITIES

- A. Typical trench backfill as per Figure 180 of Broward County Standard Details. Methods of control and testing of backfill construction are:
- B. Density Test Locations for Pipelines: The compacted backfill/fill shall be tested for in-place density at the rate of one test location per 200 lineal feet (or fraction thereof) of trench, or as shown on the Drawings or as directed by the ENGINEER. The density tests shall be taken at the trench bottom and at each location in one foot intervals beginning from the top of the piping and ending at the final grade. At existing road or pavement crossings, a minimum of two (2) density tests per crossing per lift is required.
- C. Trench backfill which does not comply with the specified densities, as indicated by such tests, shall be reworked and recompacted until the required compaction is secured, at no additional cost to the CITY. The costs for retesting such Work shall be paid for by the CONTRACTOR.

- END OF SECTION -

SECTION 02332

LIMEROCK BASE

Part 1 - GENERAL

1.01 WORK INCLUDED

- A. Furnish all labor, materials, equipment and incidentals required to provide limerock base in accordance with the grades and typical sections shown on the Drawings and as specified herein.

1.02 RELATED WORK:

- A. Section 02100 – Clearing and Grubbing.
- B. Section 02510 - Asphaltic Concrete Pavement.

Part 2 - PRODUCTS

2.01 MATERIALS

- A. Source: The material used in limerock base courses shall be material classified as either Miami Oolite Formation or Ocala Formation at the CONTRACTOR'S option; however, only one formation may be used.
- B. Limerock material shall contain not less than 70 percent of carbonates of calcium and magnesium. The maximum percentage of water sensitive clay material shall be 3.
- C. Graduation: At least 97 percent (by weight) of the material shall pass a 3-1/2-inch sieve and the material shall be grades uniformly down to dust. The fine material shall consist entirely of dust of fracture. All crushing or breaking up which might be necessary in order to meet such size requirements shall be done before the material is placed on the road.
- D. Quality:
 1. The limerock material shall be uniform in quality and shall not contain cherty or other extremely hard pieces or lumps, balls or pockets of sand or clay size material in sufficient quantity as to be detrimental to prevent proper bonding, finishing or strength of limerock base. Limerock material shall be non-plastic, and the liquid amount shall not exceed 35.
 2. Compacted limerock material shall have an average LBR value of not less than 100.

SECTION 02332

LIMEROCK BASE

Part 3 - EXECUTION

3.01 PREPARATION

- A. For new limerock base construction, or areas where pavement is to be replaced, CONTRACTOR shall remove existing subgrade as required to provide the minimum thickness of new limerock base course as indicated on plans.
- B. Compact subgrade to a density of no less than 98% of maximum density as determined by AHSHTO T-180.
- C. No separate bid item is provided in the proposal for evacuating, grading and compacting subgrade. The cost thereof shall be included in the BID schedule items.

3.02 PERFORMANCE

- A. Transporting Limerock: The limerock shall be transported to the point where it is to be used, over rock previously placed if practicable, and dumped on the end of the preceding spread. No hauling over the subgrade or dumping on the subgrade shall be done.
- B. Spreading Limerock:
 - 1. The limerock shall be spread uniformly, and all segregated areas of fine or coarse rock shall be removed and replaced with well-graded rock.
 - 2. When the specified compacted thickness of the base is greater than 6-inches, the base shall be constructed in two courses. The thickness of the first course shall be approximately one-half the total thickness of the finished base, or enough additional to bear the weight of the construction equipment without disturbing the subgrade.
- C. Establish grades and cross-sections conforming to plans
 - 1. Provide a minimum of 12" inches of limerock as required to provide grades, elevations and cross sections or as indicated on plans.
- D. Compacting and Finishing Base:
 - 1. Work shall comply with Sections 200 of the FDOT Standard Specifications for Road and Bridge Construction.

SECTION 02332

LIMEROCK BASE

2. Proposed limerock base shall be compacted to a minimum of ninety-eight percent (98%) of maximum density as determined by ASHTO T-180. Properly compact areas adjacent to curbs, catch basins, manholes and other areas not accessible to rollers with mechanical or hand tamping devices. Limerock base shall be constructed in lifts not to exceed six (6) inches.
3. Correction of Defects:
 - (a) If at any time the subgrade material should become mixed with the base course material, the CONTRACTOR shall dig out and remove the mixture, which shall be shaped and compacted as specified above.
 - (b) If cracks or checks appear in the base, either before or after priming, which in the opinion of the ENGINEER would impair the structural efficiency of the base course or checks by rescarifying, reshaping, adding base material where necessary and recompacting.
4. All tests shall be paid by the CONTRACTOR and included as incidental cost to the appropriate pay item.

- END OF SECTION -

SECTION 02507

PRIME AND TACK COATS

Part 1 - GENERAL

1.01 WORK INCLUDED

- A. The work specified in this section consists of an application of bituminous material on previously prepared base in accordance with these specifications and in conformity with the line, grades, dimensions and notes shown on the Drawings.
- B. Tack coat will be required prior to overlaying existing pavement.

1.02 RELATED WORK

- A. Section 02332 – Limerock Base
- B. Section 02510 - Asphaltic Concrete Pavement

Part 2 - PRODUCTS

2.01 MATERIALS

- A. Prime Coat: Unless otherwise indicated, the material used for the prime coat shall be cut back asphalt, Grade RC-70 or RC-250 and shall conform with the requirements specified in AASHTO Designated M 81-75 (1982). Unless otherwise indicated, the use of either RC-70 or RC-250 shall be at the CONTRACTOR'S option.
- B. Tack Coat: The material used for the tack coat shall be emulsified asphalt, Grade RS-2 and shall conform with the requirements specified in AASHTO Designation M 140-82.

2.02 EQUIPMENT

- A. The pressure distributor used for placing the tack or prime coat shall be equipped with pneumatic tires having sufficient width of rubber in contact with the road surface to avoid breaking the bond of or forming a rut in the surface. The distance between the centers of openings of the outside nozzles of the spray bar shall be equal to width of the application required, within an allowable variation of 2-inches. The outside nozzle at each end of the spray bar shall have an area of opening of not less than 25 percent, nor more than 75 percent in excess of other nozzles which shall have uniform openings.

SECTION 02507

PRIME AND TACK COATS

When the application covers less than the full width, the normal opening of the end nozzle at the junction line may remain the same as those of the interior nozzle.

Part 3 - EXECUTION

3.01 PREPARATION

- A. Before applying any bituminous material, all loose material, dust, dirt, and foreign material, which might prevent proper bond with the existing surface, shall be removed. Particular care shall be taken to clean the outer edges of the strip to be treated in order to insure that the prime or tack coat will adhere.
- B. When the prime or tack coat is applied adjacent to curb and gutter, or another concrete surface (except where they are to be covered with a bituminous wearing coarse) such concrete surfaces shall be protected by heavy paper or other protective material while the primer or tack coat is being applied. Any bituminous material deposited on such concrete surfaces shall be removed immediately.

3.02 WEATHER LIMITATIONS

- A. No bituminous material shall be applied when the air temperature is less than 50 degrees Fahrenheit in the shade, or when the weather conditions or the condition of the existing surface is unsuitable. In no case shall bituminous material be applied while rain is falling or when there is water on the surface to be covered.

3.03 APPLICATION OF PRIME COAT

- A. After the base has been finished the full width of surface shall be swept with a power broom supplemented with hand brooms and mechanical blowers prior to the application of prime coat. Care shall be taken to remove all loose dust, dirt and objectionable matter. If deemed necessary, the base shall be lightly sprinkled with water immediately in advance of the prime coat. The prime coat shall be applied to the full width of the base.
- B. The temperature of the prime material shall be such as to insure uniform distribution. The material shall be applied with a pressure distributor as specified above. The amount to be applied shall be sufficient to coat the surface thoroughly and uniformly without any excess to form pools or to flow off the base. For limerock base, the rate of application shall not be less than

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PRIME AND TACK COATS

0.10 gallons per square yard; for shell base, the rate of application shall not be less than 0.15 gallons per square yard.

- C. If the roadway is to be opened for use following the application of the prime material, a light uniform application of clean sand shall be applied and rolled. The sand shall be nonplastic, shall be free from slit and rock particles and shall not contain any sticks, vegetation, grass roots, or organic matter. After the sand covering has been applied, the surface may be opened to traffic.

3.04 APPLICATION OF TACK COAT

- A. In general, a tack coat will not be used on primed bases except in areas which have become excessively dirty and cannot be cleaned or where the prime has cured and lost all of its bonding effect.
- B. No tack coat shall be applied until the primed base or leveling course has been cleaned and is free from sand, dust or other objectionable material.
- C. The tack coat shall be applied with a pressure distributor as specified above. It shall be heated to a suitable consistency and applied in a thin uniform layer at the rate of between .02 gallons and .08 gallons per square yard.
- D. The tack coat shall be applied sufficiently in advance of the laying of the wearing surface to permit drying, but shall not be applied so far in advance or over such an area as to lose its adhesiveness as a result of being covered with dust or other foreign material. Suitable precautions shall be taken by the CONTRACTOR to protect the surface while the tack coat is drying and until the wearing surface is applied.

- END OF SECTION -

SECTION 02510

ASPHALTIC CONCRETE PAVEMENT

Part 1 - GENERAL

1.01 WORK INCLUDED

- A. The work specified in this section consists of the construction of asphaltic concrete surface course composed of a mixture of aggregates, mineral filler and asphalt cement properly laid upon a prepared base or a newly constructed and compacted, primed and tacked roadway base course, in accordance with these specifications and in conformity with the lines, grades, thickness and typical cross section shown on the Drawings. The CONTRACTOR shall furnish asphaltic concrete surface course in the locations and to the extent indicated on the Drawings.

- B. For new asphalt roadway pavement construction or reconstruction, provide asphaltic concrete structural surface course consisting of one of "Superpave Asphalt Concrete" per Section 334 of FDOT Standard Specifications for Road and Bridge Construction. Thickness of the asphalt course shall be as specified on the Drawings.

1.02 SUBMITTALS

- A. The CONTRACTOR shall submit for job mix formula to the ENGINEER for review in accordance with Section 01300 "Submittals".

1.03 QUALITY ASSURANCE

- A. Construction of asphaltic concrete surface courses shall be in accordance with FDOT Standard Specifications for Road and Bridge Construction (current edition), and supplements thereto, hereinafter referred to as FDOT Specifications, except as amended herein. The FDOT Specifications are hereby made a part of this contract to the extent they are applicable thereto and shall be as binding upon the CONTRACTOR as though reproduced herein.

1.04 RELATED SECTIONS

- A. Section 02332 - Limerock Base.
- B. Section 02507 - Prime and Tack Coats.

Part 2 - PRODUCTS

2.01 MATERIALS

Three Island Reuse Irrigation Project
City of Hallandale Beach

Asphaltic Concrete Pavement

SECTION 02510

ASPHALTIC CONCRETE PAVEMENT

- A. Bituminous Material: Asphalt cement, Viscosity Gard AC-20 or AC-30, shall conform to the requirements of FDOT Specifications, Section 916-1.
- B. Coarse Material: Coarse aggregate, stone or slag shall conform to the requirements of FDOT Specifications, Section 901.
- C. Fine Aggregate Material: Fine aggregate shall conform to the requirements of FDOT Specifications Section 902.
- D. Mineral Filler: Mineral filler shall conform to the requirements of FDOT Specifications, Sections 917-1 and 917-2.

2.02 GENERAL COMPOSITIONS OF MIXTURE:

- A. The bituminous mixture shall be composed of a combination of aggregate (coarse, fine, or mixture thereof), mineral filler, if required, and bituminous material. The several aggregate fractions shall be sized, uniformly graded and combined in such proportion that the resulting mixture will meet the grading and physical properties of the approved job mix formula.
- B. In all cases, the job mix formula shall be within the design ranges specified in the following table.

Gradation Design Range

<u>Sieve Size</u>	<u>% by Weight Passing</u> <u>Type S-III</u>
¾-inch	
½-inch	100
3/8-inch	88-100
No. 4	60-90
No. 10	40-70
No. 40	20-45
No. 80	10-30
No. 200	2-6

2.03 JOB MIX FORMULA

- A. No work shall be started on the specific project until the ENGINEER has approved the job mix formula.
- B. The job mix formula shall conform to the requirements of FDOT Specifications, Section 334. In addition, the job mix formula shall include test data showing that the material as produced meets the requirements of the following table:

SECTION 02510

ASPHALTIC CONCRETE PAVEMENT

<u>Mix Type</u>	<u>Minimum Marshall Stability (%)</u>	<u>Flow (0.01 in)</u>	<u>Minimum VMA (%)</u>	<u>Air Voids (%)</u>	<u>Min Effective Asphalt Content (%)</u>
SP-9.5	1,500	8 – 14	15	3 – 7	5.5

Part 3 - EXECUTION

3.01 TRANSPORTATION

A. The mixture shall be transported in tight vehicles previously cleaned of all foreign material and, if necessary, each load shall be covered with a waterproof canvas cover of sufficient dimensions to protect it from weather conditions. The inside surface of the truck bodies may be thinly coated with soapy water, or a mixture of water with not more than five percent of lubricating oil, but no excess of either shall be used. After the truck bodies are coated and before any mixture is placed therein, they shall be raised so that all excess water will drain out. Kerosene, gasoline or similar products shall not be used to prevent adhesion.

3.02 LIMITATION FOR SPREADING

A. The mixture shall be spread only when the surface is properly prepared and is intact, firm, cured and dry. No mixture shall be spread when the air temperature is less than 40 degree Fahrenheit, nor when the spreading cannot be finished and compacted during the daylight hours. The temperature of the mix at the time of spreading shall not be less than 230 degree Fahrenheit.

3.03 PLACING

A. The mixture shall be placed in accordance with the requirements of FDOT Specifications, Section 330-9. The new asphalt pavement shall be placed in two lifts. The second lift shall match the elevation of the adjacent pavement.

3.04 COMPACTING

A. The mixture shall be compacted in accordance with the requirements of FDOT Specifications 330-10.

SECTION 02510

ASPHALTIC CONCRETE PAVEMENT

JOINTS

- B. Joints shall conform with the requirements of FDOT Specifications, Section 330-11.

3.05 FIELD QUALITY CONTROL

- A. Surface Requirements: Following a rain event, standing water shall not exceed $\frac{1}{4}$ " in depth. Depressions which may develop after initial rolling shall be remedied by loosening or removing the mixture and adding new material to bring the areas to a true surface. No skin patching shall be done. Such portions of the completed pavement which are defective in surface compaction or in composition, or that do not comply with all other requirements of these specifications, shall be taken up and replaced with suitable mixture, properly laid in accordance with these specifications and at the expense of the CONTRACTOR.
- B. Thickness Requirements: The thickness of the compacted asphaltic concrete surface course shall be no less than that shown on the Drawings as determined by coring. Thickness testing and correction of defective work shall be as specified in FDOT Specifications, Section 330-14 and 330-15.
- C. "As-Built" limerock elevations shall be signed and sealed by a registered land surveyor and submitted to the Project Engineer for approval prior to placement of asphalt. Elevation shall be taken at high and low points, midpoint, intersections and breaks in grade at intervals not to exceed 50 feet. No separate pay item is included in bid form for this work. Include limerock as-built cost in asphalt section.
- D. Protection of Pavement: After the completion of the pavement, no vehicular traffic of any kind shall be permitted on the pavement until it has set sufficiently to prevent rutting or other distortion.

- END OF SECTION -

SECTION 02526

CONCRETE PAVEMENT, CURB AND WALKWAY

Part 1 - GENERAL

1.01 THE REQUIREMENT

- A. Concrete pavement, curbs and sidewalk shall be constructed to the lines and grades and dimensions required for a complete installation as shown on the Drawings and specified herein.

1.02 SUBMITTALS

- A. The CONTRACTOR shall submit to the ENGINEER shop drawings for reinforcing, joint material and mix designs for review in accordance with Section 01300 "Submittals".

Part 2 - PRODUCTS

2.01 CONCRETE

- A. Concrete shall be Class B, conforming to Section 03300 – Cast-in-place Concrete, Reinforcing and Formwork", unless noted or specified otherwise.

2.02 REINFORCING AND WELDED WIRE FABRIC

- A. Joint reinforcing and welded wire fabric shall conform to Section 03300 – Cast-in-place Concrete, Reinforcing and Formwork"

2.03 PREFORMED JOINT FILLER

- A. Preformed joint filler shall be sponge rubber and conform to the requirements of AASHTO Designated M148, Type 1.

Part 3 - EXECUTION

3.01 SUBGRADE CONDITION

- A. The finished subgrade shall be maintained in a smooth, compact condition and any areas which are disturbed prior to placing of the concrete shall be restored at the CONTRACTOR'S expense. The subgrade shall be moist at the time the concrete is placed. Water shall be uniformly applied ahead of the paving operations as directed by the ENGINEER. If the CONTRACTOR does not maintain the subgrade in the required moist condition, a vapor barrier sheet will be required between the subgrade and the concrete.

SECTION 02526

CONCRETE PAVEMENT, CURB AND WALKWAY

- B. The subgrade shall be accurately trimmed to the required elevation with a 1/4-inch tolerance. High areas shall be trimmed to proper elevation. Low areas may be filled with suitable material and compacted to the specified density or filled with concrete integrally with the placing of the pavement.

3.02 SETTING FORMS

- A. The forms shall be accurately set to line and grade and such that they rest firmly, throughout their entire length, upon the compacted subgrade surface. Forms shall be joined neatly and tightly and braces to test the pressure of the concrete and the finishing operations. The alignment and grade of all forms shall be approved before and immediately prior to the placing of concrete.

3.03 MIXING CONCRETE

- A. Concrete shall be mixed in accordance with Section 03300, "Cast-in-place Concrete, Reinforcing and Formwork".

3.04 PLACING CONCRETE

- A. The concrete shall be distributed on the subgrade to such depth, that, when it is consolidated and finished, the slab thickness required by the Drawings will be obtained at all points and the surface will at no point be below the grade specified for the finished surface, after application of the allowable tolerance. The concrete shall be deposited on the subgrade in a manner which will require as little re-handling as possible.
- B. Fabric reinforcement when shown on plans shall be placed at mid slab depth, and the fabric shall be maintained at this location during the placing and finishing operations.
- C. Concrete shall be thoroughly consolidated against and along the faces of all forms, by means of hand-operated, spud-type vibrators. Vibrators shall not be permitted to come in contact with the subgrade or a side form. Vibration at any one location shall not continue so long as to produce puddling or the accumulation of excessive grout on the surface. In no case shall the vibrator be operated longer than 15 seconds in any one location.

3.05 STRIKING-OFF, CONSOLIDATING AND FINISHING CONCRETE

- A. Immediately after the placing, the concrete shall be struck off, consolidated and finished, to produce a finished pavement conforming to the cross section, width and surface. Sequence of operations shall be as follows: strike-off;

SECTION 02526

CONCRETE PAVEMENT, CURB AND WALKWAY

vibratory consolidation; screeding; floating; removal of laitance; straightedging; and final surface finish.

3.06 STRAIGHTEDGING AND SURFACE CORRECTIONS

- A. After floating has been completed and the excess water removed, but while the concrete is still in a plastic state, the surface of the concrete shall be tested for trueness with an accurate 10 foot straightedge. The straightedge shall be furnished by the CONTRACTOR. The straightedge shall be held in successive positions parallel to the road center line, in contact with the surface, and the whole area tested from one side of the slab to the other as necessary. any depressions shall be immediately filled with freshly mixed concrete and struck-off; consolidated and refinished. High areas shall be cut down and refinished. Straightedge testing and surface correction shall continue until the entire surface appears to conform to the required grade and cross section.

3.07 FINAL FINISH

- A. As soon as the water sheen has disappeared from the surface of the pavement and just before the concrete becomes nonplastic, a light broom finish shall be given to the surface.

3.08 EDGING

- A. After the final finish has been applied, but before the concrete has become nonplastic, the edges of the pavement along each side of the strip being placed, on each side of construction joints and along any structure extending into the pavement, shall be carefully rounded to a 1/4 inch radius except as otherwise indicated. A well-defined and continuous radius shall be produced and a smoother, dense mortar finish obtained. All concrete shall be completely removed from the top of the joint filler.
- B. All joints shall be checked with a straightedge before the concrete has become nonplastic and, if one side of the joint is higher than the other or the entire joint is higher or lower than the adjacent slabs, corrections shall be made as necessary.

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CONCRETE PAVEMENT, CURB AND WALKWAY

3.09 JOINTS

A. Construction Joints

1. Construction joints shall be located as shown on the Drawings and/or as directed by the ENGINEER.

B. Expansion Joints Around Structures

1. Expansion joints shall be formed by placing premolded expansion joint material about all structures and features projecting through, into or against the pavement. Unless otherwise indicated, such joints shall be 1/2 inch in width.

C. Transverse Expansion Joints

1. Open type transverse expansion joints shall be provided at all sidewalk returns and at 50 feet intervals and wherever indicated on the Drawings. Open type joints shall be formed by staking a 1/4 inch thick metal bulkhead in place and placing concrete on both sides. After the concrete has set sufficiently to preserve the width and shape of the joint, the bulkhead shall be removed. After the sidewalk has been finished over the joint, the slot shall be opened and edged with a tool having a 1/2 inch radius. Transverse expansion joints shall be cleaned and filled with joint filler strips 1/4 inch thick conforming to the requirements of AASHTO M-153.

D. Scored Joints

1. Scored joints shall be either formed or sawed at 5 foot intervals and shall extend to a depth of at least one fourth of the sidewalk slab thickness.

3.10 CURING

- A. After the finishing operations have been completed and as soon as the concrete has hardened sufficiently that marring of the surface will not occur, the entire surface and the edges of the newly placed concrete shall be covered and cured with membrane curing compound.
- B. Curing compound shall be uniformly applied to the surfaces to be cured, in a single coat, continuous film, at the rate of one gallon to not more than 200 square feet, by a mechanical sprayer.

SECTION 02526

CONCRETE PAVEMENT, CURB AND WALKWAY

- C. Curing compound shall not be applied during periods of rainfall. Curing compound shall not be applied to the inside faces of joints to be sealed. Should the film become damaged from any cause within the required curing period, the damaged portions shall be repaired immediately with additional compound. Upon removal of side forms, the sides of the slabs exposed shall immediately be coated to provide a curing treatment equal to that provided for the surface.

3.11 CURB AND SIDEWALK CONSTRUCTION

- A. The concrete curbs and sidewalks shall be constructed on a prepared smooth subgrade of uniform density. Large boulders and other obstructions shall be removed to a minimum depth of 6 inches below the finished subgrade elevation and the space shall be backfilled with sand, base course material or other suitable material which shall be thoroughly compacted by rolling or tamping. The CONTRACTOR shall furnish a template and shall thoroughly check the subgrade prior to depositing concrete.
- B. Concrete for curbs and sidewalks shall be formed, mixed, placed and finished in conformance with the requirements of Division 3, except as modified herein. Concrete shall be cured with a clear membrane curing compound which shall be applied at a uniform rate of one gallon per 200 square feet in accordance with the requirements specified herein. Sidewalks shall be given a light broom finish.

3.12 CURBS

- A. Curbs shall be constructed in uniform sections ten feet in length except where shorter sections are necessary for closures or arcs. The sections shall be separated by sheet metal templates set perpendicular to the face and tip of the curb and not less than 2 inches longer than the depth of the curb. The templates shall be held firmly during the placing of the concrete and shall be allowed to remain in place until the concrete has set sufficiently to hold its shape, but shall be removed while the forms are still in place.
- B. After the concrete has sufficiently set for a minimum of 12 hours, the CONTRACTOR shall remove the forms and backfill the spaces on each side. The earth shall be compacted in satisfactory manner without damage to the concrete Work. Minor defects shall be filled with a mortar composed of one part Portland cement and two parts fine aggregate.

SECTION 02526

CONCRETE PAVEMENT, CURB AND WALKWAY

3.13 PAVEMENT CURB AND SIDEWALK REPAIR

- A. All damage to pavement, curb or sidewalk as a result of work under this Contract shall be repaired in a manner satisfactory to the ENGINEER and at no additional cost to the CITY. The repair shall include all work as specified herein.
- B. The width of all repairs shall extend at least 12 inches beyond the limit of the damage. The edge of the pavement curb or sidewalk to be left in place shall be cut to a true edge with a saw or other approved method so as to provide a clean edge to abut the repair. The line of the repair shall be reasonably uniform with no unnecessary irregularities.

- END OF SECTION -

SECTION 02580
PAVEMENT MARKING

Part 1 - GENERAL

1.01 REQUIREMENT

- A. This section consists of striping pavement as indicated on the Drawings, specified herein and as required for a complete installation.

1.02 SUBMITTALS

- A. The CONTRACTOR shall submit shop drawings and other information to the ENGINEER for review in accordance with Section 01300 "Submittals".

1.03 QUALITY CONTROL

- A. The phrase "FDOT Specifications" shall refer to the Florida Department of Transportation Standard Specifications for Road and Bridge Construction. The FDOT Specifications, are referred to herein and are hereby made a part of this Contract to the extent of such references, and shall be as binding upon the Contract as though reproduced herein in their entirety.
- B. "BCTED" shall refer to Broward County Traffic Engineering Division.

Part 2 - PRODUCTS

2.01 PAVEMENT MARKING

- A. Temporary pavement markings shall be installed with-in three calendar days of installing new asphalt roadway surfaces requiring pavement markings.
- B. In areas of new pavement that requires pavement markings, once the asphalt has cured 30-day, the permanent thermoplastic markings shall be installed.

Part 3 - EXECUTION

3.01 PAVEMENT MARKING

- A. The surface which is to be painted shall be cleaned, by compressed air or other effective means, immediately before the start of painting, and shall be clean and dry when the paint is applied. Any vegetation or soil shall be removed from the pavement before edge striping is begun.

SECTION 02580

PAVEMENT MARKING

- B. The traffic stripe shall be of the specified width, with clean, true edges and without sharp breaks in the alignment. A uniform coating of paint shall be obtained and the finished stripe shall contain no light spots or paint skips. Any stripes which do not have a uniform, satisfactory appearance, both day and night, shall be corrected.
- C. All newly painted stripes, including edge stripes, shall be protected until the paint is sufficiently dry to permit vehicles to cross the stripe without damage from the tires. While the center line stripes are being painted, all traffic shall be rouged away from the painting operations and the newly painted stripe. When necessary, a pilot car shall be used to protect the painting operations from traffic interference.
- D. Any portions of the stripes damaged by passing traffic or from other cause shall be repainted at the CONTRACTOR's expense.
 - 1. Thermoplastic Traffic Stripes and Markings: Thermoplastic pavement markings, including stripes, pavement messages, stop bars, directional arrows, reflective pavement markers and other miscellaneous items, will be replaced to match preconstruction conditions.. The thermoplastic compound shall be as specified in Section 711 of the FDOT Specifications. The thermoplastic compound shall be extruded or sprayed onto the pavement surface in a molten state by mechanical means, with surface application of glass spheres, when required, and upon cooling to ambient pavement temperature shall produce an adherent pavement marking of specified thickness and width and capable of resisting deformation.
- E. The portion of the pavement surface or thermoplastic marking to which the marker is attached by the adhesive shall be cleaned of dirt, curing compound, grease, oil, moisture, loose or unsound pavement and any other material which would adversely affect the adhesive. Reflective markers shall be installed in such a manner that the reflective face of the marker is perpendicular to a line parallel to the roadway centerline. No markers shall be installed over longitudinal or transverse joints of the pavement surface. The adhesive shall be spread on the bonding surface (not the marker) so that 100 percent of the bonding area of the marker will be covered.

SECTION 02580

PAVEMENT MARKING

The adhesive application shall be of sufficient thickness so that when the marker is pressed into the adhesive, excess adhesive shall be forced out around the entire perimeter of the marker. All excessive adhesive shall be removed from in front of the reflective faces, If any adhesive or foreign matter adheres to the reflective face of the marker, the marker shall be replaced. The ENGINEER shall determine the minimum time necessary to cure the adhesive for sufficient set to bear traffic.

- END OF SECTION -

SECTION 02581

TRAFFIC SIGNS

Part 1 - GENERAL

1.01 REQUIREMENT

- A. This section consists of traffic signs as indicated on the Drawings, specified herein and as required for a complete installation.

1.02 SUBMITTALS

- A. The CONTRACTOR shall submit shop drawings and other information to the ENGINEER for review in accordance with Section 01300, "Submittals".

1.03 CERTIFICATION

The CONTRACTOR shall furnish the manufacturer's certification that all signs furnished conform to these specifications and shall replace or repair at its expense all signs that fail to meet this requirement.

1.04 QUALITY CONTROL

- A. The phrase "FDOT Specifications" shall refer to the Florida Department of Transportation Standard Specifications for Road and Bridge Construction. The FDOT Specifications, are referred to herein and are hereby made a part of this Contract to the extent of such references, and shall be as binding upon the Contract as though reproduced herein in their entirety.
- B. "BCTED" shall refer to Broward County Traffic Engineering Division.

Part 2 - PRODUCTS

2.01 TRAFFIC SIGNS

- A. General: Traffic regulating signs shall conform to the colors, dimensions and requirements of the Manual on Uniform Traffic Control Devices (ANSI) and displaying the lettering and symbols indicated on the Drawings.
- B. Sign Panels and Support Members: Sign panels and support members shall conform to Aluminum Association Alloy 6061-T6.
- C. Bolts: Bolts shall conform to Aluminum Association Alloy 2024-T4 with an anodic coating 0.0002-inches thick minimum and chromate sealed.

SECTION 02581

TRAFFIC SIGNS

- D. Nuts: Nuts shall conform to Aluminum Association Alloy 6269-T9.
- E. Reflective Sheeting: Reflective sheeting shall conform to DOT Type A requirements.
- F. Construction Warning Signs: The CONTRACTOR shall install traffic and warning signs during construction in accordance with OSHA, DOT and Broward County Public Works requirements.

- END OF SECTION -

SECTION 02930

SODDING

Part 1 - GENERAL

1.01 SCOPE

- A. Provide all labor, materials and equipment necessary for complete sodding of areas affected by construction. This shall include, but not be limited to: liming, fertilizing, sodding, necessary barriers, tests and all incidentals to make the work complete.

1.02 WORK INCLUDED

- A. Testing of topsoil.
- B. Raking and leveling topsoil as required for sodding.
- C. Liming and fertilizing of topsoil.
- D. Laying and rolling of sod.
- E. Maintaining

1.03 SUBMITTALS

1. Submit product source and information sheets.

Part 2 - PRODUCTS

2.01 MATERIALS

A. Fertilizer

1. Fertilizer shall be commercial fertilizer, as manufactured by International Chemical Company or equal.
2. Said fertilizer shall have a 10-20-6 N.P.K. content and contain a minimum of 60% of organic material.
3. It shall be delivered at the site in the original sealed containers.

B. Sod

1. Sod from right-of-way swales within the work area shall be Saint Augustine.
2. Sod shall be first quality Saint Augustine sod of firm texture having a compacted growth and good root development.
3. Sod shall be absolutely true to varietal type, live, fresh and free from weeds or objectionable vegetation, fungus, insects and disease of any

SECTION 02930

SODDING

kind. Sod shall be kept moist from the time it is field cut until it is laid at the proposed site.

4. The sod shall be as grown by a certified turf nursery and CONTRACTOR shall inform ENGINEER as to the source of the sod to be utilized prior to ordering and delivery of sod.
5. Sod shall be furnished and installed in rectangular sod strips measuring 12 to 16-inches in width of standard lengths of not less than 2 feet and delivered on pallets.

C. Topsoil

1. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 4 percent organic material content; free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth.
2. Topsoil Source: Reuse surface soil stockpiled on-site. Verify suitability of stockpiled surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
 - (a) Supplement with imported or manufactured topsoil from off-site sources when quantities are insufficient. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes.
3. Topsoil Source: Import topsoil or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes.
4. Topsoil Source: Amend existing in-place surface soil to produce topsoil. Verify suitability of surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
 - (a) Surface soil may be supplemented with imported or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches; do not obtain from bogs or marshes.

SECTION 02930

SODDING

Part 4 - Execution

4.01 INSTALLATION

- A. These areas shall be fine graded to achieve the finished subgrade after compaction which shall be obtained by rolling, dragging or by an approved method which obtains an equivalent compaction to that produced by a hand roller weighing from 75 to 100 pounds per foot of width. All depressions caused by settlement or rolling shall be filled with additional existing or furnished topsoil and regraded and prepared as specified above until it presents a reasonably smooth and even finish at the required sod sub-grade.
- B. All sod furnished shall be living sod containing at least 70% of thickly matter grasses as specified and free from noxious weeds. All sod shall be certified free of fire ants.
- C. No broken pads or torn or uneven ends will be accepted. Standard size sections of sod shall be strong enough to support own weight and retain their size and shape when suspended vertically with a firm grasp on the upper 10% of the section. Sod shall not be harvested when its moisture content (excessively wet or dry) may adversely affect its survival.
- D. Sod shall be harvested, delivered, and installed within a period of 24 hours. Sod not installed within this time period shall be subject to inspection and rejection by ENGINEER, and shall be removed from the site and a fresh sod supply shall be furnished at no extra cost to CITY.
- E. Place 4-inch of topsoil. The topsoil shall not be moist at time of installation; however, it shall contain sufficient moisture so as not be powdery or dusty, both as determined by the supplier's representative.
- F. The overlapping of existing lawn with new sod along limit of work lines will not be permitted. Sod shall be laid in strips, edge to edge, with the lateral joints staggered. All minor or unavoidable openings in the sod shall be closed with sod plugs or with topsoil, as directed by ENGINEER. However, sod laid with joints determined to be too large shall be lifted and re-laid as specified herein at no extra cost to CITY.
- G. Immediately after the sod is laid, the sod shall be watered thoroughly by hand or mechanical sprinkling until the sod and at least 2-inch of the top soil bed have been thoroughly moistened.
- H. CONTRACTOR shall be responsible to furnish his own supply of water to the site at no extra cost. CONTRACTOR shall apply for temporary meter and pay CITY for water used at current utility billing rates. However, if CITY water supply is not available or not functioning, CONTRACTOR shall be responsible to furnish adequate supplies at his own cost. All work injured or damaged due

SECTION 02930

SODDING

to the lack of, or the use of too much water, shall be CONTRACTOR's responsibility to correct.

4.02 MAINTENANCE

- A. Maintain the entire sodded areas at least a 30-day period or until final acceptance at the completion of the Contract, whichever is longer. Maintenance shall include watering as specified, weeding and removal of stones which may appear. All bare or dead spots which become apparent shall be properly prepared, limed and fertilized, and resodded at CONTRACTOR's expense as many times as necessary to secure a good growth. In the event that the sod installation is not accepted by ENGINEER, the entire area shall be maintained and cut by CONTRACTOR until final acceptance of the sod installation.
- B. Take whatever measures are necessary to protect the sod while it is developing. These measures shall include furnishing of warning signs, barriers, or any other necessary measures of protection.

- END OF SECTION -

SECTION 03300

CAST-IN-PLACE CONCRETE, REINFORCING AND FORMWORK

Part 1 - GENERAL

1.01 DESCRIPTION

- A. Work included: Provide all labor, materials, equipment, fabrication, incidentals, transportation, placing and supervision necessary to complete all cast-in-place concrete work, its finishing, and all related work called for by the Contract Drawings and/or Specifications, or reasonably inferable from either or both, as needed for a complete and proper installation.
- B. Related work: Work affecting this Section includes, but is not limited to:
 - 1. Shop Drawings
 - 2. Materials and storage thereof
 - 3. Reinforcing-Bar and fabric
 - 4. Accessories of every nature, including form tie system.
 - 5. Formwork and removal thereof, including shoring and reshoring
 - 6. Concrete proportions and mixes
 - 7. Placing of concrete
 - 8. Admixtures
 - 9. Joints, metal joint screeds and joint fillers
 - 10. Finishes of all types
 - 11. Protection and curing
 - 12. Patching
 - 13. Laboratory Testing

1.02 QUALITY ASSURANCE

- A. Unless otherwise indicated, all materials, workmanship and practices shall conform to the requirements of ACI 301-96 "Specifications for Structural Concrete for Buildings", except as modified by supplemental requirements hereinafter.

1.03 STANDARDS

- A. ACI 301-96 Specifications for Structural Concrete
- B. ACI 318-95 Building Code Requirements for Reinforced Concrete
- C. Florida Building Code, latest edition.
- D. ACI 117-90 Standard Specifications for Tolerances for Concrete Construction and Materials

SECTION 03300

CAST-IN-PLACE CONCRETE, REINFORCING AND FORMWORK

Part 2 - PRODUCTS

2.01 MATERIALS

A. Materials for Concrete:

1. Cement shall conform to the following: Portland Cement ASTM C150, normal, type I or type II. Provide domestic cement of one type and from same source for entire project.
2. Mineral Admixtures:
 - (a) Fly Ash: Shall conform to ASTM C 618, with 20% maximum of total cementitious weight.
 - (b) Ground Blast Furnace Slag: Shall conform to ASTM C 989-93. 30% maximum of total cementitious weight.
3. Chemical Admixtures: The following admixtures are permitted, but require written approval from the ENGINEER:
 - (a) Air Entraining Admixture: Comply with ASTM C260. "Specifications for Air-Entraining Admixtures for Concrete.
 - (b) Water Reducing Admixture: Comply with ASTM C494 "Specifications for Chemical Admixtures for Concrete", Type A, and compatible with air entraining admixture.
 - (c) Water Reducing and Retarding Admixture: Comply with ASTM C494, "Specifications for Chemical Admixtures for Concrete, Type D, and compatible with air entraining admixture.
 - (d) High Range Water Reducing Admixture: Comply with ASTM C494, "Specifications for Chemical Admixtures for Concrete", Type F or G, and compatible with air entraining admixture (Including superplasticizer to reduce water content.)
 - (e) Admixtures containing added calcium chloride are not permitted.
4. Aggregates: Shall conform to ASTM C 33 and shall be quarried/mined in fresh water. Aggregates from salt water or brackish water are not permitted. Coarse aggregate size shall not exceed:

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<u>Concrete member</u>	<u>Size</u>	
Walls	3/4"	67#
Beams or structural slabs not on ground	3/4"	67#
Columns and all other concrete	1"	57#
Drilling concrete pad or slabs on ground	1"	57#

5. In sanitary sewage applications, where called for in the plans and/or specifications an antimicrobial admixture as specified below shall be utilized:

- (a) An antimicrobial agent, Con^{mic}Shield[®], or approved equal, shall be used to render the concrete uninhabitable for bacteria growth.
- (b) CONTRACTOR shall mix the liquid antimicrobial additive with the total water content of the concrete mix design in a proportion of 1 gallon per cubic yard. In the case of repairs to damaged concrete a proportion of 2 gallons per cubic yard shall be utilized.
- (c) In some instances all of the concrete in the structure in will receive the additive and in other instances only a portion of the concrete will receive the additive. Hence, the CONTRACTOR shall apply the additive only as directed in the specific instance.
- (d) CONTRACTOR shall submit a letter of certification to the City, stating that the correct amount and correct mixing procedure was followed for all antimicrobial concrete.
- (e) Con^{mic}Shield[®] antimicrobial additive shall be as manufactured by Con^{mic}Shield[®] Technologies, Inc. 541 - 10th Street NW, #233, Atlanta, GA 30318. Phone: (877)543-2094.

- B. Portland cement and reinforcing steel: Comply with ACI 301-96 and, with all modifications and supplements thereto listed in Part 3 of this specification.
- C. Burlap mats: Conform to AASHTO Specification M182. (Burleen non-staining mats.)
- D. Epoxy bonding agent: A two (2) component, solvent free, moisture insensitive structural epoxy adhesive conforming to ASTM C881-90 Type II, Sikadur 32 Hi-Mod, as manufactured by Sika Corp., Coneresive 1090 Liquid by Master Builders or approved equal.
- E. Anchor bolts, nuts and washers: Conform to ASTM A449-89, hot-dip galvanized.
- F. Dovetail slots: Galvanized steel, 22 gauge, 1"x 1", with 5/8" throat, fiber filled.
- G. Forms:

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1. Plywood Forms: PS-1, B-B Concrete Form, Class I, exterior type, mill oiled and edge sealed. Thickness shall be as required to support concrete at the rate placed, but not less than 3/4".
2. Steel Forms: Uncoated steel, 3/16"-inch minimum thickness, fabricated to close tolerances, protected only by the specified release agent, braced so as not to dent, bend or dimple under wet concrete loads, vibrator impact and tool impact. Maintain steel forms in rust free condition by use of steel wool and light grinding, followed by coats of the specified release agent. Forms should be adjustable to be brought into true alignment without steps or ridges.

H. Form release agent:

1. For plywood forms use a natural non-petroleum base, non-staining and non-retarding release agent that will effectively prevent absorption of moisture and prevent bond with concrete, and leaves the concrete with a paintable surface.
2. For steel forms, use an approved material that will not stain, color or otherwise affect the finish of the concrete. Form coating shall not be detectable on finished surfaces.
3. Round column forms: Provide seamless fiber forms with the three plies nearest to the interior surface of the form deckled or scarfed and overlapped to minimize spiral gaps or seams on the column surface.

I. Form Ties: Steel rod type with integral waterstops and cones, and with ends or end fasteners that can be removed without spalling the concrete and which leave a hole equal in depth to the required reinforcement clearance, but not less than 2 inches from the formed face of the concrete. Wire tie, banding wire and wood spreaders will not be permitted.

J. Form Inserts:

1. Bevel or chamfer strips: Wood or non-staining plastic, 3/4" wide on each leg at exposed edges of concrete members, unless otherwise noted on plans.
2. Tongue and Groove Joint Forms: Minimum 24 gauge with steel stakes and splice plates. Forms shall be designed for joints not to receive a poured seal.
3. Pipe hangers and other utility supports: AISI Type 316 stainless steel.

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- K. Non-Shrink Grout: Non-shrink, non-metallic grout conforming to ASTM C 1107 Grade B or Grade C only. Grout must meet ASTM C 1107 at a temperature range of 50 F to 90 F at a flowable consistency.
- L. Grout for Surface Repair and Bond Coat:
1. For repair, one part Portland cement to two parts fine sand, and a 50% of water and 50% Acryl 60 or equal (Thoroseal or Acryl Set Bonding Agent by Master Builders) to produce a stiff mortar.
 2. For bond coat, one part Portland cement to one part sand, and a 50% of water and 50% Acryl 60 or equal (Thoroseal or Acryl Set Bonding Agent) to produce a slurry mix.
- M. Moisture Barrier: Kraft paper and glass reinforcing fibers sandwiched between 2 layers of polyethylene film with a permeance rating of maximum 0.1 as per ASTM E-96, Procedure A.
- N. Preformed Expansion Joint Filler: Non-extruding type, self-expanding cork, 3/4", 1", and 1½" cork (not to be used for sidewalks), conforming to plans or as otherwise noted on drawings, conforming to the requirements of ASTM D1752, Type II, and compatible with joint sealant compound.
- O. Joint Sealant Compound: Non-sag, 2 component, solvent free, moisture insensitive, flexible, epoxy resin conforming to the requirements ASTM C920-87 Type M, Grade NS. Additionally, the sealant must be recommended by the manufacturer to perform under continuous immersion in water.
- P. Polyurethane Elastomeric Sealant: Sikaflex-2c, NS/SL or approved equal. Provide a 2- component, premium-grade, polyurethane-based, elastomeric sealant. It is principally a chemical cure in a non-sag and self-leveling consistency. Sealant shall meet ASTM C-920 and Federal Specifications TT-S-00227E.
1. Joint Movement: +50%.
- Q. Waterstops:
1. Volclay Waterstop-RX or approved equal. Flexible strip of bentonite waterproofing compound in coiled form.
 - (a) Chemical Composition:
 - (1) Butyl Rubber-Hydrocarbon: 24.9% by weight; ASTM D-297.
 - (2) Bentonite: 75 % by weight; SS-S-210-A.
 - (3) Volatile Matter: Below 1 %; ASTM D-6.

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- (4) Waterstop shall not contain any asbestos fibers or asphaltics.
- (b) Physical Properties:
 - (1) Specific Gravity: 1.57; ASTM D-71.
 - (2) Application Temperature Range: 5-125 F.
 - (3) Flash Point: 365; ASTM D 93-97.
 - (4) Accelerated Aging: Maintained 99% solids.
 - (5) Dimensions: 1" x 3/4" x 16'-6"
2. Polyvinyl chloride (PVC): Conforming to the requirements of U.S. Army Corps of Engineers Specification CRD-C-572 and of the following type:
 - (a) Expansion Joints: 9-inches by 3/8-inch, ribbed center bulb.
 - (b) Construction Joint: 9-inches by 3/8-inch, flat ribbed.
 - (c) Only where specified on Plans at construction and expansion joints: 9-inches by 3/8-inch, split ribbed.
 - (d) Install waterstops as shown as manufactured structures.
- R. Fiber Reinforcement: Fiber reinforcement shall not be used in the concrete unless ordered by the ENGINEER in writing. It shall consist of 100% virgin polypropylene fibrillated fiber- dosage of 2 lbs. per cubic foot.
 1. Compressive Strength: 1 psi (.006895 M Pa), ASTM C-39.
 2. Flexural Strength: 288 psi (2.0 M Pa) after 7 days, 390 psi (2.7 M Pa) after 28 days; ASTM C-78.
 3. Splitting Tensile Strength: 194 psi (1.3 M Pa) after 7 days, and 290 psi (2.0 M Pa) after 28 days; ASTM C-496.
 4. Source: Fibermesh Micro-Reinforcement System by Fibermesh Company, Division of Synthetic Industries, Inc., or approved equal.
- S. Provide other materials, not specifically described but required for a complete and proper installation, as selected by the CONTRACTOR subject to the approval of the ENGINEER.
- T. A shrinkage reducing admixture (Teraguard) or equivalent at the rate of 2.2% by weight of cement may be used in the concrete to meet the shrinkage limitations.
- U. To protect the concrete slab against the elements, the ENGINEER may direct the CONTRACTOR to spray an evaporation retarder on the finished concrete

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slab immediately behind the cement finishing process at no additional cost to the City. This is not a curing compound.

Part 3 - EXECUTION

3.01 SURFACE CONDITIONS

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work.

3.02 SUPPLEMENTAL REQUIREMENTS

- A. All phases of concrete construction, including materials formwork, and all other related procedures shall comply with the most stringent allowed tolerances of ACI-301 and ACI-117 Standards (Latest Edition) - Noncompliance with these standards will cause full rejection of any work done.
- B. Comply with ACI 301-96 and with all modifications and supplements thereto listed herein. In addition to the ACI Standards on finished concrete, the ENGINEER will only approve quality finished concrete which in his opinion is ready to receive a grout finish, paint or liquid membrane.
- C. The following modifications and supplements to ACI 301-96 shall also apply to the work.

1. General

- (a) These specifications cover cast-in-place structural concrete for use in buildings and appurtenances, including foundations, curbs, sidewalks, concrete pavements and utility structures, water containment tanks, and piles.
- (b) Keep minimum two (2) copies of ACI 301-96 "Specifications for Structural Concrete" in field office at all times.

2. Proportioning and Design of Mixes:

- (a) General: Proportion concrete to meet properties as specified. Prepare mix designs for each type and strength of concrete. Submit with mix design the chemical admixture manufacturer's statement that the admixture proposed complies with the requirements of this specification. Where concrete of different strengths are specified for the same location, the higher strength concrete shall be used.

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Concrete proportions shall be established on the basis of previous field experience, or laboratory trial batches as specified in ACI 301-96 Sections 4.2.2 & 4.2.3.

(b) Classes of Concrete:

- (1) Structural concrete of normal weight for portions of the structure that are required to be watertight containments or tremie concrete, the water/cementitious ratio shall not exceed 0.45 if exposure is to be to fresh water.
- (2) If the concrete is exposed to salt or brackish water, or if exposed to injurious concentrations of sulfate-containing solutions (1500 ppm or more of Sulfate in water) or other chemically aggressive solutions, use Type II cement with Rheobuild 1000 admixture by Master Builders, or approved equal; water/cementitious ratio shall not exceed 0.34.
- (3) Other Concrete: (This would be slabs-on-grade, concrete thrust blocks, and miscellaneous concrete). The water cementitious ratio shall not exceed 0.50 to 0.55.
- (4) Minimum $f'c$ @ 28 days shall be 4000 KSI with a Water/Cement ratio of 0.45.
- (5) Minimum $f'c$ @ 28 days shall be 7000 KSI with a Water/Cement ratio of 0.34.

(c) Slumps:

- (1) All structural concrete, pumped concrete and tremie concrete shall contain a High Range Water Reducing Admixture and be designed with a maximum water content of 270 pounds per cubic yard. The initial water slump prior to addition of the High Range Water Reducing Admixture shall be 2-inch maximum. Concrete at point of placement shall not exceed 10-inches. Concrete shall be non-segregating.
- (2) Slabs including slabs-on-grade, and all other concrete shall have a maximum water content of 287 pounds per cubic yard and have a 5-inch maximum slump with a water reducer, or water reducer and retarder admixture added.

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3. Formwork

- (a) Earth cuts are not permitted for forms for vertical surfaces. Footings, grade beams and slab edges shall be formed. Provide moisture barrier under all slabs on grade. Lap 6-inches and tape punctures.
- (b) The CONTRACTOR is responsible for the adequacy of forms and shoring including placing, fill and equipment on roof, and for safe practice in their use and removal. Submit formwork calculations, and shop drawings including shoring and reshoring. In addition, the calculations and shop drawings for formwork, shoring, and reshoring, if required by the ENGINEER or Building Department, shall be signed and sealed by a Professional Engineer registered in the State of Florida.
- (c) Design forms for the loads and lateral pressures resulting from the placement and vibration of concrete and for design considerations, wind loads, allowable stresses, and other applicable requirements of the South Florida Building Code.
- (d) Provide form facing materials as required by the specified finish of the formed surface. Do not use facing material with raised grain, torn surfaces, worn edges, patches, dents or other defects. No form may be reused more than three times without the City's approval. The maximum deflection permitted of facing materials reflected in concrete surfaces exposed to view is 1/240 of the span between structural members.
 - (1) Forms shall be free from surface defects, tight to prevent leakage and braced to keep its position and shape when filled with concrete. Adjacent edges and end panels and sections shall be held together to provide accurate alignment and prevent forming ridges, fins, offsets or similar type defects in finished concrete. It shall be tight to prevent loss of water, cement or fines during placing and vibrating concrete. The bottom of the forms placed in continuous straight even footings or slabs shall be watertight to prevent loss of water, cement and fines during placement and vibration of concrete, a gasket may be required by the ENGINEER under the forms to provide water tightness at the CONTRACTOR expense. The CONTRACTOR shall not proceed to place forms for concrete work adjacent to or on top of previous placed concrete without the ENGINEER's approval, if the stripped forms reveals columns, walls or beams

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are out of level or plumb or there are cold joints or other objectionable work in the opinion of the ENGINEER. CONTRACTOR shall submit to the ENGINEER for approval, how he intends to correct or remove the defective work promptly at his expense. CONTRACTOR shall perform such corrections prior to proceeding to place concrete in the next Section.

- (e) Provide positive means of adjustment (wedges or jacks) of shores and struts, and all settlement shall be taken up during concrete placing operation. Brace forms securely against lateral deflection. Do not anchor form bracing to poured concrete floors, or make holes in floor.
- (f) Provide temporary openings in columns and wall forms to limit the free fall of concrete to five (5) feet. Place such openings at no more than eight (8) feet apart to facilitate placing and consolidation of concrete. Elephant trunks may be used to vertical heights of fifteen (15) feet for tremie and other purposes, if approved by the ENGINEER. Provide temporary openings at the bottom of wall and column forms and elsewhere as necessary to facilitate cleaning and observation immediately before concrete is placed. Blow formwork entirely clean of all saw dust, dirt, or other items not specifically intended to be a part of the final concrete. Any evidence of non-intended items in the forms is considered sufficient cause to stop concreting operation and/or require removal of concrete placed in such contaminated forms.
- (g) Provide inserts, conduits, boxes, sleeves, anchors, ties, bolts, hangers, dowels, thimbles, nailers, grounds and other devices in coordination with other trades.
- (h) Set anchor bolts and other embedded items accurately and hold securely until concrete is placed and set. Anchor bolts shall be galvanized and of size and length as indicated on the Contract Drawings. Bolts not sized shall be 3/4-inch diameter.
- (i) Insert galvanized dovetail anchor slot in forms, in columns, beams and slabs completely around in-fill masonry panels. Coordinate with Section 04220 Unit Masonry, Part 3 Execution, 3.01.J.2.c. for spacing of dovetails.
- (j) Install wall spools, wall flanges and wall anchors before placing concrete. Do not weld, tie or otherwise connect the wall spools to the reinforcing steel.

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- (k) Do not use pinch bars, wrecking bars or other metal tools against as-cast concrete to wedge forms loose; use only wooden wedges carefully and gradually. Driving shall be accomplished by light tapping.
- (l) The CONTRACTOR is responsible for the removal of forms and shores. Do not remove forms or shores before the member has attained sufficient strength to support its weight and the loads imposed, nor sooner than listed below
 - (1) Wall forms: 24 hours
 - (2) Column forms: 24 hours.
 - (3) Beam and girder side forms only (not bottom form): 24 hours.
 - (4) Beam and Girder bottom forms: 7 days minimum unless otherwise approved by the ENGINEER.
 - (5) Slab forms: 14 days.
 - (6) Arch centers: 7 days.
 - (7) Pan joist forms: 4 days.

4. Reinforcement

- (a) Prior to fabrication, submit for review shop drawings showing all fabrication dimensions, bar lists and location for placing of the reinforcing steel and accessories, including spacing of reinforcing, splices (lap, welded, Cadweld and/or mechanically threaded), grade of reinforcing and name of manufacturer. Note all deviations from the Contract Drawings and use the same designation mark as shown on the Contract Drawings where possible.
- (b) Reinforcing bars: ASTM A615, Grade 60, deformed bars of USA manufacturer.
- (c) Welded wire fabric: ASTM A185, galvanized.
- (d) Metal bar supports: CRSI MSP-1, Chapter 3, Class 2, Type B stainless steel protected bar supports.
- (e) Coupler Splice Devices: Cadweld, tension couplers capable of developing the ultimate strength of the bar.
- (f) Reinforcing steel upon which unauthorized welding has been done, shall be removed and replaced at no additional cost to the City.
- (g) Place reinforcing bars to the most stringent tolerances indicated in ACI 301 and ACI 117 (Latest Edition). Tolerances specified in those standards shall govern over any other reference code or standard.

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- (h) All reinforcement at time concrete is placed, shall be free of mud, oil or other materials that may affect or reduce the bond. Reinforcing with rust or mill scale will not be accepted without cleaning and/or brushing to remove scale and rust.
- (i) Support rebar and mesh reinforcing for slabs on grade 1½ inches from top of slab on masonry blocks not less than 4 sq. in., having a compressive strength equal to or greater than the specified strength of the concrete being placed. Space blocks at no more than 4 feet apart each way for rebars, and no more than 3 feet apart for mesh reinforcement.
- (j) Support reinforcing off from formwork for columns, walls and beams with stainless steel protected bar supports. Support slab reinforcing on #5 bars, or larger, spaced at no more than 48 inches on center. Space individual high chairs no more than 48 inches apart and support bars shall not exceed 24 inches past outermost chairs.
- (k) Overlap welded wire fabric in such a manner that the overlap measured between outermost cross wires of each fabric sheet is not less than the spacing of the cross wires plus 2 inches or 6 inches, whichever is greater. Do not extend fabric through expansion and/or contraction joints, unless otherwise noted on the Contract Drawings.
- (l) The minimum clear distance between parallel bars, both vertical and horizontally, shall not be less than the nominal diameter of the bars, or less than 1½ times the maximum size of the aggregate, or 1-inch in beams, or 1½ inches in columns, whichever is greater. Where reinforcement in beams is placed in two or more layers, the upper layer shall be placed directly above the bars in the bottom layer. Misplacement, misalignment or improper length of dowels shall be sufficient cause to require removal and reconstruction of affected work.
- (m) Unless allowed by the ENGINEER, bending of reinforcing partially embedded in concrete is not permitted. When permitted, bending shall be in accordance with CRSI Manual of Standard Practice.

5. Joints and Embedded Items.

- (a) Provide premolded expansion joint filler strips of proper width and length as specified in the Contract Drawings. Place ½" expansion joint fillers every 20 feet in straight runs of walkways or sidewalks, at right angle turns and wherever concrete butts into vertical surfaces, unless otherwise noted on the Contract Drawings.

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- (b) Provide waterstops in all construction joints, unless otherwise indicated on the Contract Drawings.
 - (c) Join all waterstops at all intersections so that a continuous seal is provided. Center the waterstop in the joint. Hold water stop positively in correct position. In the event of damage to the waterstop, repair the water stop in an acceptable manner. Vibrate concrete to obtain impervious concrete in the vicinity of all joints.
 - (d) Install waterstop in accordance with instructions of the manufacturer. Prior to use of the waterstop material in the field, submit to the ENGINEER for approval a sample of each size and shape to be used. Fabricate sample so that the material and workmanship represent in all respects the fittings to be furnished under this Specification.
 - (e) Place all sleeves, inserts, anchors, and other embedded items prior to placing concrete. Anchors and bolts cast in concrete shall be hot dip galvanized or stainless steel. Where permitted by the ENGINEER, concrete expansion bolts shall be stainless steel and of the wedge anchor type. Take all necessary precautions to prevent embedded items from being displaced, broken or deformed during concreting operation. Protect drains from intrusion of concrete.
6. Placing:
- (a) Equipment for mixing and transporting concrete must be clean. Forms shall be thoroughly clean and damp, and reinforcing shall be secured in place. Runways for transporting concrete shall not rest on reinforcing. When concrete is placed against earth, sprinkle sufficiently before placing.
 - (b) Deposit of concrete in forms no longer than ninety (90) minutes after the initial design water has been added to the cement and aggregates. Concrete which cannot be so placed shall not be used and shall be wasted. **No additional water shall be added.** No retempering with water is permitted.
 - (c) In addition to the requirements of ASTM C94, the concrete delivery tickets shall indicate the cement content and water/cement ratio.
 - (d) During hot weather, proper attention shall be given to ingredients, production methods, handling, placing, protection and curing. Comply with ACI 305R "Hot Weather Concreting" recommendations.
 - (e) Do not place concrete in forms unless the water level is below the concrete to be placed, even if it is necessary to maintain the dewatering, or under rain.

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- (f) Do not place concrete under water except for tremie concrete as called for on the Contract Drawings. Submit for approval plan and details of means and methods for installation of seal tremie concrete prior to commencement of work. Seal concrete which subsequently fails to perform, shall be repaired or replaced at no additional cost to the City.
- (g) Place seal concrete under water in the space in which it is to remain, by means of a tremie, a closed-bottom dump bucket of not less than one cubic yard capacity, or other approved method, and do not disturb after it is deposited. Deposit all seal concrete in one continuous pour. Do not place concrete in running water. Design all formwork, to retain concrete under water, to be watertight. Submit shop drawings for the design of formwork and excavation sheeting signed and sealed by a Florida Registered Professional Engineer.
- (h) The tremie shall consist of a tube having a minimum inside diameter of ten (10) inches, and shall be constructed of sections having tight joints. No aluminum parts which have contact with the concrete will be permitted. The discharge end shall be entirely seated at all times and the tremie tube kept full to the bottom of the hopper. When a batch is dumped into the hopper, the tremie shall be slightly raised (but not out of the concrete at the bottom) until the batch discharges to the bottom of the hopper, after which the flow shall be stopped by lowering the tremie. The means of supporting the tremie shall be such as to permit the free movement of the discharge end over the entire top surface of the work, and shall permit it being lowered rapidly when necessary to choke off or retard the flow. The flow shall preferably be continuous and in no case shall be interrupted until the work is completed. Exercise special care to maintain still water at the point of deposit.
- (i) When the concrete is placed by means of a bottom dump bucket, the bucket shall be lowered gradually and carefully until it rests upon the concrete already placed. The bucket shall then be raised very slowly during the discharge travel; the intent being to maintain, as nearly as possible, still water at the point of discharge and to avoid agitating the mixture. Aluminum buckets will not be permitted.
- (j) Do not commence pumping, to dewater a sealed cofferdam, until the seal has set sufficiently to withstand the hydrostatic pressure, and in no case earlier than 72 hours after placement of concrete.
- (k) Notify ENGINEER a minimum of 24 hours prior to concreting and request a specific time for observation of reinforcing and formwork for portions of concrete work to be placed. No observation will be made by

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the ENGINEER until rebar installation for all work to be done and all formwork has been completed and approved by the CONTRACTOR's field superintendent. Do not order concrete until all correction and additions indicated by the ENGINEER have been made. Should the ENGINEER'S observation reveal that work is improperly prepared and an additional observation will be required, he will so inform the CONTRACTOR and all above requirements shall also govern.

7. Repair of Surface Defects:
 - (a) Repair all concrete surface defects, which includes, but not limited to cracks, tie holes (no plastic cones), uneven holes, honey combs, rough frame work and other objectionable conditions deemed unacceptable to the ENGINEER immediately after form removal. This repair work is to be done for all concrete expose surfaces, liquid applied surface or painted surfaces in or out of the water. Repair all cracks and defects in the concrete floors, beams, joists, columns, and other structural members, roof and walls, to the satisfaction of the ENGINEER, that may occur up to one year after acceptance of work regardless of the cause. Test unformed, surfaces such as monolithic slabs, for smoothness and verify placement tolerances specified for each surface and finish. Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness. Repair unformed surfaces that contain surface defects which affect durability of concrete. Surface defects, as such, include cracking, cracks which penetrate to reinforcement or completely through non-reinforced sections regardless of width, spalling, pop-outs, honeycomb, rock pockets and other objectionable and rough conditions.
 - (b) Proprietary compounds for adhesion or as patching ingredients may be used, if approved by the ENGINEER. All structural repair of surface defects to be made require the approval of the ENGINEER, as to the method and procedure. Approval of the completed work must be obtained from the ENGINEER.
8. Finishing of Formed Surfaces.
 - (a) Apply rough form finish to exterior walls below grade not exposed to water.
 - (b) Apply smooth form finish to exterior and interior walls and columns exposed to water.

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- (c) Apply smooth form finish to interior walls and underside of floors, stairs and slabs.
- (d) In addition to the smooth form finish, apply a grout cleaned finish to concrete walls and surfaces exposed to public view and underside of formed floors, stairs or slabs.
- (e) Apply a rubber float grout mix to properly prepared concrete surface, only when approved by the ENGINEER. Mix shall have one part Portland cement to two parts fine sand in a 50% water and 50% Acryl #60 (Thorseal or Acryl Set) mix or Acryl Set by Master Builders. Make a 10' by 10' sample on the concrete wall for the approval of the ENGINEER. Finished surface shall be a non dusting hard finish, when scratched with a ¼" metal edge.
- (f) Finish concrete surface, interior or exterior, below or above water shall include all:
 - (1) Exposed concrete.
 - (2) Grout finished concrete.
 - (3) Painted surface concrete.
 - (4) Liquid membrane finished concrete shall comply with manufacturer's requirements.
 - (5) The entire surface of finished concrete shall have a smooth uniform surface, there shall be no offsets, visually bulges, or wavering in the finished surfaces. The joints must be accurately aligned, they cannot be uneven or in or out, a higher and lower, there shall be no fins, projection or unevenness between forms.
 - (6) If after stripping the forms the ENGINEER determines that the finished concrete does not comply with any or all of the above requirements, the CONTRACTOR shall submit his proposal in writing to the ENGINEER as to his methods of correcting the work at no added cost to the City, which shall include, but not limited to all grinding of fins, projections, unevenness between joints, form high spots and uneven spots.
 - (7) In addition to all other requirements, concrete surfaces exposed to public view, irrespective of size, area or location shall be completely clean and free of: (1) Stains of any nature, (2) Parts of forms or other wood of any nature, (3) laitance, (4) "Run-downs" of leaked water from secondary pours, (5) Nails, (6) Strips, (7) Ties and (8) all other extraneous, deleterious materials and/or substances which may affect the finished appearance and

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condition of exposed concrete. Surfaces not meeting the above requirements are to be repaired and treated at no additional cost to the City.

9. Slabs

- (a) Unless otherwise noted on the Contract Drawings, place strips alternately at maximum 20 feet center-to-center and to align with column centerline. Do not place adjacent strips until elapse of twenty four hours after first strip is placed. Place slabs on grade by the "strip-cast" method. Method to be reviewed by the ENGINEER. Provide saw-cut joints at maximum 20 feet center-to-center and to align with column center lines within four hours of final finishing.
- (b) Provide doweled construction joints where shown on the Contract Drawings.
- (c) Provide a hard steel troweled finish, free from trowel marks and irregularities, to slabs and floors.
- (d) Provide a light hair-broom finish to exterior slabs and floors exposed to public view. Leave hair-broom lines parallel to direction of the slab drainage.
- (e) Provide a stiff bristle broom finish to slabs and floors with slopes greater than 10 percent. Leave broom lines parallel to slope drainage.
- (f) Finish exposed edges of slabs, floors and tops of walls with a ¼-inch radius edge unless a chamfer is called for on the Contract Drawings.

10. Curing and Protection

- (a) Comply with ACI 305 "Hot Weather Concreting", Chapter 4, with the supplements and modifications to ACI 301 listed herein.
- (b) Only concrete water curing for not less than 7 days (24 hours/day continuously) will not be accepted; Burleen mats shall be used in curing. Water cure by ponding or continuous sprinkling covering complete surface with minimum runoff. The application of water to wall may be interrupted for grout cleaning only over the areas being cleaned at the time, and the concrete surfaces shall not be permitted to become dry during such interruption.
- (c) Begin all water curing as soon as concrete is set and concrete will not be damaged. Keep concrete and wall forms wet the first 24 hours. Remove forms as indicated in Formwork, Section 3.02-C.4, and continue with 7 day water curing. Recoat damaged surfaces

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subject to heavy or surfaces damaged by construction procedures within 3 hours of damage. Method of repair shall be approved by the ENGINEER.

11. Testing

- (a) Testing laboratory will be selected and paid for by the CONTRACTOR. Send results of all test to the City and to the ENGINEER. The CONTRACTOR shall notify the Testing laboratory at least 24 hours before each concrete placing.
- (b) Obtain and mold 3 specimens for each fifty (50) cu. yds., or fraction thereof, of each class of concrete placed each day or as directed by the ENGINEER.
- (c) Cure specimens from each sample in accordance with ASTM C31. Record in test report any deviations from this Standard.
- (d) Test specimens in accordance with ASTM C39. Test one specimen at twenty eight (28) days for acceptance and, one specimen at three (3) days and seven (7) days respectively, for information. If one specimen in a test manifests evidence of improper sampling, molding or testing, it shall be discarded and the strength of the remaining cylinders shall be considered the test result.
- (e) CONTRACTORs Superintendent shall color code on a set of structural drawings the extent of days work and date to conform to cylinders test.
- (f) Perform slump test at discharge of mixer, one for each strength test in accordance with ASTM C143. In the event slump is excessive, testing laboratory will immediately notify the CONTRACTOR's superintendent and the Engineer on site. The CONTRACTOR shall then reject all concrete with excessive slump and/or deposit time.
- (g) Drying Shrinkage Test: A drying shrinkage test shall be conducted on the preliminary trial batch with the maximum water-cementitious materials ratio used to qualify each proposed concrete mix design using the concrete materials, including admixtures, that are proposed for the project. Three test specimens shall be prepared for each test. Drying shrinkage specimens shall be 4 x 4 x 11 inch prisms with an effective gauge length of 10 inches fabricated, cured, dried, and measured in accordance with ASTM C 157 except with the following modifications:

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- (1) Specimens shall be removed from the molds at an age of 23 hours \pm 1 hour after trial batching, shall be placed immediately in water at 73° F \pm 3° F for at least 30 minutes, and shall be measured within 30 minutes thereafter to determine original length and then submerged in lime-saturated water as specified in ASTM C157. Measurement to determine expansion expressed as a percentage of original length shall be taken at age 7 days. The length at 7 days shall be the base length for drying shrinkage calculations ("0" days drying age). Specimens then shall be stored immediately in a humidity controlled room maintained at 73° F \pm 3° F and $50\% \pm 4\%$ relative humidity for the remainder of the test. Measurements to determine shrinkage expressed as percentage of base length shall be reported separately for 7, 14, and 21 days \pm 4 hours of drying from "0" day after 7 days of moist curing.
- (2) Drying shrinkage deformation for each specimen shall be computed as the difference between the base length (at "0" days drying age) and the length after drying at each test age. Results of the shrinkage test shall be reported to the nearest 0.001 percent. If drying shrinkage of any specimen deviates from the average for that test age more than 0.004 percent, the results for that specimen shall be disregarded.
- (3) The average drying shrinkage of each set of test specimens cast in the laboratory from a trial batch as measured at the 21 days drying age shall not exceed 0.036 percent and 0.042 percent at the 28-day drying stage for all concrete.
- (4) The maximum concrete shrinkage for specimens cast in the field shall not exceed the trial batch maximum shrinkage requirement by more than 25 percent.
- (5) If the required shrinkage limitation is not met during construction, the CONTRACTOR shall take any or all of the following actions at no additional cost to the CITY, for securing the specified shrinkage requirements. These actions may include changing the source or aggregates, cement and/or admixtures, including Tetra Guard AS 20 or approved equal; reducing water content; washing of aggregate to reduce fines; increasing the number of construction joints; modifying the curing requirements; or other actions designed to minimize shrinkage or the effects of shrinkage.

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- (6) Alkali-aggregate reactivity potential shall be determined in accordance with Appendix XI of ASTM C 33. Aggregates shall be tested in accordance with ASTM C 289 and C295 to determine potential reactivity. Aggregates which do not indicate a potential for alkali reactivity or reactive constituents may be used without further testing. Aggregates which indicate a potential for alkali reactivity shall be further tested in accordance with ASTM C227 or C1105, as appropriate, using a cement containing less than 0.6 percent alkalies. At the discretion of the ENGINEER, testing in addition to that indicated in Appendix XI of ASTM C33 may be performed on potentially reactive aggregates. Nonreactive aggregates shall be imported if, in the opinion of the ENGINEER, local aggregates exhibit unacceptable potential reactivity.

12. Evaluation and Acceptance of Concrete

- (a) If tests are insufficient or inadequate, test and evaluate by core tests. Failure of any concrete cylinder to meet specified requirements shall be deemed as non-complying and costs of additional tests to determine the adequacy or inadequacy shall be borne by the CONTRACTOR. Concrete rejected for any reason is to be removed and replaced, including labor, forms and reinforcing, to meet specifications at no additional cost to the City and no additional time extension.

13. Additional Requirements

- (a) Submit shop drawings as required per General Conditions and elsewhere in these specifications. Prime CONTRACTOR shall check and approve all shop drawings prior to submission. Do not fabricate any item requiring shop drawings until approval of shop drawings has been granted by the City. Partial shop drawings are not accepted, submit drawings for complete submittal.
- (b) Provide precast or cast-in-place reinforced concrete lintels at all masonry openings and sills at all windows. Reinforce to suit loads and span. Provide minimum 8" bearing at each end and, pour integral with columns where opening abuts columns.
- (c) Sidewalks in R.O.W.: Provide poured-in-place 6" thick concrete slab, 3000 psi concrete, with continuous 8" deep thickened slab edges.

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Isolate walks from vertical surfaces with ½" expansion joint material. Provide ½" expansion bituminous joint material flush with top of concrete slabs at 20 feet on center and tooled joints at 5 feet on center. Tool all open edges to a smooth radius and all edges adjacent to the forms.

- END OF SECTION -

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PIPING GENERAL

Part 1 - GENERAL

1.01 THE REQUIREMENT

- A. The CONTRACTOR shall furnish and install to the required line and grade, all piping together with all fittings and appurtenances, required for a complete installation. All piping located outside the face of structures or building foundations and all piping embedded in concrete within a structure or foundation shall be considered exterior piping.
- B. The CONTRACTOR shall furnish and install fittings, couplings, connections, sleeves, adapters, harness rods and closure pieces as required to connect pipelines of dissimilar materials and/or sizes herein included under this Section and other concurrent contracts for a complete installation.
- C. The CONTRACTOR shall furnish all labor, materials, equipment, tools, and services required for the furnishing, installation and testing of all piping as shown on the Drawings, specified in this Section and required for the Work. Piping shall be furnished and installed of the material, sizes, classes, and at the locations shown on the Drawings and/or designated in this Section. Piping shall include all fittings, adapter pieces, couplings, closure pieces, joint restraints, harnessing rods, hardware, bolts, gaskets, hangers, supports, and other associated appurtenances for required connections to equipment, valves, or structures for a complete installation.
- D. The CONTRACTOR shall provide taps on piping where required or shown on the Drawings. Where pipe or fitting wall thicknesses are insufficient to provide the required number of threads, a boss or pipe saddle shall be installed.
- E. The work shall include, but not be limited to, the following:
 - 1. Connections to existing pipelines.
 - 2. Test excavations necessary to locate or verify existing pipe and appurtenances.
 - 3. Installation of all new pipe and materials required for a complete installation.
 - 4. Cleaning, testing and disinfecting as required.

1.02 QUALITY ASSURANCE

- A. Contractor's Qualification
 - 1. The CONTRACTOR must have a minimum five (5) years total of industry experience and constructed at least three (3) water, wastewater, or

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PIPING GENERAL

reclaimed water/reuse pipeline projects of similar size within the last five (5) years.

2. Experience of Superintendent and Pipe Installation Crews must submit history and resume of past performance having completed two (2) projects on schedule and to the satisfaction of the facility owner.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Division 2, Sitework
- B. Division 15, Mechanical

1.04 SUBMITTALS

- A. The CONTRACTOR shall submit complete shop drawings and certificates, test reports, affidavits of compliance, of all piping systems specified in this section.
- B. Each shop drawing submittal shall be complete in all aspects incorporating all information and data listed herein and all additional information required to evaluate the proposed piping material's compliance with the Contract Documents. Partial or incomplete submissions will be returned to the CONTRACTOR without review.
- C. Data to be submitted shall include, but not be limited to:
 1. Catalog Data consisting of specifications, illustrations, and a parts schedule that identifies the materials to be used for the various piping components and accessories. The illustrations shall be in sufficient detail to serve as a guide for assembly and disassembly.
- D. Certifications: Prior to installation, the CONTRACTOR shall furnish an Affidavit of Compliance certified by the pipe manufacturer that the pipe, fittings and specials furnished under this Contract comply with all applicable provisions of AWWA and these specifications.

No pipe or fittings will be accepted for use in the Work on this project until the affidavits have been submitted and accepted.
- E. All expenses incurred in making samples for certification of tests shall be borne by the CONTRACTOR.

1.05 QUALITY ASSURANCE

- A. Tests: Except where otherwise specified, all materials used in the manufacture of the pipe shall be tested in accordance with the applicable Specifications and Standards. QUALITY ASSURANCE

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1.06 MANUFACTURER'S SERVICE REPRESENTATIVE

- A. Where the assistance of a manufacturer's service representative is advisable, in order to obtain correct pipe joints, supports, or special connections, the CONTRACTOR shall furnish such assistance at no additional cost to the CITY.

1.07 MATERIAL DELIVERY, STORAGE, AND PROTECTION

- A. All piping materials, fittings, valves, and accessories shall be delivered in a clean and undamaged condition and stored off the ground, to provide protection against oxidation caused by ground contact. Any materials susceptible to UV degradation shall be protected to eliminate exposure to sunlight. All defective or damaged materials shall be replaced with new materials

1.08 CLEANUP

- A. After completion of the work, all remaining pipe cuttings, joining and wrapping materials, and other scattered debris, shall be removed from the site. The entire piping system shall be handed over in a clean and functional condition.

Part 2 - PRODUCTS

2.01 GENERAL

- A. All specials and every length of pipe shall be marked with the manufacturer's name or trademark, size, class, and the date of manufacture. Special care in handling shall be exercised during delivery, distribution, and storage of pipe to avoid damage and unnecessary stresses. Damaged pipe will be rejected and shall be replaced at the CONTRACTOR's expense. Pipe and specials stored prior to use shall be stored in such a manner as to keep the interior free from dirt and foreign matter.
- B. Testing of pipe before installation shall be as described in the corresponding ASTM or AWWA Specifications and in the applicable standard specifications listed in the following sections.
- C. Joints in piping shall be of the type as specified in Section 15060, "Piping and Fittings".
- D. Unless otherwise specified or shown on the drawings, all buried exterior piping shall have restrained joints for thrust protection, and all exposed exterior piping shall have flanged joints.

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- E. The Drawings indicate work affecting existing piping and appurtenances. The CONTRACTOR shall excavate test pits as required of all connections and crossings which may affect the CONTRACTOR's work prior to ordering pipe and fittings to determine sufficient information for ordering materials. The CONTRACTOR shall take whatever measurements that are required to complete the work as shown or specified.

2.02 MECHANICAL COUPLINGS

- A. Construction: Mechanical couplings shall be provided where shown on the Drawing, and shall be of similar material as the pipe, without pipe stop, and shall be of sizes to fit the pipe and fittings shown. The middle ring shall be not less than 1/4-inch in thickness and shall be either 5 or 7-inches long for standard steel couplings, and 16-inches long for long-sleeve couplings. The followers shall be single-piece contoured mill section welded and cold-expanded as required for the middle rings. They shall be of sufficient strength to accommodate the number of bolts necessary to obtain adequate gasket pressures without excessive rolling. The shape of the follower shall be of such design as to provide positive confinement of the gasket.

B. Gaskets

1. Gaskets for mechanical couplings shall be rubber-compound material that will not deteriorate from age or exposure to air under normal storage or use conditions. The rubber in the gasket shall meet the following specifications:
 - (a) Color - Jet Black.
 - (b) Surface - Nonblooming.
 - (c) Durometer Hardness - 74 + 5.
 - (d) Tensile Strength - 1000 psi Minimum.
 - (e) Elongation - 175 percent Minimum.
2. The gaskets shall be immune to attack by the material which is being transported.
3. Where couplings are used in water containing chloramines or other fluids which attack rubber materials, gasket material shall be compatible with the piping service and fluid utilized.

- C. Harnessing: Where harnesses are required for mechanical couplings, they shall be in accordance with the requirements shown on the Drawings.

- D. Manufacturer shall be the following, or equal:

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1. Rockwell (Smith-Blair), Style 411
2. Dresser, Style 38
3. Total Piping Solution, Inc. (TPS) -Hymax
4. Ford Meter Box Co., Inc., Style FC1 or FC3.

2.03 TAPPING SLEEVES AND TAPPING SADDLES

- A. Refer to Section 15102 - Tapping Sleeves and Tapping Valves.

Part 3 - EXECUTION

3.01 INSTALLATION

- A. All piping shall be installed by skilled workmen and in accordance with the best standard practice for piping installation as shown on the Drawings, specified or recommended by the pipe manufacturer. Proper tools and appliances for the safe and convenient handling and installing of the pipe and fittings shall be used. Great care shall be taken to prevent any pipe coating from being damaged on the inside or outside of the pipe and fittings. All pieces shall be carefully examined for defects, and no piece shall be installed which is known to be cracked, damaged, or otherwise defective. If any defective pieces should be discovered after having been installed, it shall be removed and replaced with a sound one in a satisfactory manner by the CONTRACTOR and at his own expense. Pipe and fittings shall be thoroughly cleaned before they are installed and shall be kept clean until they are accepted in the complete work. All piping shall be installed in such a manner that it will be free to expand and contract without injury to itself or to structures and equipment to which it is connected. All piping shall be erected to accurate lines and grades with no abrupt changes in line or grade and shall be supported and braced against movement, temporary, or permanent. All exposed piping shall be installed with vertical and horizontal angles properly related to adjoining surfaces or pipes to give the appearance of good workmanship.
- B. All excavation shall be made in such a manner and to such widths as will provide ample room for properly installing the pipe and permit thorough compaction of backfill around the pipe. The minimum trench widths shall be in strict accordance with the "Trench Width Excavation Limits" as shown on the Drawings. All excavation and trenching shall be done in strict accordance with these specifications and all applicable parts of the OSHA Regulations, 29CFR 1926, Subpart P.
- C. Enlargements of the trench shall be made as needed to give ample space for operations at pipe joints. The width of the trench shall be limited to the

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PIPING GENERAL

maximum dimensions shown on the Drawings, except where a wider trench is needed for the installation of and work within sheeting and bracing. Except where otherwise specified, excavation slopes shall be flat enough to avoid slides which will cause disturbance of the subgrade, damage to adjacent areas, or endanger the lives or safety of persons in the vicinity.

- D. Hand excavation shall be employed wherever, in the opinion of the ENGINEER, it is necessary for the protection of existing utilities, poles, trees, pavements, or obstructions.
- E. No greater length of trench in any location shall be left open, in advance of pipe laying, than shall be authorized or directed by the ENGINEER and, in general, such length shall be limited to approximately one hundred (100) feet. The CONTRACTOR shall excavate the trenches to the full depth, width and grade indicated on the Drawings including the relevant requirements for bedding. The trench bottoms shall then be examined by the ENGINEER as to the condition and bearing value before any pipe is laid or bedding is placed.
- F. Following proper preparation of the trench subgrade, pipe and fittings shall be carefully lowered into the trench so as to prevent dirt and other foreign substances from gaining entrance into the pipe and fittings. Proper facilities shall be provided for lowering sections of pipe into trenches. Under no circumstances shall any of the materials be dropped or dumped into the trench.
- G. Water shall be kept out of the trench until jointing and backfilling are completed. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that no water, earth, or other substance will enter the pipes, fitting, or valves. Pipe ends left for future connections shall be valved, plugged, or capped, and anchored as required.
- H. The full length of each section of pipe shall rest solidly upon the bed of the trench, with recesses excavated to accommodate bells, couplings, joints, and fittings. Before joints are made, each pipe shall be well bedded on a solid foundation; and no pipe shall be brought into position until the preceding length has been thoroughly bedded and secured in place. Pipe that has the grade or joint disturbed after laying shall be taken up and relaid by the CONTRACTOR at his own expense. Pipe shall not be laid in water or when trench conditions are unsuitable for work.
- I. Proper and suitable tools and appliances for the safe convenient handling and laying of pipe shall be used and shall in general agree with manufacturer's recommendations.
- J. At the close of each work day the end of the pipeline shall be tightly sealed with a cap or plug so that no water, dirt, or other foreign substance may enter the pipeline, and this plug shall be kept in place until pipe laying is resumed.

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- K. During the laying of pipe, each pipe manufacturer shall provide his own supervisor to instruct the CONTRACTOR's pipe laying personnel in the correct procedure to be followed.
- L. All piping shall have bedding – refer to the Drawings and other Specification Sections.

3.02 JOINTS IN PIPING

- A. Restrained joints: shall be provided on all pipe joints as specified herein and shown on the Drawings. Restrained joints shall be made up similar to that for push-on joints.
- B. Push-on joints: include a single rubber gasket which fits into the bell end of the pipe. The gasket shall be wiped clean, flexed and then placed in the socket. Any bulges in the gasket which might interfere with the entry of the plain end of the pipe shall be removed. A thin film of lubricant shall be applied to the gasket surface which will come into contact with the spigot end of the pipe. The lubricant shall be furnished by the pipe manufacturer. The plain end of the pipe, which is tapered for ease of assembly, shall be wiped clean and a thick film of lubricant applied to the outside. The pipe shall be aligned and carefully entered into the socket until it just makes contact with the gasket. The joint assembly shall be completed by entering the pipe past the gasket until it makes contact with the bottom of the socket. The pipe shall be pulled "home" with an approved jack assembly as recommended by the pipe manufacturer. If assembly is not accomplished by reasonable force, the plain end shall be removed and the condition corrected.
- C. Mechanical joints: shall be made up with gaskets, glands and bolts. When a joint is to be made up, the bell or socket and plain end shall be cleaned and washed with a solution or mild soap in water; the gland and gasket shall be slid onto the plain end and the end then entered into the socket until it is fully "home" on the centering ring. The gasket shall then be painted with soapy water and slid into position, followed by the gland. All bolts shall be inserted and made up hand tight and then tightened alternately to bring the gland into position evenly. Excessive tightening of the bolts shall be avoided. All nuts shall be pulled up using a torque wrench which will not permit unequal stresses in the bolts. Torque shall not exceed the recommendations of the manufacturer of the pipe and bolts for the various sizes. Care shall be taken to assure that the pipe remains fully "home" while the joint is being made. Joints shall conform to the applicable AWWA Specifications.
- D. Eccentric reducers: shall be installed where air or water pockets would otherwise occur in mains because of a reduction in pipe size.

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3.03 PAINTING

- A. All reclaimed water piping and appurtenances shall be clearly identified as reclaimed water facilities.
- B. The standard color is Pantone Purple 522C for all reclaimed water system piping and above ground appurtenances including valves, meter assemblies and backflow prevention devices.

- END OF SECTION -

SECTION 15060
PIPING AND FITTINGS

Part 1 - GENERAL

1.01 SCOPE

- A. The work included in this section consists of furnishing all material, equipment and labor, and performing all operations necessary for the complete installation of all piping, fittings (bends, reducers, tees, crosses, etc) and accessories within the limits of work, as shown on the drawings and specified herein.
- B. Where references are made to other standards or codes, unless specific date references are indicated the latest edition of said standard or code shall govern.

1.02 RELATED SECTIONS

- A. Section 15000 – General Piping

1.03 PIPING LAYOUT

Field-verify dimensions prior to preparation of layout and shop drawings. Obtain shop drawing approval prior to fabrication of piping. All items not specifically mentioned in the Specifications or noted on the approved Plans, but which are obviously necessary to make a complete working installation shall be included.

1.04 QUALITY ASSURANCE

- A. All piping and related appurtenances shall be manufactured in the United States and shall be supplied by a Broward County pre-approved manufacturer.

1.05 SUBMITTALS

- A. The CONTRACTOR shall submit to the ENGINEER shop drawings and other information for review in accordance with Section 01300 "Submittals".

1.06 DELIVERY, STORAGE AND HANDLING

- A. During shipping, delivery and installation of pipe and accessories, handle in a manner as to ensure a sound undamaged condition.
- B. Exercise particular care not to injure pipe coatings.

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PIPING AND FITTINGS

Part 2 - PRODUCTS

2.01 GENERAL

1. As used herein, "ANSI" denotes the American National Standards Institute, "AWWA" denotes the American Water Works Association, and "ASTM" denotes the American Society for Testing and Materials.
2. All fittings to be furnished hereunder shall be manufactured in the United States, and shall conform to the referenced ANSI and/or AWWA Standard as modified herein, as appearing in the following sections.
3. All markings required on fittings, shall be clearly legible and located such that they will not be hidden or destroyed when assembled into the intended system.

2.02 JOINTS AND ACCESSORIES

1. Mechanical Joints - Mechanical joints for fittings shall conform to ANSI/AWWA Standard C111/A21.11-12, except that the gaskets for each fitting under Groups D and D1 shall be neoprene. Bolt holes for mechanical joints shall be equally spaced, and shall straddle the vertical centerline. Tee head bolts and hexagonal nuts for all mechanical joints in fittings shall be of high strength low-alloy steel with composition, dimensions and threading as specified in ANSI/AWWA Standard C111/A21.11-00. Glands shall be of ductile-iron construction for ductile iron fittings.

The proper number of gaskets, glands, bolts and nuts, all conforming to ANSI/AWWA Standard C111/A21.11-00, plus one extra gasket for every 10 joints or fraction thereof, shall be furnished with each order. The gaskets and joint accessories shall be shipped in suitable protective containers. Follower glands held in place with set screws will not be acceptable. Segmented glands will not be acceptable.

2. Mechanical Joint and Push-on Joint "Megalog®"-type Restraining Systems
Use of this type of restraint is restricted to underground mechanical joint or push-on joint applications, and in general may not be used above grade or as a substitute for flanged joints. Any above grade applications will require submission of shop drawings of the piping system where they are utilized and may require design by a Florida registered Professional Engineer.

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PIPING AND FITTINGS

This type of restraint may be utilized as dictated by design and/or field conditions in any mechanical joint or push-on joint underground piping system of 30-inch nominal diameter and smaller.

It is recognized that flange adapters of this type form a useful tool for adjusting lengths of flanged pipe runs in instances such as runs with a large number of deflections where it is almost impossible to predict all lengths correctly. Therefore, a very restricted number of these joints will be allowed in instances where it can be clearly shown to the satisfaction of the ENGINEER that they are necessary. This application is restricted to 20-inch nominal diameter and below. Further, this use shall be designed in and shall not be made as a field substitution. In all instances flange adapters shall be rated for a minimum working pressure of 250 psi with a minimum safety factor of 2:1. In no case will these flange adapters be used as a general substitute for standard flanged joints.

The CITY absolutely reserves the right to require other forms of restraint and/or thrust anchoring where, in the opinion of the ENGINEER, the use of this form of restraint is not in the best interest of the Department. In this regard, the ENGINEER's decision shall be final.

The "Megalug®" joint-restraint systems manufactured by EBAA Iron, Inc., of Eastland Texas, will be considered the standard of quality for the purpose of evaluating substitute systems. Any entity offering a substitute system for consideration shall demonstrate to the complete satisfaction of the ENGINEER that their restraint system has been in use for a minimum of three years in the United States, and shall bear the entire burden of providing all material, documentation and performance testing data to prove substantial equivalence of their restraint system to the "Megalug®" system.

Each thrust-resistant mechanical joint or push on joint made up with this type of restraint and the pipe and fitting of which it is a part, shall be designed to withstand an axial thrust from an internal pipeline pressure of at least 150 psi at bulkhead conditions without reduction because of its position in the pipeline nor for support from external thrust blocks.

This type of joint restraint shall not be used above grade except as previously specified nor shall it be used as a carrier pipe within a casing.

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PIPING AND FITTINGS

This type of restraint shall not be used with tape wrapped pipe or with too great a coating thickness on the exterior of the pipe.

2.03 QUALITY ASSURANCE

1. All piping, fittings and other materials supplied under this contract shall be subject to inspection while still on the delivery truck. It is the sole responsibility of the vendor and supplier to make prior contact with the CITY and provide a minimum of 48-hours prior notice of delivery. When so notified, the CITY will make arrangements for inspection of the material upon arrival or within a reasonable time thereafter. Material will not be unloaded without inspection taking place either prior to, or if necessary for examination, during the unloading procedure. The CITY will not be responsible for any delays or additional costs created by non-compliance with the requirement for prior notification or the requirement for thorough inspection.
2. Materials shall be delivered in complete compliance with the AWWA Standards as modified herein, without damage, and shall match or exceed the quality of any samples supplied. The CITY absolutely reserves the right to require samples of any material supplied and to perform whatever tests considered by the ENGINEER, whose decision shall be final, to be in the Department's best interest on said samples. Where such tests are of a destructive nature, the sample, if it passes the test will be paid for (at cost as shown by invoice) by the CITY. Samples failing will be immediately replaced with suitable material at the supplier's/CONTRACTOR's expense. Samples required prior to order as a condition for purchase or as a materials submittal for approval will be at the supplier's/CONTRACTOR's expense but, if approved and not used for destructive tests, may be used in the work with permission from the ENGINEER.
3. Materials found to be defective, not in strict compliance with the quality standards of samples supplied or these specifications shall be immediately returned to the vendor at his expense. If defects are discovered at a later time, the vendor shall be required to remove said items and shall bare all costs for so doing together with any replacement costs. Rejection of items may subject the vendor to liquidated and/or actual damages as specified elsewhere herein.
4. Foundries supplying materials shall maintain their metallurgical records for a minimum period of two years after fabrication and firms not doing so may be found in default.

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5. Flaws which provide cause for rejection include but are not limited to:
 - (a) Incorrect metallurgy or metallurgy which cannot be verified to the complete satisfaction of the ENGINEER
 - (b) Foundry identification/location, size, pressure and material identification information lost, removed, non-existent, or not visible when assembled
 - (c) Not in complete compliance with all applicable AWWA and NSF standards and requirements as modified herein and/or these specifications
 - (d) Not in complete compliance with approved shop drawings
 - (e) Incorrect, rough, chipped, cracked, scratched, flawed or otherwise damaged interior or exterior coatings or linings
 - (f) interior or exterior coatings which are too thin, or too thick to allow proper assembly, or too thick to allow proper grip by restraining gaskets or other restraining elements
 - (g) Pin holes or honey combing of pipe
 - (h) Weld spatter or excess metal in gasket grooves or the whole of the bell area
 - (i) Bell areas which are distorted or otherwise improperly cast
 - (j) Spigots which are out of round, not of proper dimension, or not beveled to an extent that will allow easy assembly of the pipe joint
 - (k) Gaskets which are defective or of the wrong material
 - (l) Lack of joint materials, improper or defective joint materials
 - (m) Bolting of the wrong material or size
 - (n) Electro-galvanizing or other exterior plating when hot-dip galvanizing is required
 - (o) Non-timely or non-submittal of all required certifications, incorrect/incomplete certifications, or certifications lacking the signature, date and seal of a professional engineer when so required
 - (p) Flanges which are too thin, not a right angles to the pipe centerline, or otherwise distorted
 - (q) All other flaws or defects which, in the opinion of the ENGINEER whose decision shall be final, adversely affect the assembly and/or function of the piping system as intended.

2.04 AWWA C900 PVC PIPE

1. AWWA C900 Pipe for irrigation mains and laterals shall conform to ANSI/AWWA C900, "(PVC) Pressure Pipe and Fabricated Fittings", for 4-

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PIPING AND FITTINGS

inch through 12-inch PVC pressure pipe and fabricated fittings with cast-iron-pipe-equivalent (CI) outside diameter (OD) dimensions and with wall-thickness-dimension ratio (DR 18).

- (a) AWWA C900 pipe shall be made from PVC thermoplastic having physical and chemical properties which meet or exceed a cell classification of 12454-A or 12454-B virgin compounds as defined in ASTM Standard D 1784.
- (b) The AWWA C900 pipe shall be push-on type, with bells, spigots and elastomeric gaskets in accordance with ASTM Standard D 3139, "Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals ". The gaskets shall conform to ASTM Standard F477 and shall be synthetic rubber. One gasket shall be furnished with each length of elastomeric-gasket bell-end pipe. Pipe spigots shall be beveled. Pipe bells shall be extruded integral with the pipe barrel with a thickness equal to or greater than that of the barrel.
- (c) Nominal laid length of AWWA C900 PVC (CI) pipe shall be 20 feet.

2.05 FITTINGS

1. Fittings for AWWA C900, PVC pressure pipe shall be ductile iron with mechanical joints having, at a minimum, the same pressure rating as the pipe and shall be as specified for ductile iron pipe and fittings.

2.06 JOINT RESTRAINTS

1. For restraining C900 PVC pressure pipe and fittings, refer to Section 2.01.D.3, "Mechanical Joint and Push-on Joint "Megalug®"-type Restraining Systems", elsewhere in this specification..

2.07 CERTIFICATION

1. The CONTRACTOR shall provide the CITY with notarized Certifications, signed by an authorized agent of the manufacturer, that the material was manufactured, sampled, tested, and inspected in accordance with these specifications, and has been found to meet the requirements. A report of said test results shall be furnished.
2. No pipe or fitting will be accepted for use in the project until the Certifications have been sub-mitted to and approved by the CITY.

2.08 HANDLING AND STORING PVC PIPE AND FITTINGS

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PIPING AND FITTINGS

1. Pipe and fittings shall at all times be handled with great care to avoid damage. In loading or unloading operations, the manufacturer's unitized package of pipe and/or fittings shall be lifted with a forklift or other suitable equipment in such a manner as to prevent damage. Pipe may be unloaded by individual lengths. However, each length shall be slid or rolled on skidways in such a manner that the pipe is not dropped, and to avoid any shock. Under no circumstances shall pipe and/or fittings be dropped or allowed to roll or slide against obstructions.
2. Pipe and/or fittings having ultraviolet degradation, warpage, impact damage, abrasion damage, or gouges or cuts will not be accepted. Bell ends showing compression set, damage or deformation will not be acceptable.
3. Gaskets, if not prepositioned in the bell ends, shall be stored and shipped in suitable protective containers. Gaskets shall not be exposed to excessive heat, direct sunlight, oil or grease.
4. Pipe and fittings shall be stored in a manner that will prevent warpage or other damage as previously specified.
5. If the pipe and/or fittings are to be stored for any period in excess of six months in direct sunlight the items shall be covered with an opaque material. The cover shall be placed in such a manner that will permit air circulation above and around the items being covered to prevent excessive heat accumulation.
6. Pipe and fittings shall be manually or mechanically lowered into the trench for installation, and shall not be thrown, dropped or pushed in the trench.

Part 3 - EXECUTION

3.01 GENERAL:

- A. The CONTRACTOR shall provide all barricades and/or flashing warning lights necessary to warn of the construction throughout the Project.
- B. Pipe and fittings shall at all times be handled with great care to avoid damage. In loading and unloading, they shall be lifted with cranes or hoists or slid or rolled on skidways in such manner as to avoid shock. Under no circumstances shall this material be dropped or allowed to roll or slide against obstructions.
- C. All work shall be performed by skilled workmen experienced in similar installations. All pipe and fittings shall be adequately supported by clamps, brackets, straps, concrete supports, rollers or other devices as shown and/or specified. Supports or hangers shall be spaced so that maximum deflection

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PIPING AND FITTINGS

between supports or hangers shall not exceed 0.050 inch for pipe filled with liquid, but shall not be further than 6 feet apart, whichever is closer, unless otherwise shown. All pipe supports shall be secured to structures by ap-proved inserts or expansion shields and bolts.

- D. All pipe shall be thoroughly cleaned internally before being installed. All pipes, except oxygen service, air and gas, shall be flushed with water and swabbed to assure removal of all foreign matter before installation. Air and gas piping shall be tapped with a hammer to loosen scale or other foreign matter that might be within the pipe, then thoroughly blown with a high pressure air hose. Air shall be from the CONTRACTOR's air compressor.
- E. Whenever possible, the pipe will be installed with minimum 48-inches of cover, however, due to the numerous utilities in the area, this burial could change substantially.
- F. At all horizontal or vertical pipe deviation, the CONTRACTOR shall install both restrained pipe and thrust blocks. Joints may only be opened to adjust alignment by half of the AWWA or manufacturer's recommended opening (which is smaller).
- G. Tie Rods: Unless otherwise indicated on the Drawings, the size and number of tie rods for a joint or installation shall be as recommended by the manufacturer's design chart for a working pressure of 150 psi. Tie rods shall be installed as recommended by the manufacturer.

3.02 EXCAVATION FOR PIPING

- A. The CONTRACTOR shall make all excavation necessary for the construction of the pipelines, connections, valves and appurtenances, to the lines and grades shown on the Plans.
- B. The trench shall be excavated at least 6 inches below pipe laying grade as shown on the Plans. All sheeting and shoring shall be installed at the CONTRACTOR's expense where it is necessary for pipe installation and property protection or required by the Trench Safety Act. The cost of dewatering any excavation shall be at the CONTRACTOR's expense. The disposal of water removed from an excavation shall be in a manner which will not create a hazard, or be detrimental to the public health or to public or private property.
- C. The CONTRACTOR shall obtain all necessary permits approving the location and proposed method of disposal before discharging water from any excavation into any portion of the public right-of-way or into any existing drainage structure or facility. All construction signs required shall be provided by the CONTRACTOR.

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PIPING AND FITTINGS

3.03 INSTALLATION OF PIPE, FITTINGS AND VALVES

A. GENERAL:

1. The design Drawings are in some cases diagrammatic. They may not show every bend, off-set, elbow or other fitting which may be required in the piping for installation in the space allotted.
2. The centerline of the pipe shall not vary by more than 2 inches from the location shown on the Plans and the top of the pipe shall not vary by more than 2 inches from the established grade, except at points where this tolerance must be changed to clear obstructions, or make connections. Deviation from this location will be permitted only upon written instructions from the ENGINEER.
3. Sandbags may be used to support the pipe in the ditch but no pipe shall be laid on blocks, except by the written permission of the ENGINEER. The trench shall be dewatered to the extent that all poured lead joints in cast iron pipe and fittings may be made perfectly dry. Flanged joints, mechanical joints and push-on joints in cast iron pipe and fittings may be made under water.

B. INSTALLATION OF PVC PIPE:

1. In the installation of glue joint PVC pipe, the pipe shall first be cut square and smooth. Wipe all surfaces to be connected with a cloth moistened with an appropriate solvent and remove any foreign matter from socket of fitting. Using an ordinary paint brush of width about equal to the nominal pipe size, apply a generous coat of cement to inside and shoulder of socket, flowing on but not brushing out. A similar coat shall then be applied to the end of the pipe for at least the same distance on the pipe as the depth of socket, and to the cut end. Pipe and fittings shall then be pressed firmly together and the pipe turned a quarter to a half turn to evenly distribute the cement. The cementing and joining operation must not exceed one minute. Allow 24 hours setup time before applying pressure. Sand shall be used as backfill material around pipe installed underground.
2. Thread Sealant: Teflon tape.
3. All rigid PVC pipe shall be cut, made up, and installed in accordance with the pipe manufacturer's recommendations. Plastic pipe shall be laid by snaking the pipe from one side of the trench to the other. Offset shall be

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PIPING AND FITTINGS

as recommended by the manufacturer for the maximum temperature variation between time of solvent welding and during operation.

4. Schedule 80 pipe shall not be threaded. Use Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting.
5. Only strap wrenches shall be used for tightening threaded plastic joints, and care shall be taken not to over tighten these fittings.
6. Provide adequate ventilation when working with pipe joint solvent cement.
7. Testing: All lines shall be hydrostatically tested at the pressures specified elsewhere herein or at the design pressures.
8. Supports and Hangers: In accordance with the manufacturer's recommendations.

C. PIPE PROTECTION:

1. Paint all uninsulated metal (ductile iron or steel) piping underground with two coats of asphaltic paint.

D. CLEANING AND TESTING:

All of the piping installed under this project shall be tested as follows and as directed by the ENGINEER:

1. Unless otherwise specified elsewhere herein, all PVC pressure system piping shall be tested at 150 psi. No leakage will be permitted.

- END OF SECTION -

SECTION 15080

HORIZONTAL DIRECTIONAL DRILLING

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A Provide all labor, materials, necessary equipment and services to complete the Reuse Irrigation Systems work using the horizontal directional drilling method at the location(s) indicated on the drawings. Products used shall be pre-approved manufacturers by Broward County or approved equal by the City of Hallandale Beach.

1.02 QUALITY ASSURANCE

- A. Contractor's Qualification
 1. Directional drilling CONTRACTOR or Subcontractor shall have a minimum of five years' experience constructing water, wastewater, or reclaimed water/reuse pipelines of the same or larger diameter and the same or greater lengths and shall have completed 3 projects similar in nature that include subaqueous crossings. Qualifications should be included with the bid. All pipe and appurtenances of similar type and material shall be furnished by a single manufacturer.
 2. Field supervisory personnel employed by the directional drilling CONTRACTOR or Subcontractor shall have at least five years' experience in the performance of the work.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 15060 – PIPING AND FITTINGS

1.04 EXISTING UTILITIES

- A. The CONTRACTOR shall locate all existing active utility lines traversing the site and determine and develop implementation plan for their protection throughout project duration. Note that all active utilities adjacent to or traversing the site and or designated to remain shall remain in continuous, uninterrupted service throughout the duration of the work.
- B. The CONTRACTOR shall furnish all temporary support, adequate protection and maintenance of all underground and surface utility structures, drains, sewers, and other obstructions encountered during the progress of the work, whether shown or not on the drawings. Such work shall be considered incidental to the scope of the project and no separate compensation will be provided for such.
- C. It shall be the responsibility of the CONTRACTOR to notify the owners of existing

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HORIZONTAL DIRECTIONAL DRILLING

utilities in the area of construction a minimum of 48 hours prior to any excavation adjacent of such utilities, so that field locations of said utilities may be established.

- D. The CONTRACTOR shall record location of all utilities, whether shown on the drawings or not.
- E. No deviation shall be made from the required line or grade except as directed by the CITY representative and/or ENGINEER.

1.05 SUBMITTALS

- A. Before starting fabrication, the CONTRACTOR shall furnish complete 'Submittals' to the ENGINEER for review and acceptance prior to construction. 'Submittals' shall include:
 - 1. Work Plan
 - 2. Pipe and joints
 - 3. Couplings
 - 4. HDPE mechanical joint adapters
 - 5. Training and experience of directional boring machine operator
 - 6. Directional drilling equipment Specifications including calibration records
- B. Prior to beginning work, the CONTRACTOR shall submit a work plan to the CITY's representative and or ENGINEER detailing the procedure and schedule to be used to execute the work. The work plan should include but not limited to the following:
 - 1. Supporting calculations and shop drawing of the work that are signed and sealed by a professional engineer registered in the State of Florida
 - 2. A description of all equipment to be used
 - 3. Down-hole tools
 - 4. A list of personnel and their qualifications and experience
 - 5. List of Subcontractors
 - 6. A schedule of work activity
 - 7. A safety plan and traffic control plan (if applicable)
 - 8. An environmental protection plan
 - 9. Contingency plans for possible problems.
- C. Equipment: The CONTRACTOR will submit specifications on directional drilling equipment to be used to ensure that the equipment will be adequate to complete the work. Equipment shall include but not be limited to the following:

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HORIZONTAL DIRECTIONAL DRILLING

1. Drilling rig
2. Mud system
3. Mud motors (if applicable)
4. Down-hole tools
5. Guidance system
6. Rig safety systems

1.06 DELIVERY, STORAGE AND HANDLING

- A. The CONTRACTOR shall take precautions to protect the pipe while being handled. Chains, end hooks or cable slings shall not be used to handle HDPE pipe. Pipe shall be stored on clean level surface to prevent undue scratching or gouging of the pipe.
- B. Care shall be taken to protect the pipe from scarring, gouging or excessive abrasion. Pipe with gouges greater than 10% of the minimum wall thickness will be rejected.
- C. The CONTRACTOR shall comply with the Manufacturer's requirements for the handling, storage and handling.

PART 2 – PRODUCTS

2.01 GENERAL

- A. All equipment shall be in good, safe operating condition with sufficient supplies, materials, and spare parts on hand to maintain the system in proper working order.
- B. The directional drilling equipment shall consist of the following:
 1. A directional drilling rig of sufficient capacity to perform the bore and pullback operations.
 2. A drilling fluid mixing, delivery, and recovery system of sufficient capacity to complete the work.
 3. A drilling fluid recycling system to remove solids from the drilling fluid so that the fluid can be reused.
 4. A magnetic guidance system to accurately guide boring operations.
 5. A vacuum truck of sufficient capacity to handle the drilling fluid volume.
 6. Trained and competent personnel shall operate the system.

2.02 DRILLING SYSTEM

Three Island Reuse Irrigation Project
City of Hallandale Beach

Horizontal Directional Drilling

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HORIZONTAL DIRECTIONAL DRILLING

- A. The directional drilling machine shall consist of a hydraulically powered system to rotate, push and pull hollow drill pipe into the ground at a variable angle while delivering a pressurized fluid mixture to a guidable drill (bore) head. The machine shall be anchored to the ground to withstand the pulling, pushing, and rotating pressure required to complete the work. The hydraulic power system shall be self-contained with sufficient pressure and volume to power drilling operations. Hydraulic system shall be free of leaks. Rig shall have a system to monitor and record maximum pullback pressure during pullback operations. The rig shall be grounded during drilling and pullback operations. There shall be a system to detect electrical current from the drilling string and an audible alarm that automatically sounds when an electrical current is detected.

2.03 PIPE

- A Pipe shall be high density polyethylene (HDPE) PE4710, and shall meet or exceed the requirements of the latest revision of ANSI/NSF 61 and AWWA C906. The pipe shall be DR 9. The resin material shall also meet or exceed the requirements of ASTM D3350, latest edition. Permanent identification of the piping shall be provided by equally spaced color stripes on the outside surface or by a solid colored pipe shell. The identifying colors are as follows:

COLOR	SERVICE
Purple	Reclaimed Water

HDPE pipe shall have been continuously marked by the manufacturer with permanent printing indicating at a minimum the following:

- a. Nominal size (inches)
- b. Dimension ratio (DR)
- c. Pressure rating (psi)
- d. Trade name
- e. Material classification (PE 4710)
- f. Plant, extruder, and operator codes
- g. Resin supplier code
- h. Date produced

Pipe lengths and fittings shall be joined by zero leak-rate butt fusion welds or mechanical joint methods according to the latest revisions of ASTM F2620, D2657 and F1290. All butt fusion welds shall be in strict conformance with the pipe manufacturer's recommendations and perform by a firm or individual recommended in writing by the manufacturer. Flanged joints shall not be below ground. Each butt fusion weld shall be given an ID number and its location identified on the record drawing.

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HORIZONTAL DIRECTIONAL DRILLING

2.04 LOCATING WIRE

- A. Locating wire shall be 10 gauge copper clad steel tracer wire. A minimum of two tracer wires shall be installed with the pipe. The CONTRACTOR shall install as many wires as necessary to maintain continuity throughout the length of the directional bore. Failure of continuous continuity in the locating wires shall result in abandonment and reinstallation of the directional drill, at the discretion of the CITY's representative and/or ENGINEER.

2.05 DRILLING FLUIDS

- A. Drilling fluids shall consist of a mixture of potable water and gel-forming colloidal material, such as bentonite or a polymer surfactant mixture producing slurry of custard-like consistency.

2.06 OTHER EQUIPMENT

- A. Pipe Rollers: Pipe rollers shall be of sufficient size to fully support the weight of the pipe. A sufficient number of rollers shall be used to prevent excessive sagging of the pipe.

PART 3 – EXECUTION

3.01 GENERAL

- A. Field supervisory personnel employed by the directional drilling CONTRACTOR or Subcontractor shall be present at all times during directional drilling operations. The field supervisory personnel shall be authorized to represent the CONTRACTOR or Subcontractor in routine decision making capacity concerning the manner and method of carrying out the work.
- B. The CONTRACTOR and Subcontractor shall have sufficient number of competent workers on the project site at all times to ensure the directional drilling operation is made in a timely, satisfactory manner.
- C. CONTRACTOR must exercise care in unloading and handling pipe, fittings, and all other materials.

3.02 WORK PLAN

- A. Work plan should be submitted. This plan should be comprehensive, realistic, and based on actual working conditions for this particular work. The plan should document the requirements to complete the work. Calibration records for the guidance equipment shall be included as well as specifications for any drilling fluid additives that the CONTRACTOR or Subcontractor intends to use or might use.

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HORIZONTAL DIRECTIONAL DRILLING

- B. The CONTRACTOR or Subcontractor shall notify the CITY's Representative and other utility companies that may be affected by the work at least two days in advance of the start of work.
- C. Install all appropriate traffic safety and warning devices prior to beginning the work.

3.03 INSTALLATION

- A. Erosion and sedimentation control measures and on-site containers shall be installed to prevent drilling mud from spilling out of entry and/or exit pits. Drilling mud shall be disposed of off-site in accordance with local, state, and federal requirements and/or permit conditions.
 - 1. No other chemicals or polymer surfactant shall be used in the drilling fluid without written consent of the CITY and after a determination is made that the chemicals to be added are not harmful or corrosive to the facility and are environmentally safe.
- B. Pilot Hole: Pilot hole shall be drilled on bore path with no deviations greater than 2% of depth over a length of 100 feet. In the event that pilot does deviate from bore path more than 2% of depth in 100 feet, the CONTRACTOR shall notify the CITY's Representative who may require the CONTRACTOR to pullback and re-drill from the location along bore path before the deviation.
- C. Reaming: Conduct pre-reaming operations to insure that a hole sufficient to accommodate the pull section or push section has been produced. Upon successful completion of pilot hole, the CONTRACTOR will ream borehole to a minimum of 50% greater than outside diameter of pipe using the appropriate tools. CONTRACTOR will not attempt to ream more than the drilling equipment and mud system are designed to safely handle. Any damage to the pipe resulting from inadequate pre-reaming shall be the responsibility of the HDD contractor.
- D. Pullback: After successfully reaming borehole to the required diameter, CONTRACTOR shall put the pipe through the borehole. In front of the pipe shall be a swivel and barrel reamer to compact borehole walls. Once pullback operations have commenced, operations must continue without interruption until pipe is completely pulled into borehole. During pullback operations, the CONTRACTOR shall not apply more than the maximum safe pipe pull pressure at any time. A break away head rated at the maximum safe pull pressure shall be utilized.
- E. As-built variance from the designed bore path shall not exceed \pm (plus or minus) 1 foot in the vertical plane and \pm 2 feet in the horizontal plane.

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HORIZONTAL DIRECTIONAL DRILLING

- F. The pipe entry area shall be graded to provide support for the pipe to allow free movement into the borehole. The pipe shall be guided in the borehole to avoid deformation of, or damage to, the pipe.
- G. If unexpected subsurface conditions are encountered during the bore, the procedure shall be stopped. The installation shall not continue until the CITY's Representative has been consulted.
- H. The pipe shall be pulled back through the borehole using the wet insertion construction technique. The pipe shall be installed full of water.
- I. The pipe shall be installed in a manner that does not cause upheaval, settlement, cracking, movement or distortion of surface features and other underground facilities.
- J. A boring log shall be kept with horizontal and vertical location every 10 feet. The horizontal location of the bore shall be marked in the field during the bore. The Surveyor shall locate these marks and include this information with the bore depths and the location and ID number of the butt fusion welds in the Record Drawings. The Surveyor may make a note on the drawing page containing the directional drill and provide an exception for the directional drill only, as the directional drill route cannot be uncovered and physically located.
- K. All directional drilled pipe to be installed shall be placed on rollers to minimize pipe strain.
- L. Contractor shall provide sufficient length of pipe to allow recovery of the elastic strain following pull-in. An additional length of 100 feet is recommended. The ends of the pipe shall not be allowed to retract back into the borehole entrance or exit level during the recovery period.
- M. Restoration needs to be defined once a final length of the line is established utilizing the easements and where the pipe will be terminated and capped.

3.04 FIELD TESTING

- A. Perform hydrostatic testing for leakage following installation of the directional drill.
 - 1. Test Duration: The total test time including initial pressurization, initial expansion, and time at test pressure must not exceed 8 hours. If the test is not completed due to leakage, equipment failure, etc., the test section shall be depressurized and allowed to "relax" for a minimum of 8 hours before it is brought back up to test pressure. The test procedure consists of the initial expansion phase and leakage test phase.
 - 2. Initial Expansion Phase: During the initial expansion phase, the test section is pressurized to the test pressure and enough make-up liquid is added each hour for 3-hours to return to test pressure.

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HORIZONTAL DIRECTIONAL DRILLING

3. Leakage Test Phase: The leakage test phase follows immediately and shall be subjected to hydrostatic pressure test in accordance with current Broward County Water and Wastewater Standards. After the main has been brought up to test pressure, it will be held at this pressure, and any make up water carefully measured by use of displacement meter.
- B. Test pressure for the pipe shall be 150 psi.
- C. A mandrel test shall be performed through the entire length of the installed HDPE pipe. The mandrel size shall be 90% of the inside diameter of the pipe.

3.05 WARRANTY

- A. The CONTRACTOR will make any repairs or replacement necessitated by mechanical failure due to faulty materials, improper installation and or poor workmanship within a specified number of days after notification by the ENGINEER.
- B. At the expiration of this time, if the work has not been properly completed to the satisfaction of the ENGINEER, the CITY will be entitled to have work done by others at the expense of the CONTRACTOR.
- C. If so, such repair work done by others will not void the warranty or the responsibility of the CONTRACTOR as to balance of the installation.

3.06 RESTORATION OF SURFACE AND OR STRUCTURES

- A. The CONTRACTOR will be required to restore and or replace paving, curbing, sidewalks, fences, sod, survey points and other disturbed surfaces to a condition equal to that before the work was begun and to satisfaction of the CITY's Representative(s).

- END OF SECTION -

SECTION 15100
VALVES GENERAL

Part 1 - GENERAL

1.01 WORK INCLUDED

- A. The CONTRACTOR shall provide all tools, supplies, materials, equipment, and labor necessary for furnishing, epoxy coating, installing, adjusting, and testing of all valves and appurtenant work, complete and operable, in accordance with the requirements of the Contract Documents. Where buried valves are shown, the CONTRACTOR shall furnish and install valve boxes to grade, with covers, extensions, and position indicators.
- B. The provisions of this Section shall apply to all valves and valve operators specified in the various Sections and Division 2 of these Specifications except where otherwise specified in the Contract Documents. Valves and operators in particular locations may require a combination of units, sensors, limit switches, and controls specified in other Sections of these Specifications.

1.02 RELATED WORK

- A. Section 02222 - Excavation and Backfill for Utilities
- B. Section 15000 - Piping General

1.03 REFERENCE STANDARDS

- A. Codes: All codes, as referenced herein.
- B. Commercial Standards:

ANSI B16.5	Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys
ANSI/ASME B31.1	Power Piping
ASTM A 36	Specification for Structural Steel
ASTM A 48	Specification for Gray Iron Castings
ASTM A 126	Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A 536	Specification for Ductile Iron Castings
ASTM B 61	Specification for Steam or Valve Bronze Castings
ASTM B 62	Specification for Composition Bronze or Ounce Metal Castings
ASTM B 148	Specification for Aluminum-Bronze Castings

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VALVES GENERAL

ASTM B 584	Specification for Copper Alloy Sand Castings for General Applications
ANSI/AWWA C500	Gate Valves
ANSI/AWWA C507	Ball Valves 6 Inches Through 48 Inches
ANSI/AWWA C509	Resilient-Seated Gate Valves for Water and Sewage Systems
ANSI/AWWA C511	Reduced-Pressure Principle Backflow-Prevention Assembly
AWWA C550	Protective Interior Coatings for Valves and Hydrants
SSPC-SP-2	Hand Tool Cleaning
SSPC-SP-5	White Metal Blast Cleaning

1.04 SUBMITTALS

- A. Shop Drawings: Shop drawings of all valves and operators including associated wiring diagrams and electrical data, shall be furnished.
- B. Valve Labeling: The CONTRACTOR shall submit a schedule of valves to be labeled indicating in each case the valve location and the proposed wording for the label.

1.05 QUALITY ASSURANCE

- A. All valves and related appurtenances shall be manufactured in the United States.
- B. Valve Testing: Unless otherwise specified, each valve body shall be tested under a test pressure equal to twice its design water-working pressure.
- C. Bronze Parts: Unless otherwise specified, all interior bronze parts of valves shall conform to the requirements of ASTM B 62, or where not subject to dezincification, to ASTM B 584.
- D. Certification: Prior to shipment, the CONTRACTOR shall submit for all valves over 12 inches in size, certified, notarized copies of the hydrostatic factory tests, showing compliance with the applicable standards of AWWA, ANSI, ASTM, etc.
- E. All lids and valve boxes shall be colored Pantone Purple 522C and marked "Reclaimed Water".

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VALVES GENERAL

Part 2 - PRODUCTS

2.01 GENERAL

- A. The CONTRACTOR shall furnish all valves, gates, valve operating units, stem extensions, operators and other accessories as shown or specified. All valves and gates shall be new and of current manufacture. All valve boxes shall be Taylor and all valves shall have a minimum design pressure rating of 150 psi unless otherwise specified elsewhere herein.
- B. Ductile iron parts of valves shall meet the requirements of ASTM A126, "Standard Specifications for Gray Iron Castings for Valves, Flanges and Pipe Fittings, Class 'B'." Flanged ends shall be flat-faced and have bolt circle and bolt patterns conforming to ANSI B16.1 Class 125.
- C. All castings shall be clean and sound, without defects of any kind and no plugging, welding or repairing of defects will be permitted. All bolt heads and nuts shall be hexagonal conforming to ANSI B18.2. Gaskets shall be full-face and made of synthetic elastomers in conformance with ANSI B16.21 suitable for the service characteristics, especially chemical compatibility and temperature. Non-ferrous alloys of various types shall be used for parts of valves as specified. Where no definite specification is given, the material shall be the recognized acceptable standard for that particular application.
- D. All buried valves shall be provided with cast-iron valve boxes unless otherwise indicated. The boxes shall conform to CITY Standards and be installed perpendicularly, centered around and covering the upper portions of the valve operator. The top of each valve box shall be placed flush with finish grade unless otherwise indicated on the Drawings. Valve boxes shall be as specified elsewhere in this Section.
- E. All buried valves and other valves located below a concrete operating deck or level, specified or noted to be key operated, shall have an operator to finish grade or deck level, non-rising stem, a 2-inch square AWWA nut with skirt, and cover or box and cover, as may be required.
- F. Protective Coating: Except where otherwise specified, ferrous surfaces, exclusive of stainless steel surfaces, in the fluid passages of all valves 4-inch and larger shall receive an epoxy coating in accordance with AWWA C550. Flange faces of valves shall not be epoxy coated. The valve manufacturer shall certify in writing that such coating has been applied and tested in the manufacturing plant prior to shipment, in accordance with these

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VALVES GENERAL

Specifications. Exterior coating shall be asphalt varnish conforming to Federal Specification TT-C-494A.

- G. Nuts and Bolts: All nuts and bolts on valve flanges and supports shall be in accordance with manufacturer's recommendations. Where submerged or buried, all nuts and bolts on valve flanges and valve bodies shall be stainless steel. Nuts and bolts shall be of different grades of stainless steel to prevent galling.
- H. Valve Labeling: A label shall be provided on all shut-off valves exclusive of hose bibs and chlorine cylinder valves. The label shall be of 1/16-inch brass or stainless steel, minimum 2 inches by 4 inches in size, and shall be permanently attached to the valve or on the wall adjacent to the valve or as indicated by the CITY.

I. END CONNECTIONS:

- 1. The dimensions of end connections shall conform to AWWA Standard C111-85. The end flanges of flanged valves shall conform in dimensions and drilling to ANSI Standard B16.1 for cast iron flanges and flanged fittings, Class 125, unless specifically provided otherwise. The bolt holes shall straddle the vertical center-line.

2.02 GATE VALVES THREE INCH (3") TO TWELVE INCH (12"):

- A. The valves shall be resilient seated and shall conform in design, material, and workmanship to the standards of AWWA C509. Gate valves shall open counterclockwise and shall be of iron body, non-rising stem, and mechanical cut-in joint ends. All resilient seat valves must be bi-directional.
- B. Valves shall be coated with a two-part thermosetting epoxy coating on inside of valve and on valve disc. The coating shall conform to the requirements of AWWA C-550. After the factory test and inspection, all ferrous parts of the valves except finished or bearing surfaces shall be painted with two (2) coats of asphalt varnish, Federal Specification TT-V-51A or approved equal.
- C. Gate valves four inches (4") through twelve inches (12") in diameter shall be lead free American Flow Control Series 2500, or U.S. Pipe A-USP1 Resilient Wedge Gate Valves. No Substitutions.

2.03 TERMINAL BLOW-OFF VALVES:

- A. The terminal blow-off valve assemblies shall be installed in accordance with the details shown in Broward County Standard Details. The following products shall be used to construct the assemblies:

SECTION 15100

VALVES GENERAL

- B. Angle Valves (for terminal blow-off): 2-inch threaded valves with handwheel, bronze body and composition disc. 2-inch angle valves for terminal blow-off shall be Nibco T311 or ITT Grinnell Fig. No. 3220
- C. After the tap has been made and the corporation stop has been installed on a pipe conveying potable water, the exposed exterior surfaces of the stop shall be heavily coated with Kop-Coat Super Hi-Gard 891 White 1898, or approved equal. Where taps are made in a pipe conveying sewerage, the CONTRACTOR shall heavily coat the inside of the pipe around the stop and the exposed exterior surfaces of the stop with Bitumastic 300M, by Kop-Coat Co., or Protector 401 for sewer applications.
- D. The installation of the terminal blow-off outlet shall include excavation; cutting, threading and installing PVC and galvanized pipe and fittings; tapping the ductile iron plug; concrete thrust block; furnishing and installing angle valve; cutting and placing cast iron riser pipe complete with valve boxes and cover, set in concrete; backfilling and compaction; and all other appurtenant items and work.

2.04 AIR-VACUUM AND AIR-RELEASE VALVES

- A. Air and Vacuum Valves: Air and vacuum valves shall be capable of venting large quantities of air while pipelines are being filled, and allowing air to re-enter while pipelines are being drained. They shall be of the size shown, with flanged or screwed ends to match piping. Bodies shall be of high-strength cast iron. The float, seat, and all moving parts shall be constructed of Type 316 stainless steel. Seat washers and gaskets shall be of a material insuring water tightness with a minimum of maintenance. Valves shall be designed for minimum 150 psi water-working pressure, unless otherwise shown.
- B. Air-Release Valves: Air-release valves shall vent accumulating air while system is in service and under pressure and be of the size shown and shall meet the same general requirements as specified for air and vacuum valves except that the vacuum feature will not be required. They shall be designed for a minimum water-working pressure of 150 psi, unless otherwise shown.
- C. Combination Air Valves: Combination air valves shall combine the characteristics of air and vacuum valves and air release valves by exhausting accumulated air in systems under pressure and releasing or re-admitting large quantities of air while a system is being filled or drained, respectively. They shall have the same general requirements as specified for air and vacuum valves.
- D. Air Vacuum and Release Manufacturers or Equal:

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1. APCO (Valve and Primer Corporation);
2. Golden-Anderson Valve Division (GA Industries, Inc);
3. Val-Matic (Valve and Manufacturing Corporation).

2.05 CORPORATION STOPS (Ball Valve Type)

- A. Unless otherwise shown, corporation stops shall be made of brass alloy for key operation, with screwed ends with corporation thread or iron pipe thread, as required. AWWA taper thread for inlet thread and compression type fittings for outlet.
- B. Corporation Stop Manufacturer or Equal:
 1. Ford Meter Box Company;
 2. James Jones Company;
 3. Mueller Company.

2.06 TAPPING VALVES AND TAPPING SLEEVES:

- A. Tapping Sleeves - See Section 15102 – Tapping Sleeves and Tapping Valve.
- B. Tapping Valves – Refer to Gate Valves in Section 2.04.C above.

2.07 VALVE BOXES AND COVERS

- A. Valve boxes and covers for all size valves shall be of cast iron construction and adjustable screw-on type. The lid shall have cast in the metal the word "RECLAIMED WATER" for the reuse water lines. All valve boxes shall be six-inch (6") nominal diameter and shall be suitable for depths of the particular valve. The stem of the buried valve shall be within twenty-four inches (24") of the finished grade unless otherwise approved by the ENGINEER. Valve boxes for 3" through 20" valves shall be Tyler Union model 6860 Cast Iron screw-type valve box with 5- $\frac{1}{4}$ " locking lid, or approved equal.
- B. Cast iron valve box shall not rest directly upon the body of the valve or upon the pipe. The box shall be placed in proper alignment and to such an elevation that its top will be at the final grade. Backfilling around both units shall be placed and compacted to the satisfaction of the ENGINEER.

Part 3 - EXECUTION

3.01 VALVE INSTALLATION

- A. General: All work shall be performed by skilled workmen experienced in similar installations. All valves shall be adequately supported by clamps, brackets,

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straps, concrete supports or other devices as shown or specified. All supports shall be secured to structures by approved inserts or expansion shields and bolts.

- B. All valves shall be thoroughly cleaned internally before being installed. Installation of valves shall be done in accordance with this section.
- C. All valves, gates, operating units, stem extensions, valve boxes, and accessories shall be installed in accordance with the manufacturer's written instructions and as shown and specified. All gates shall be adequately braced to prevent warpage and bending under the intended use. Valves shall be firmly supported to avoid undue stresses on the pipe. Install valves so that they are easily accessible for operation, visual inspection and preventive maintenance.
- D. Location of valves and chain operators: Install valves so as to be accessible for operation and free from interferences when operated. Position so that leakage will not contact any electrical equipment that may be located below.
- E. The installation of all underground valves shall include a valve box and riser in accordance with the Details shown on the Plans or in the Standard Details for the various sizes and types of valves to be installed. Riser pipes and valve boxes shall be carefully centered and set flush with the finished grade if in paving, or with the top of the ground if out of paved areas. All valve boxes shall be held in position with concrete as shown on the Plans or in the Standard Details.
- F. Upon completion of the Project, but prior to final acceptance, the CONTRACTOR in the presence of the ENGINEER, shall fully open each valve installed by him, except at connections to existing CITY mains. Valves at connections to existing CITY mains shall only be operated by CITY forces.
- G. Valve Accessories: Where combinations of valves, sensors, switches, and controls are specified, it shall be the responsibility of the CONTRACTOR to properly assemble and install these various items so that all systems are compatible and operating properly. The relationship between interrelated items shall be clearly noted on shop drawing submittals.
- H. Flange Ends:
 - 1. Flanged valve bolt holes shall straddle vertical centerline of pipe.
 - 2. Clean flanged faces, insert gasket and bolts, and tighten nuts progressively and uniformly.
- I. Screwed Ends:
 - 1. Clean threads by wire brushing or swabbing.

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2. Apply joint compound.

J. Valve Orientation:

1. Install operating stem vertical when valve is installed in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above finished floor, unless otherwise shown.
2. Install operating stem horizontal in horizontal runs of pipe having centerline elevations between 4 feet 6 inches and 6 feet 9 inches above finish floor, unless otherwise shown.
3. Orient butterfly valve shaft so that unbalanced flows or eddies are equally divided to each half of the disc, i.e., shaft is in the plane of rotation of the eddy.
4. If no plug valve seat position is shown, locate as follows:
 - (a) Horizontal Flow: The flow shall produce an "unseating" pressure, and the plug shall open into the top half of valve.
 - (b) Vertical Flow: Install seat in the highest portion of the valve.

K. Install a line size ball valve and union upstream of each solenoid valve, in-line flow switch, or other in-line electrical device, excluding magnetic flowmeters, for isolation during maintenance.

L. Locate valve to provide accessibility for control and maintenance. Install access doors in finished walls and plaster ceilings for valve access.

M. Extension Stem for Operator: Where the depth of the valve is such that its centerline is more than 3 feet below grade, furnish an operating extension stem with 2-inch operating nut to bring the operating nut to a point 6 inches below the surface of the ground and/or box cover.

N. Torque Tube: Where operator for quarter-turn valve is located on floor stand, furnish extension stem torque tube of a type properly sized for maximum torque capacity of the valve.

3.02 TESTS AND INSPECTION

- A. Valve may be either tested while testing pipelines, or as a separate step.
- B. Test that valves open and close smoothly with operating pressure on one side and atmospheric pressure on the other, in both directions for two-way valve and applications.
- C. Inspect air and vacuum valves as pipe is being filled to verify venting and seating is fully functional.

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- D. Count and record number of turns to open and close valve; account for any discrepancies with manufacturer's data.
- E. Set, verify, and record set pressures for all relief and regulating valves.
- F. Test hydrostatic relief valve seating; record leakage. Adjust and retest to maximum leakage of 0.1 gpm per foot of seat periphery.

- END OF SECTION -

SECTION 15102

TAPPING SLEEVES AND TAPPING VALVES

Part 1 - GENERAL

1.01 SCOPE

- A. The CONTRACTOR shall furnish and install tapping sleeves and tapping valves, as shown on the Plans and/or as specified herein. All items not specifically mentioned in these specifications or noted on the Drawings, but which can be reasonably inferred as necessary to make a complete working installation, shall be included.
- B. Tapping sleeves, where shown on the Plans, shall fit the existing pipe to be tapped and the CONTRACTOR shall determine the outside diameter and type of pipe before ordering the sleeve. CONTRACTOR must field verify dimensions, locations, distances and elevations before ordering tapping sleeves. The CONTRACTOR shall adjust his work to conform to said field conditions.
- C. Only tapping sleeves shall be used for tapping existing mains to connect new mains. Tapping saddles will not be permitted.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 15000 - Piping General

1.03 MANUFACTURE

- A. All valves shall be the products of domestic manufacturing firms which have been regularly engaged in the production of valves for at least 5 years. All valves specified herein shall be tested at the factory in accordance with the AWWA Standard Leakage and Hydrostatic Test as modified herein and a certified test report shall be furnished for each valve.

1.04 SUBMITTALS

- A. Shop Drawings: Submit shop drawings for all tapping sleeves and valves.
- B. For all AWWA valves, submit an affidavit stating the valves and all materials used in their construction conform to the applicable requirements of AWWA C500 as modified herein, that all specified tests have been performed and all test requirements have been met.

Part 2 - PRODUCTS

2.01 TAPPING SLEEVES

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TAPPING SLEEVES AND TAPPING VALVES

- A. Tapping sleeves shall be of cast iron construction except as specified below, shall be full-bodied and shall be designed to withstand a working pressure of at least 150 psi.
- B. The tapping sleeves, including outlet flanges shall be as dimensioned and thicknesses shall be as required by AWWA/ANSI C110/A21.10. The tapping sleeves shall be mechanical joint ended, on the run, and shall have a connecting flange outlet, with centering groove (for all valves size 12-inch and below and for valves above 12-inch if available from the manufacturer), for connecting to the tapping valve. For tapping sleeves with outlets 12 inches and smaller, the connecting flange joint between the tapping sleeve and the tapping valve shall be in compliance with all applicable provisions of MSS Standard Practice SP60, latest revision, as developed and approved by the Manufacturers Standardization Society of the Valve and Fittings Industry, 127 Park Street N.E. Vienna, VA. 22180. For tapping sleeves with outlets larger than 12 inches, the connecting flange must provide a matching fit with tapping valves by other manufacturers.
- C. Each mechanical joint on the tapping sleeve shall be furnished complete with tee-head bolts and nuts complying with ANSI/AWWA C111/A21.11, "Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings" (latest edition). Tee-head bolts and hex nuts shall be of high strength cast iron. Bolts and nuts to join the two halves of the sleeve together shall be standard stainless steel, hex, or tee-head bolts and nuts.
- D. Each tapping sleeve shall be furnished complete with all necessary split end gaskets, longitudinal gaskets and two-piece (split) steel glands (follower glands held in place by set screws not acceptable). Gasket shall be shipped separately in suitable protective containers. Material for split end gaskets shall conform to ANSI/AWWA Standard C111/A21.11. Material for longitudinal gaskets shall be rubber conforming to ANSI/AWWA Standard C111/A21.11.
- E. The sleeves shall be suitable for use with ductile iron pipe conforming to ANSI/AWWA Standard C151/A21.51, "Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids", with wall thickness and outside diameter as specified in Table 51.4 and 51.5. The sleeves shall also be suitable for use with other cast iron pipe with differing outside diameters and other types of pipe where required.
- F. The CITY will permit the use of the PowerSeal Pipeline Products Corp. 3490MJ Mechanical Joint tapping sleeve as an approved equal to ductile iron flange-outlet tapping sleeves. This unit has a mechanical joint branch outlet tapping connection which mates with a standard resilient-seated gate valve rather than the tapping flange x mechanical joint ends required by the standard design of tapping sleeves. These units shall be manufactured of Type 304 (18-

SECTION 15102

TAPPING SLEEVES AND TAPPING VALVES

8) Stainless Steel per ASTM A240, with MJ outlets fabricated of Type 304 (18-8) Stainless Steel per ANSI 21.11. Bolts and nuts shall be made of Type 304 (18-8) Stainless Steel per ASTM A193 and A194, respectively. Stainless steel hex nuts shall be furnished with fusion bonded coating to prevent seizing and galling.

2.02 TAPPING VALVE

A. See Specification Section 15100 – Valves, General

Part 3 - EXECUTION

3.01 GENERAL

- A. Where shown on the approved plans, the CONTRACTOR shall install the tapping sleeves and valves of the indicated size, without taking existing main out of service. Under no circumstances shall be CONTRACTOR be permitted to tap these existing mains. The CONTRACTOR shall pressure test the tapping sleeve and valve after installation on the main, but prior to tapping operations. The test shall be conducted in the presence of the CITY's Inspector. No leakage will be permitted at any joint in either the tapping sleeve or tapping valve. Taps shall be made by tapping specialists with credentials acceptable to the CITY.
- B. Tapping valves 16-inch and smaller require the installation of a cast iron or C900 PVC riser pipe, complete with ductile iron valve box and cover, centered over the operator and set in concrete. Tapping valves 16-inch and larger shall be installed in a horizontal position with the operator in the vertical position with valve box over the operator and set in concrete.
- C. Where a tapping valve with by-pass gate valve will be installed, the CONTRACTOR shall install a valve box over the main valve and a valve box over the by-pass valve. Valve boxes and covers for all size valves shall be of cast iron construction and adjustable screw-on type. The lid shall have cast in the metal the word "IRRIGATION" for irrigation mains. All valve boxes shall be six-inch (6") nominal diameter and shall be suitable for depths of the particular valve. The stem of the buried valve shall be within twenty-four inches (24") of the finished grade unless otherwise approved by the ENGINEER. Valve boxes for 3" through 20" valves shall be Tyler Union model 6860 Cast Iron screw-type valve box with 5-1/4" locking lid, or approved equal.
- D. The tapping sleeve and valve shall be installed complete, and the work shall include all necessary excavation, including interlocking sheeting and shoring, backfilling and compaction, surface repairs, and sheeting and shoring outside

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TAPPING SLEEVES AND TAPPING VALVES

of the main trench line, dewatering, testing the sleeve and valve, supporting tapping by CITY forces, constructing the concrete thrust anchor and all other appurtenant items and work. Installation of tapping sleeve shall be in accordance with Broward County Standard Details.

- E. Prior to ordering the tapping sleeve, the CONTRACTOR shall excavate and field-verify the type and outside diameter of the main.

3.02 TAPS

- A. The CONTRACTOR shall comply with all applicable provisions of Subsections 3.01 above, including installation and pressure testing of tapping sleeve and tapping valve in the presence of the CITY's Inspector.
- B. Since cutting equipment used for this type of installation is of a special design, the CONTRACTOR shall make provisions for furnishing a tapping specialist to perform actual tapping operation. The qualifications of the tapping specialist shall be forwarded to the CITY prior to any tapping work. The CONTRACTOR shall also furnish all incidental equipment necessary to operate the tapping machine.
- C. The tapping valve shall be installed in the horizontal position with the operator in the vertical position, and shall include a valve box cover. Tapping valves shall be left in the closed position.
- D. When the invert of the tapping valve is under water, interlocking sheeting and tremie concrete shall be used, unless otherwise approved by the CITY. Seal the perimeter of all pipes passing through the sheeting below the water table. Only minimum seepage will be permitted. The cofferdam must be designed and sealed by a State of Florida, P.E. No work will be permitted within the cofferdam until it is demonstrated to the CITY to be dry. Approval to remove the initial water in the cofferdam must be obtained from the CITY and other governmental agencies having jurisdiction over the work.
- E. All tapping operations shall be conducted under the direct supervision of CITY and/or ENGINEER. All operations shall have prior approval of the CITY.

3.03 RECORD DRAWINGS

- A. The location and elevation for each valve, tapping flange outlet, fitting, service line and other appurtenances along the pipeline shall be recorded by the CONTRACTOR's Florida Registered Land Surveyor.

- END OF SECTION -

SECTION 16000

REMOTE TERMINAL UNIT

PART 1 - GENERAL

1.01 REMOTE TERMINAL UNIT (RTU)

- A) The specific attention of the Contractor is directed to the fact that the City of Hallandale Beach has an existing infrastructure intended for an RTU as manufactured by Data Flow Systems, Melbourne, Florida (321) 259-5009. For compatibility purposes, the Contractor will be required to obtain the Remote Terminal Unit (RTU) specified herein from Data Flow Systems (DFS) 321-259-5009.
- B) The Contractor shall coordinate tower and antenna requirements with DFS. A complete radio survey shall be conducted by DFS to verify antenna requirements. DFS shall license the new RTU with the FCC for operation under the existing radio frequency. The Contractor shall provide station(s) physical location information to DFS for radio communication study purposes. Information shall be provided in the form of GPS readings or street map with actual site location(s) clearly marked. The Contractor shall provide all required information for Sunshine underground locate services and shall serve as underground locate point of contact.
- C) The specified RTU shall be housed in the Motor Control Panel and powered by 480 VAC commercial power. The RTU panel shall be an integral component of the Motor Control Panel and shall provide local and automatic pump station control functions, monitor local statuses and transmit those statuses to the existing central site when polled by the master radio
- D) These specifications are intended to cover the furnishing, the shop testing, the delivery, complete installation and field testing of all equipment and appurtenances for the complete RTU system herein specified, whether specifically mentioned in the Specifications or not. This includes all discrete and analog signal isolation necessary for interfacing with an existing telemetry system.
- E) The unit shall be furnished and installed with all necessary and desirable accessory equipment and auxiliaries whether specifically mentioned in these specifications or not.

PART 2 – PRODUCTS

2.01 REMOTE TERMINAL UNIT (RTU)

The Telemetry Control Unit (TCU) shall be a microprocessor-based multi-pump controller module designed for automatic pump station control. The TCU shall include an integrated radio as specified in paragraph 3.2. As a minimum, the TCU shall incorporate the following features:

- A) On-Board 12-button operator interface keypad and 4x20-character LCD display. Configuration parameters shall be adjustable via the 12-button operator interface keypad or required RS-232 service port.

- B) The LCD display shall provide the elapsed runtime of each pump, the average runtime of each pump, the flow of each pump, the flow of the station and the time of day.
- C) Triplex/Duplex/Simplex configurable. The device shall have the capability of easily being configured for one, two or three pumps via the on-board keypad.
- D) Three (3) on-board HOA switches. Local manual control provided by the HOA switches. Each HOA switch shall be fail safe and operate in the OFF and HAND position without power. Alarms shall indicate that an HOA switch has been left in the HAND or OFF position.
- E) Integrated pump alternation. The pump alternation function will operate based on the number of pumps configured. Automatic alternation around non-operational pumps shall be provided.
- F) Pumps/Starter/Breaker Fault alarms shall be determined by the unit automatically. These alarms shall be activated when a pump is called to run, but fails to run, or if the pump is turned off by the TCU, but continues to run.
- G) Multiple level control input options. The unit shall provide local automatic level control from float, bubbler, transducer, or ultrasonic inputs. Redundancy of level control input shall be supported. An alarm shall be generated when floats are operating out of sequence.
- H) On-board 240 / 480 VAC three-phase-power monitor. The phase monitor shall be transformer-isolated and detect loss of phase, phase reversal, low phase and high phase faults. All phase monitor adjustments shall be adjustable from the keyboard. Phase voltages from phase A to B and from phase A to C shall be transmitted to the central site computer.
- I) Integrated Alarm Light output and Alarm Horn output, each capable of driving 120 VAC loads to ½ amp. An input shall be supplied for external alarm silence button, which shall be used to silence the Alarm Horn.
- J) The unit's internal power supply shall keep the backup battery at a float charge. The backup battery shall not be damaged by deep discharges.
- K) All inputs and outputs shall be optically or magnetically isolated and surge suppressed.
- L) A local RS-232 service port shall provide local access to all the functions of the unit.
- M) The TCU shall be easily removed/replaced by removing two industry standard wire terminal connectors.
- N) Wire terminals shall be used as an interface between the TCU and field wiring. Fuses and voltage reducing resistors shall be used where required by the manufacturer. Wire terminals shall be housed in the same enclosure as the TCU.
- O) Supply voltage shall be 115 VAC. Ambient operating temperature shall be -10°C to 60°C (14°F to 140°F). The upper temperature limit is 50°C (122°F) when using the backup battery. Unit shall be UL Listed and surge tested for EMI Susceptibility to IEC 61000-4-5 Surge Immunity Tests.

2.02 INTEGRATED RADIO

The Integrated Radio shall function as the interface between the TCU and TAC II central site. The Integrated Radio shall incorporate a radio transceiver and associated electronics. The Integrated Radio shall be mounted inside the TCU radio compartment. When combined the TCU with Integrated Radio is referred to as model TAC Pack TCU. At a minimum, the Integrated Radio shall have the following features:

- A) Surge protected radio power.
- B) On board communications and functional firmware.
- C) Watchdog Timer.
- D) On board voltage regulation and radio power supply control.
- E) Radio current, receiver sensitivity and operating temperature are monitored for system diagnostics.

2.03 RTU INPUT & OUTPUT SCHEDULE

- A) As a minimum, the RTU shall provide the following monitor and control capability.
 - 1. Monitor and Control Points
 - a) The following points shall be monitored by the RTU. On, Off, or Fault condition shall be indicated locally at the RTU and remotely at any SCADA Workstation Computer. Any monitoring point shall have the capability of being configured as an alarm in the SCADA software. Any unused monitor points listed, i.e., there is no 3rd pump, shall be capable of being used to monitor other discrete devices.
 - 1) Pump 1 Status
 - 2) Pump 1 Start Fault
 - 3) Pump 1 Stop Fault
 - 4) Pump 2 Status
 - 5) Pump 2 Start Fault
 - 6) Pump 2 Stop Fault
 - 7) Pump 3 Status
 - 8) Pump 3 Start Fault
 - 9) Pump 3 Stop Fault
 - 10) Pump 1 HOA in HAND
 - 11) Pump 1 HOA in AUTO
 - 12) Pump 1 HOA in OFF
 - 13) Pump 2 HOA in HAND
 - 14) Pump 2 HOA in AUTO
 - 15) Pump 2 HOA in OFF
 - 16) Pump 3 HOA in HAND
 - 17) Pump 3 HOA in AUTO
 - 18) Pump 3 HOA in OFF
 - 19) Low Well Level Float
 - 20) Off Well Level Float
 - 21) Lead Well Level Float
 - 22) Lag Well Level Float
 - 23) Lag2 Well Level Float

- 24) High Well Level Float
- 25) Float Sequence Fault
- 26) Well Level Transducer (4-20 mA)
- 27) Well Level Transducer Input Fault
- 28) Analog Input 2 (4-20 mA)
- 29) Analog Input 2 Fault
- 30) Auxiliary Discrete Input (discrete or pulse)
- 31) Phase Voltage Fault
- 32) Three Phase Power Monitor (240/480)
- 33) Phase Sequence Fault
- 34) Phase AB Voltage
- 35) Phase AC Voltage
- 36) RTU Memory Fault
- 37) AC Power Fault
- 38) DC Bias Voltage Fault
- 39) Alarm Silence Button
- 40) Alarm Horn Status
- 41) Alarm Light Status

b) The following discrete control points shall be provided with the RTU. On or Off condition shall be indicated locally at the RTU and remotely at any SCADA Workstation Computer. Any unused control points listed, i.e., there is no 3rd pump, shall be capable of being used as a general purpose discrete outputs.

- 1) Pump 1 Control
- 2) Pump 1 Disable
- 3) Pump 2 Control
- 4) Pump 2 Disable
- 5) Pump 3 Control
- 6) Pump 3 Disable
- 7) Total Station Disable
- 8) Alarm Horn Control
- 9) Alarm Horn Disable
- 10) Alarm Light Control
- 11) Alarm Light Disable
- 12) Auxiliary Output
- 13) Auxiliary Output Override
- 14) Auxiliary Output Disable

c) The RTU shall automatically control a pump based on level settings only when the RTU's HOA is in the Auto position for a given pump. Both local auto and remote control functions shall be disabled when the RTU's HOA switch is in the "Off" or "Hand" position for a given pump.

2.04 BACKUP BATTERY

The RTU shall be provided with a 3.0 AHr backup battery. The backup battery shall be model PE12V3A as manufactured by Portalac.

2.05 SURGE PROTECTION

Multiple staged surge protection shall be provided for all power supply and power monitoring circuits. One stage of protection shall be equipped with both energy limiting and clamping circuits with slow blow fuses designed for overload conditions. This design shall provide a very high level of non-destructive transient immunity. With the exception of a direct lightning strike, the device shall protect the TCU power supply and power monitoring circuits from damage due to voltage transients. The unit shall provide circuit protection to withstand multiple transients in excess of 6,500 volts, 3,250 amps, without damage. Damage shall be limited to a blown fuse when exposed to larger transients. The device shall be transient-tested to ANSI standard C62.41. The unit shall meet or exceed the quality, reliability and performance of the Transient Filter Shield TFS001 as manufactured by Data Flow Systems. The AC power input protection shall meet or exceed the quality, reliability and performance of the Single Phase Suppressor, SPS001 (or, if three phase power is in use, the Three Phase Suppressor, TPS001) as supplied by Data Flow Systems.

2.06 ANTENNA SUBSYSTEM

- A) A high gain directional antenna shall be used to transmit and receive data at the RTU. It shall be supported on a mast/pole and have DC grounding for lightning protection. The antenna mast/pole shall be hot dipped galvanized for corrosion protection. All mounting hardware shall be made of stainless steel. The mast shall meet or exceed the quality and reliability of the AG20 manufactured by Rohn.
- B) The coax cable shall be the type that utilizes an inert semi-liquid compound to flood the copper braid. The coax cable shall be of the RG-8 construction type and have the RF loss characteristic of foam flex. The coax cable shall be RTC 400 as supplied by Data Flow Systems, Inc.
- C) Type N connectors shall be utilized at both ends of the coax. The Type N connectors shall be sealed with 3-inch sections of Alpha FIT321-1-0 sealant shrink tubing. The coax cable shall be secured to the mast/pole with E.V.A.-coated 316 stainless steel cable ties. The cable ties shall meet or exceed the quality, reliability and performance of AE112 cable ties manufactured by Band-It.
- D) The antenna shall be an all welded aluminum elements. The antenna shall have a single radiator element connected to a type N female connector. The antenna shall be the RTA series as supplied by Data Flow Systems, Inc.
- E) A coaxial surge protector model IS-B50LN-C2 as manufactured by Polyphaser shall be supplied with the RTU.

2.07 WET WELL SUBMERSIBLE PRESSURE TRANSDUCER

- A) A Blue Ribbon Corp. Birdcage series submersible pressure transducer will be installed in the wet well. It will provide a 4-20 mA level signal to the TCU.

PART 3 – EXECUTION

3.01 INSTALLATION

Three Island Reuse Irrigation Project
City of Hallandale Beach

Remote Terminal Unit

- A) Install and place into operation a complete new RTU System at the site. This work shall include the new antenna system, all interconnecting wiring, conduit, and circuitry necessary to provide the owner with a fully operable RTU.
- B) Install and mount equipment in accordance with the Contract Documents, manufacturer's instructions and shop drawings. Rigidly support and mount equipment level and plumb, and in such a manner as to provide accessibility; protection from damage; isolation from heat, shock, and vibration; and freedom from interference with other equipment, piping, and electrical components.
- C) Include the services of a factory trained, qualified service engineer of the equipment manufacturer to inspect the complete equipment installation to assure that it's installed in accordance with the manufacturer's recommendations, make all adjustments necessary to place the system into trouble-free operation.
- D) All workmanship utilized in the manufacture and installation of this system shall be of the highest quality and performed in a manner consistent with all accepted industry practices.
- E) The Central Site SCADA Server shall be modified to incorporate a new HMI graphical screen for this station. The graphical screen shall be consistent with existing lift station screens.

3.02 WARRANTY

The manufacturer shall warrant all hardware and software provided under this contract against all defects in material and workmanship for a period of one year. The TAC Pack TCU shall carry an additional 2-year return-to-factory warranty. The TAC Pack TCU warranty shall also cover damage due to lightning the entire three year period.

3.03. SERVICE

The manufacturer shall offer full factory support of the installed system through the use of factory employees. Service representatives who are not direct employees of the manufacturer, or who are not specifically trained in the service of the owner's existing SCADA System shall be unacceptable. The customer shall have 24 hour per day access to service personnel.

END OF SECTION

ELECTRONIC CONTROL VALVE



Purchase Specification

Model No. 131-01/631-01 ELECTRONIC CONTROL VALVE

Sizes 1" - 36"

Function

The Electronic Control Valve shall control flow, pressure, tank level or valve position. The optional VC-22D Electronic Valve Controller enables remote computer control over valve operations.

"Tying" of equipment into packages for the purpose of thwarting competition shall be considered to be in non-compliance with these specifications. Manufacturers shall price items under different subsections or sections separately.

Main Valve

The valve shall be hydraulically operated, single diaphragm-actuated, globe or angle pattern. The valve shall consist of three major components: the body with seat installed, the cover with bearing installed, and the diaphragm assembly. The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure. Packing glands and/or stuffing boxes are not permitted and there shall be no pistons operating the main valve or pilot controls.

Main Valve Body

No separate chambers shall be allowed between the main valve cover and body. Valve body and cover shall be of cast material. Ductile Iron is standard and other materials shall be available. No fabrication or welding shall be used in the manufacturing process. Total shipping weight shall be equal or greater in all respects to the Hytrol 100-01/100-20 body.

The valve shall contain a resilient, synthetic rubber disc with a rectangular cross-section contained on three and one-half sides by a disc retainer and forming a tight seal against a single removable seat insert. No O-ring type discs (circular, square, or quad type) shall be permitted as the seating surface. The disc guide shall be of the contoured type to permit smooth transition of flow and shall hold the disc firmly in place. The disc retainer shall be of a sturdy one-piece design capable of withstanding opening and closing shocks. It must have straight edge sides and a radius at the top edge to prevent excessive diaphragm wear as the diaphragm flexes across this surface. No hour-glass shaped disc retainers shall be permitted and no V-type or slotted type disc guides shall be used.

The diaphragm assembly containing a non-magnetic 303 stainless steel stem; of sufficient diameter to withstand high hydraulic pressures, shall be fully guided at both ends by a bearing in the valve cover and an integral bearing in the valve seat. The seat shall be a solid, one-piece design and shall have a minimum of a five-degree taper on the seating surface for a positive, drip-tight shut off. No center guides shall be permitted. The stem shall be drilled and tapped in the cover end to receive and affix such accessories as may be deemed necessary. The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure.

The flexible, non-wicking, FDA approved diaphragm shall consist of nylon fabric bonded with synthetic rubber compatible with the operating fluid. The center hole for the main valve stem must be sealed by the vulcanized process or a rubber grommet sealing the center stem hole from the operating pressure. The diaphragm must withstand a Mullins Burst Test of a minimum of 600 x per layer of nylon fabric and shall be cycle tested 100,000 times to insure longevity. The diaphragm shall not be used as the seating surface. The diaphragm shall be fully supported in the valve body and cover by machined surfaces which support no less than one-half of the total surface area of the diaphragm in either the fully opened or fully closed position.



Purchase Specification

The main valve seat and the stem bearing in the valve cover shall be removable. The cover bearing and seat in 6" and smaller size valves shall be threaded into the cover and body. The valve seat in 8" and larger size valves shall be retained by flat head machine screws for ease of maintenance. The lower bearing of the valve stem shall be contained concentrically within the seat and shall be exposed to the flow on all sides to avoid deposits. To insure proper alignment of the valve stem, the valve body and cover shall be machined with a locating lip. No "pinned" covers to the valve body shall be permitted. Cover bearing, disc retainer, and seat shall be made of the same material. All necessary repairs and/or modifications other than replacement of the main valve body shall be possible without removing the valve from the pipeline. Packing glands and/or stuffing boxes shall not be permitted and components including cast material shall be of North American manufacture.

The valve manufacturer shall warrant the valve to be free of defects in material and workmanship for a period of three years from date of shipment, provided the valve is installed and used in accordance with all applicable instructions. Electrical components shall have a one-year warranty.

The valve manufacturer shall be able to supply a complete line of equipment from 1 1/4" through 24" sizes and a complete selection of complementary equipment. The valve manufacturer shall also provide a computerized cavitation chart which shows flow rate, differential pressure, percentage of valve opening, Cv factor, system velocity, and if there will be cavitation damage.

Material Specification

Valve Size:
Main Valve Body and Cover:
Main Valve Trim:
End Detail:
Pressure Rating:
Temperature Range:
Rubber Material:
Coating:
Desired Options:

Pilot Control System

The 131/631-01 hydraulic control valve pilot system shall consist of dual solenoids which alternately apply or relieve pressure to the diaphragm chamber to position the main valve. They shall be normally closed (energized to open), 120 or 240 volt AC with Nema type 4 enclosure. A manual system to by-pass the solenoids shall also be provided.

Optional Electronic Valve Controller

The Model VC-22D electronic controller shall provide the interface between a remote computer system and a hydraulic control valve to provide remote electronic control operation of the valve. The electronic controller shall be supplied with pre-programmed valve application templates used to setup and configure the controller to match the desired function of the valve in the piping system.

The controller display shall be a color TFT screen to graphically display valve application with integral real-time system information.

An IP-68 enclosure shall be provided to house the controller for environmental protection. An anodized aluminum mounting bracket suitable for mounting on pipe or wall shall be supplied as standard. The controller shall feature a multi-PID loop control with local or remote set point input. The controller shall include six (6) configurable analog inputs; six (6) dry contact digital inputs; four (4) 4-20mA analog inputs; and two (2) solid-state relays.

The controller shall be enable configurable set point ramping to protect against system surges and shall also include a configurable flow totalizer. High speed logging data (1000Hz) shall be downloadable to a portable memory device such as a USB drive. Security codes shall be provided to protect against unauthorized changes.



Purchase Specification

The electronic controller shall be capable of data retransmission to SCADA or similar control systems and shall be capable of generating and sending signal loss warnings and other configurable control actions. Alarm outputs shall be provided as standard rather than an optional feature.

Each VC-22D controller enclosure and supporting AC/DC power supply conversion box enclosure (where required), come standard with their own individual universal bracket(s), allowing for versatile installation as follows:

- System Piping (horizontally or vertically)
- Panel / Cabinet (via DIN rail furnished by others. Clips for mounting to DIN rail to be supplied by Cla-Val)
- Sufficient clearance around controller enclosure should be made for adequate access/wiring
- Considerations should be made to comply with all the various local codes, standards and best practices
- Band clamps
- Wall mounting

Function

Utilizing electronic digital control, solenoid pilots equipped onto the control valve(s) are actuated by electrical signals received from the Electronic Valve Controller which enables remote computer control over the diaphragm valve operations. The solenoids either add or relieve line pressure from the cover chamber of the diaphragm valve, causing it to open or close as directed by the Electronic Valve Controller. Each solenoid is controlled by a solid state relay with zero switching voltage. The total cycle time between each pulse shall be programmable.

In either digital or analog control, the Electronic Valve Controller shall accept an analog 4-20mA feedback signal. Upon receiving the remote set-point command from the computer system or local command from the operator, the Electronic Valve Controller shall provide a digital signal or 4-20 mA analog signal to the appropriate pilot(s) and maintain the desired set-point value. When the feedback signal is within a programmable dead band zone, the appropriate electronic pilot(s) on the control valve will not activate; control valve will maintain position. When the feedback signal deviates from or approaches the set-point, the appropriate electronic pilot(s) will be activated, smoothly modulating the valve to its set-point. Preinstalled valve application templates allow the Electronic Valve Controller to be configured to perform a wide range of control valve functions, such as; pressure management, pressure reducing, pressure sustaining, rate of flow control, level control or valve position.

For additional VC-22D Electronic Valve Controller purchase specs., please refer to VC-22D Purchase Specifications at: <http://www.cla-val.com/vc-22d-e-controller-p-482-l-en.html>

This valve shall be a Cla-Val Co. Model No. 131-01/631-01 Electronic Control Valve as manufactured by Cla-Val Co., Costa Mesa, CA 92627.

Electronic Control Valves



Model 131-01/631-01

- Simple Proven Design
- Quality Solenoid Pilot Controls
- Ideal For SCADA Systems
- Multi-Function Capability; Hydraulic Backup
- Security System to Prevent Unauthorized Changes
- Easy to Maintain

The Cla-Val Series 131/631 Electronic Control Valves are designed specifically for applications where remote control of the valve is preferred. It is a hydraulically operated, pilot controlled, diaphragm valve. The solenoid pilot controls are actuated by electrical signals from the optional VC-22D Electronic Valve Controller. The solenoid pilots either add or relieve line pressure from the cover chamber of the valve, causing it to open or close as directed by the electronic controller.

Series 131/631 Electronic Control valves can be configured to perform a wide range of functions, such as; pressure reducing, pressure sustaining, flow control, or level control. The electric controls can also be combined with hydraulic controls to create dual function, or fail-safe capability.

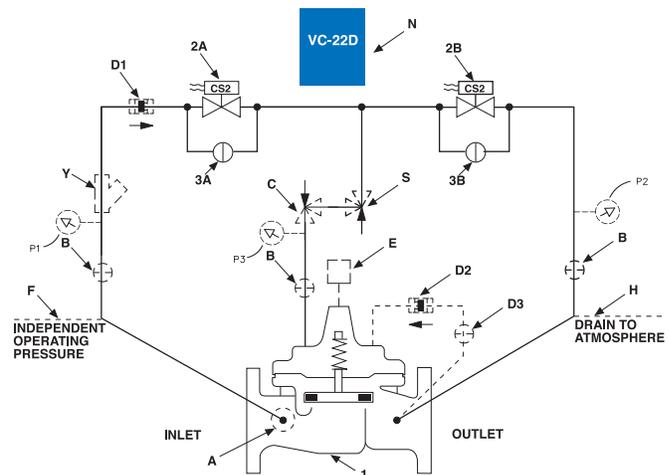
The basic 131-01/631-01 Electronic Control Valve (Schematic shown below) includes the main valve and solenoid pilot controls. Optional features include the VC-22D Electronic Valve Controller and the X117 Series Valve Position Transmitter. If the check feature option is added, and a pressure reversal occurs, the downstream pressure is admitted into the cover, closing the valve.

Schematic Diagram

Item	Description
1	Hytrol (Main Valve)
2	CS2 Solenoid Control
3	CK2 (Solenoid By-Pass)

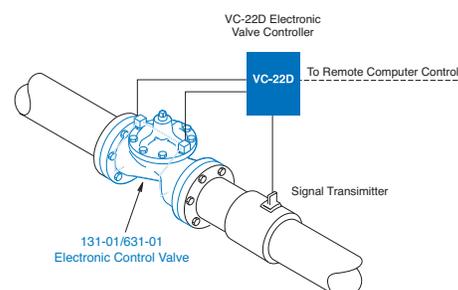
Optional Features

Item	Description
A	X46A Flow Clean Strainer
B	CK2 (Isolation Valve)
C	CV Flow Control (Closing)
D	Check Valves With Isolation Valve
E	X117 Series Position Transmitter
F	Independent Operating Pressure
H	Atmospheric Drain
N	Electronic Controller
P	X141 Pressure Gauge
S	CV Flow Control (Opening)
Y	X43 "Y" Strainer



Typical Applications

This brochure contains typical application that are modifications to the basic 131-01/631-01 Electronic Control Valve shown here. It is typical installed in a pipeline with a VC-22D Series Controller that receives a process variable signal that is compared to set-point and adjusts the main valve's capacity until the signals match. There are many different variations not shown in this brochure. Contact us with your specific application and we will provide a field proven solution.



Schematic Diagram

- | Item | Description |
|------|---------------------------------|
| 1 | Hytrol (Main Valve) |
| 2 | CS2 Solenoid Control |
| 3 | CK2 Cock (Solenoid By-Pass) |
| 4 | CDS6A Altitude Control |
| 5 | 100-02 Powertrol (Reverse Flow) |
| 6 | 100-01 Hytrol (Reverse Flow) |

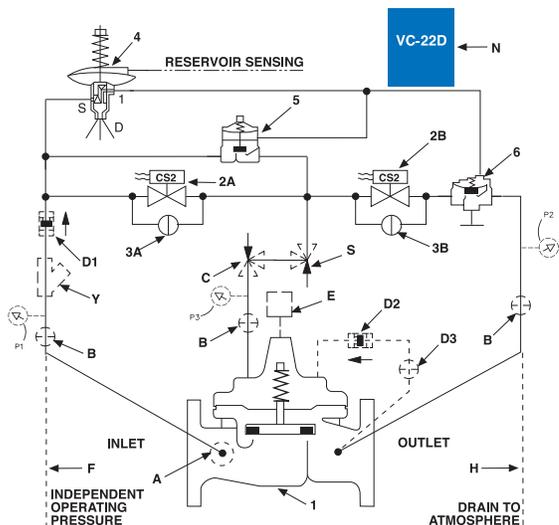
Optional Features

- | Item | Description |
|------|-----------------------------------|
| A | X46A Flow Clean Strainer |
| B | CK2 Cock (Isolation Valve) |
| C | CV Flow Control (Closing) |
| D | Check Valves with Isolation Valve |
| E | X117 Series Position Transmitter |
| F | Independent Operating Pressure |
| H | Atmospheric Drain |
| N | Electronic Controller |
| P | X141 Pressure Gauge |
| S | CV Flow Control (Opening) |
| Y | X43 "Y" Strainer |

131-06/631-06

Combination Electronic Control And High Level Shut-Off Valve

This valve is used in reservoir applications where the filling or draining rate is controlled and modulated by the electronic controller. Flow pressure and valve position can also be controlled. Should the liquid in the reservoir reach a high level, the hydraulic altitude control automatically overrides the electronic control and closes the valve. The altitude control can be adjusted to close the valve over a wide range of settings. The optional check feature will close the valve if there is a pressure reversal in the line.



131-09/631-09

Modulating Float Valve With Solenoid Lockout of Float Control and Electronic Positioning

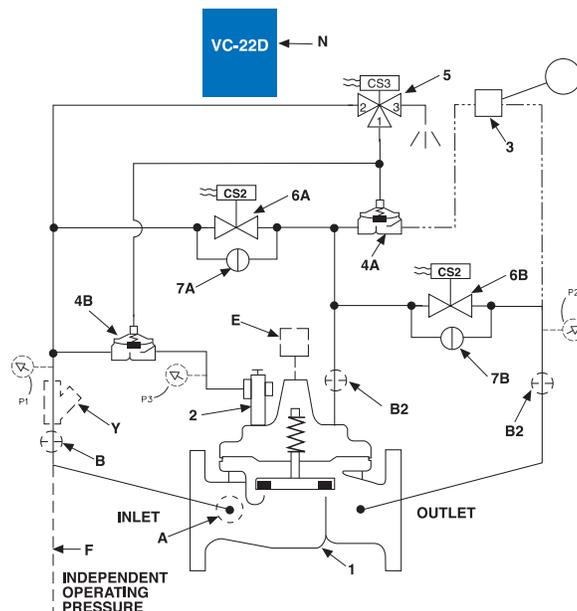
The electronic controller modulates the flow through this valve to control liquid level in a tank. If power failure should occur, the third solenoid shifts, and the float control will allow the valve to modulate using hydraulic line pressure. The VC-22D Electronic Valve Controller and X117 Series Valve Position Transmitter are used in combination with an electronic level sensing device to provide modulating flow control of the valve.

Schematic Diagram

- | Item | Description |
|------|------------------------------|
| 1 | Hytrol (Main Valve) |
| 2 | X74B-3 Stem Valve |
| 3 | CFM-7 Float Pilot |
| 4 | 100-01 Hytrol (Reverse Flow) |
| 5 | CS3 Solenoid Control |
| 6 | CS2 Solenoid Control |
| 7 | CK2 Solenoid By-Pass |

Optional Features

- | Item | Description |
|------|----------------------------------|
| A | X46A Flow Clean Strainer |
| B | CK2 Cock (Isolation Valve) |
| E | X117 Series Position Transmitter |
| F | Independent Operating Pressure |
| N | Electronic Controller |
| P | X141 Pressure Gauge |
| Y | X43 "Y" Strainer |



Schematic Diagram

- | Item | Description |
|------|-------------------------------|
| 1 | Hytrol (Main Valve) |
| 2 | X58C Restriction Assembly |
| 3 | CS3 Solenoid Control |
| 4 | 100-01 Hytrol (Reverse Flow) |
| 5 | CRD Pressure Reducing Control |
| 6 | CK2 Solenoid Control |
| 7 | CK2 Solenoid Bypass |

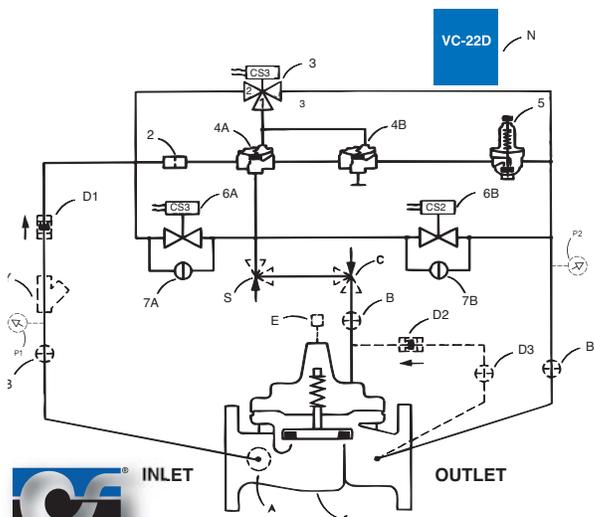
Optional Features

- | Item | Description |
|------|--|
| A | X46A Flow Clean Strainer |
| B | CK2 Isolation Valve |
| C | CV Flow Control (Closing) |
| D | Check Valves Isolation Valve |
| E | X117 Series/X117E Position Transmitter |
| N | Electronic Controller (Single) |
| P | X141 Pressure Gauge |
| S | CV Flow Control (Opening) |
| Y | X43 "Y" Strainer |

131-18/631-18

Electronic Control Valve Equipped with Hydraulic Pressure Reducing Solenoid Selected

Flow, pressure, level or valve position is normally controlled by the electronic controller that operates two solenoids to modulate the valve to maintain the process variable. Should a power failure occur, a parallel hydraulically operated pressure reducing pilot system takes control of the valve maintaining a preset outlet pressure. When power is restored, the valve automatically reverts back to the electronic mode. The optional check feature automatically will close the valve if a pressure reversal occurs in the pipeline.



131-22/631-22

Electronic Control Valve (Power Fail Closed)

Flow, pressure, level or valve position is normally controlled by the electronic controller that operates two solenoids to modulate the valve to maintain the process variable. Should a power failure occur, the valve can be configured to go open or closed. The optional check feature automatically will close the valve if a pressure reversal occurs in the pipeline.

Schematic Diagram

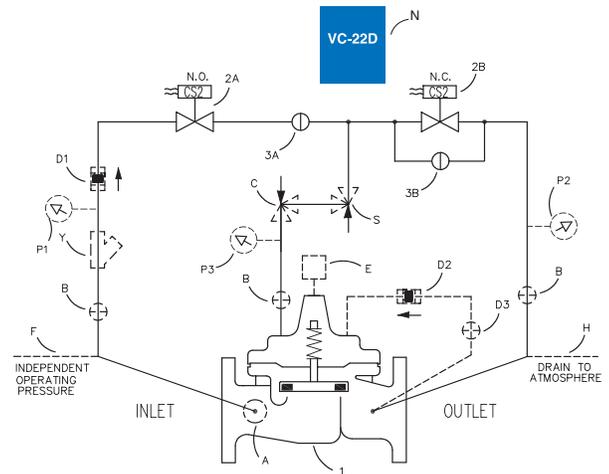
Item Description

- 1 100-01 Hytrol (Main Valve)
- 2 CS2 Solenoid Control
- 3 CK2 (Solenoid By-Pass)

Optional Features

Item Description

- A X46A Flow Clean Strainer
- B CK2 Isolation Valve
- C CV Flow Control (Closing)
- D Check Valves with Isolation valve
- E X117 Series Position Transmitter
- F Independent Operating Pressure
- H Atmospheric Drain
- N Electronic Controller
- P X141 Pressure Gauge
- S CV Flow Control (Opening)
- Y X43 "Y" Strainer



Schematic Diagram

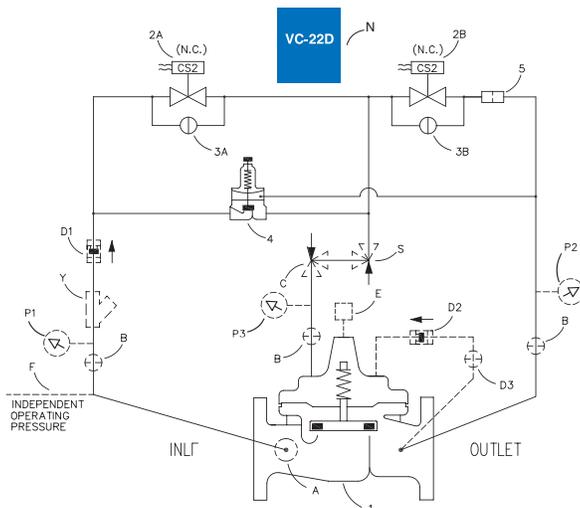
Item Description

- 1 Hytrol (Main Valve)
- 2 CS2 Solenoid Control
- 3 CK2 Solenoid By-Pass
- 4 CRL5 Pressure Relief Control
- 5 X58C Restriction Assembly

Optional Features

Item Description

- A X46A Flow Clean Strainer
- B CK2 Isolation Valve
- C CV Flow Control (Closing)
- D Check Valves with Isolation Valve
- E X117 Series Position Transmitter
- F Independent Operating Pressure
- N Electronic Controller (Single)
- P X141 Pressure Gauge
- S CV Flow Control (Opening)
- Y X43 "Y" Strainer



131-CW/631-CW

Electronic Interface Control with Pressure Reducing Feature, Hydraulically Operated

Flow, pressure, level or valve position is normally controlled by the electronic controller that operates two solenoids to modulate the valve to maintain the process variable. Should a power failure occur, a parallel hydraulically operated pressure reducing pilot system takes control of the valve limiting the maximum outlet pressure. When power is restored, the valve automatically reverts back to the electronic mode. The optional check feature automatically will close the valve if a pressure reversal occurs in the pipeline.

131-EJ/631-EJ

Electronic Interface Control with Pressure Sustaining Feature, Hydraulically Operated

Flow, pressure, level or valve position is normally controlled by the electronic controller that operates two solenoids to modulate the valve to maintain the process variable. Should a power failure occur, a parallel hydraulically operated pressure sustaining pilot system takes control of the valve limiting the minimum inlet pressure. When power is restored, the valve automatically reverts back to the electronic mode. The optional check feature automatically will close the valve if a pressure reversal occurs in the pipeline.

Schematic Diagram

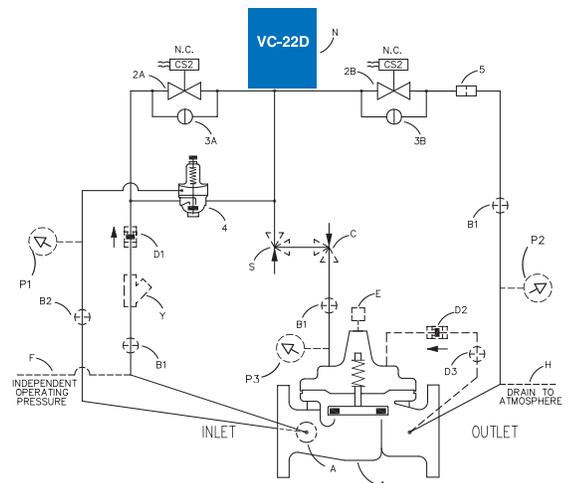
Item Description

- 1 Hytrol (Main Valve)
- 2 CS2 Solenoid Control
- 3 CK2 Solenoid By-Pass
- 4 CRA Pressure Reducing Control
- 5 X58C Restriction Assembly

Optional Features

Item Description

- A X46A Flow Clean Strainer
- B CK2 Isolation Valve
- C CV Flow Control (Closing)
- D Check Valves with Isolation Valve
- E X117 Series Position Transmitter
- F Independent Operating Pressure
- H Atmospheric Drain
- N Electronic Controller (Single)
- P X141 Pressure Gauge
- S CV Flow Control (Opening)
- Y X43 "Y" Strainer



Pressure Ratings (Recommended Maximum Pressure - psi)

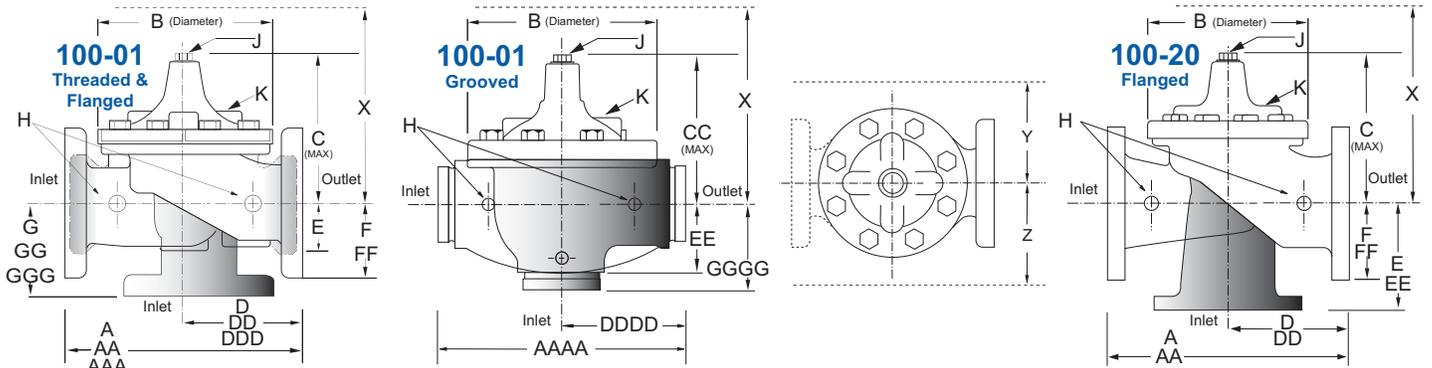
Valve Body & Cover		Pressure Class				
		Flanged			Grooved	Threaded
Grade	Material	ANSI Standards*	150 Class	300 Class	300 Class	End‡ Details
ASTM A536	Ductile Iron	B16.42	250	400	400	400
ASTM A216-WCB	Cast Steel	B16.5	285	400	400	400
ASTM B62	Bronze	B16.24	225	400	400	400

Note: * ANSI standards are for flange dimensions only.
 Flanged valves are available faced but not drilled.
 ‡ End Details machined to ANSI B2.1 specifications.
Valves for higher pressure are available; consult factory for details

Materials

Component	Standard Material Combinations		
Body & Cover	Ductile Iron	Cast Steel	Bronze
100-01 Available Sizes	1" - 36"	1" - 16"	1" - 16"
100-20 Available Sizes	3" - 48"	3" - 16"	3" - 16"
Disc Retainer & Diaphragm Washer	Cast Iron	Cast Steel	Bronze
Trim: Disc Guide, Seat & Cover Bearing	Bronze is Standard Stainless Steel is Optional		
Disc	Buna-N® Rubber		
Diaphragm	Nylon Reinforced Buna-N® Rubber		
Stem, Nut & Spring	Stainless Steel		

For material options not listed, consult factory.
 Cla-Val manufactures valves in more than 50 different alloys.



Model 100-01 Dimensions (Full Internal Port) (In Inches)

Valve Size (Inches)	1	1 1/4	1 1/2	2	2 1/2	3	4	6	8	10	12	14	16	18	20	24	30	36
A Threaded	7.25	7.25	7.25	9.38	11.00	12.50	—	—	—	—	—	—	—	—	—	—	—	—
AA 150 ANSI	—	—	8.50	9.38	11.00	12.00	15.00	20.00	25.38	29.75	34.00	39.00	41.38	46.00	52.00	61.50	63.00	76.00
AAA 300 ANSI	—	—	9.00	10.00	11.62	13.25	15.62	21.00	26.38	31.12	35.50	40.50	43.50	47.64	53.62	63.24	64.50	76.00
AAAA Grooved End	—	—	8.50	9.00	11.00	12.50	15.00	20.00	25.38	—	—	—	—	—	—	—	—	—
B Dia.	5.62	5.62	5.62	6.62	8.00	9.12	11.50	15.75	20.00	23.62	28.00	32.75	35.50	41.50	45.00	53.16	56.00	66.00
C Max.	5.50	5.50	5.50	6.50	7.56	8.19	10.62	13.38	16.00	17.12	20.88	24.19	25.00	39.06	41.90	43.93	54.60	61.50
CC Max. Grooved End	—	—	4.75	5.75	6.88	7.25	9.31	12.12	14.62	—	—	—	—	—	—	—	—	—
D Threaded	3.25	3.25	3.25	4.75	5.50	6.25	—	—	—	—	—	—	—	—	—	—	—	—
DD 150 ANSI	—	—	4.00	4.75	5.50	6.00	7.50	10.00	12.69	14.88	17.00	19.50	20.81	—	—	30.75	—	—
DDD 300 ANSI	—	—	4.25	5.00	5.88	6.38	7.88	10.50	13.25	15.56	17.75	20.25	21.62	—	—	31.62	—	—
DDDD Grooved End	—	—	4.75	—	6.00	7.50	—	—	—	—	—	—	—	—	—	—	—	—
E	1.12	1.12	1.12	1.50	1.69	2.06	3.19	4.31	5.31	9.25	10.75	12.62	15.50	12.95	15.00	17.75	21.31	24.56
EE Grooved End	—	—	2.00	2.50	2.88	3.12	4.25	6.00	7.56	—	—	—	—	—	—	—	—	—
F 150 ANSI	—	—	2.50	3.00	3.50	3.75	4.50	5.50	6.75	8.00	9.50	10.50	11.75	15.00	16.50	19.25	22.50	25.60
FF 300 ANSI	—	—	3.06	3.25	3.75	4.13	5.00	6.25	7.50	8.75	10.25	11.50	12.75	15.00	16.50	19.25	24.00	25.60
G Threaded	1.88	1.88	1.88	3.25	4.00	4.50	—	—	—	—	—	—	—	—	—	—	—	—
GG 150 ANSI	—	—	4.00	3.25	4.00	4.00	5.00	6.00	8.00	8.62	13.75	14.88	15.69	—	—	22.06	—	—
GGG 300 ANSI	—	—	4.25	3.50	4.31	4.38	5.31	6.50	8.50	9.31	14.50	15.62	16.50	—	—	22.90	—	—
GGGG Grooved End	—	—	3.25	—	4.25	5.00	—	—	—	—	—	—	—	—	—	—	—	—
H NPT Body Tapping	.375	.375	.375	.375	.50	.50	.75	.75	1	1	1	1	1	1	1	1	1	2
J NPT Cover Center Plug	.25	.25	.25	.50	.50	.50	.75	.75	1	1	1.25	1.5	2	1.5	1.5	1.5	2	2
K NPT Cover Tapping	.375	.375	.375	.375	.50	.50	.75	.75	1	1	1	1	1	1	1	1	2	2
Stem Travel	0.4	0.4	0.4	0.6	0.7	0.8	1.1	1.7	2.3	2.8	3.4	4.0	4.5	5.1	5.63	6.75	7.5	8.5
Approx. Ship Wt. Lbs.	15	15	15	35	50	70	140	285	500	780	1165	1600	2265	2982	3900	6200	7703	11720
X Pilot System	11	11	11	13	14	15	17	29	31	33	36	40	40	43	47	68	79	85
Y Pilot System	9	9	9	9	10	11	12	20	22	24	26	29	30	32	34	39	40	45
Z Pilot System	9	9	9	9	10	11	12	20	22	24	26	29	30	32	34	39	42	47

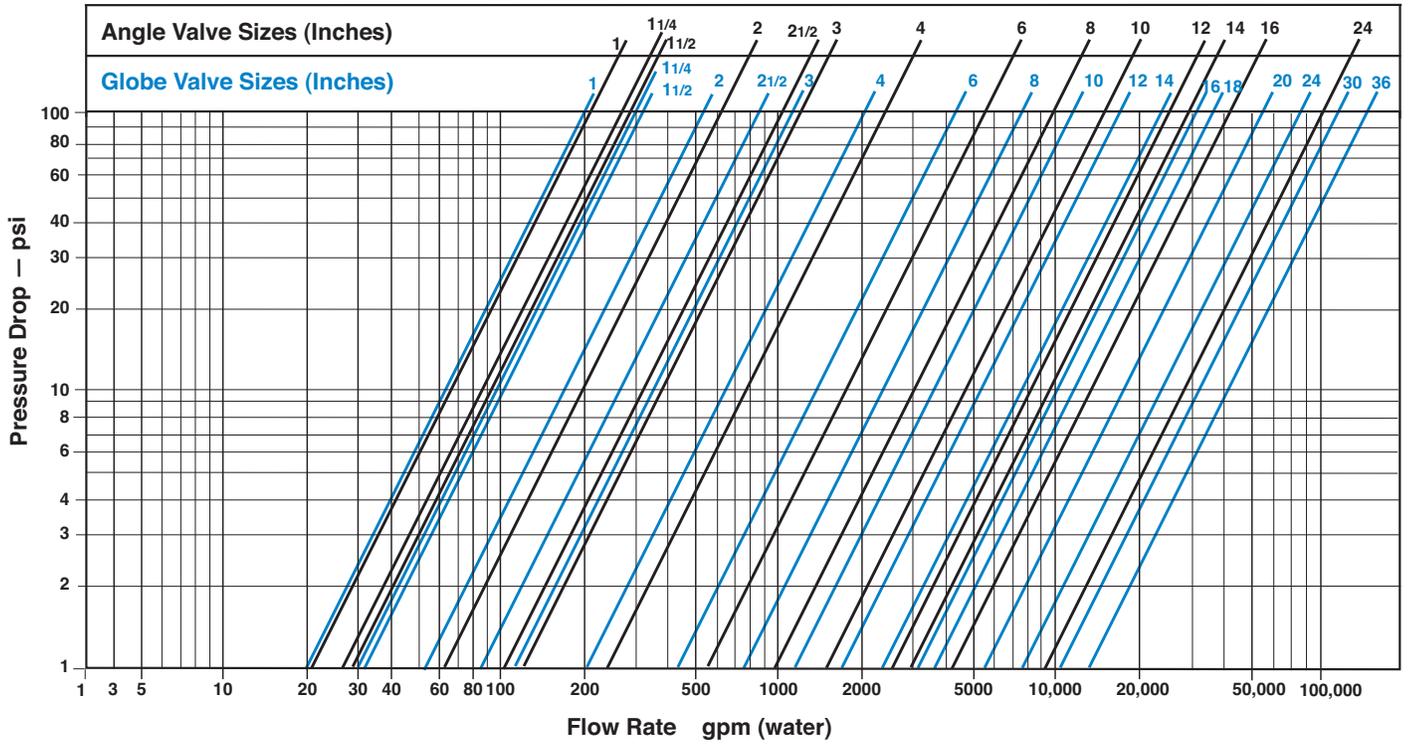
Note: The top two flange holes on valve size 36 are threaded to 1 1/2"-6 UNC.

Model 100-20 Dimensions (Reduced Internal Port) (In Inches)

Valve Size (Inches)	3	4	6	8	10	12	14	16	18	20	24	30	36	42	48
A 150 ANSI	10.25	13.88	17.75	21.38	26.00	30.00	34.25	35.00	42.12	48.00	48.00	63.25	65.00	76.00	94.50
AA 300 ANSI	11.00	14.50	18.62	22.38	27.38	31.50	35.75	36.62	43.63	49.62	49.75	63.75	67.00	76.00	94.50
B Dia.	6.62	9.12	11.50	15.75	20.00	23.62	27.47	28.00	35.44	35.44	35.44	53.19	56.00	66.00	66.00
C Max.	7.00	8.62	11.62	15.00	17.88	21.00	20.88	25.75	25.00	31.00	31.00	43.94	54.60	61.50	61.50
D 150 ANSI	—	6.94	8.88	10.69	CF*	—	—	—	—						
DD 300 ANSI	—	7.25	9.38	11.19	CF*	—	—	—	—						
E 150 ANSI	—	5.50	6.75	7.25	CF*	—	—	—	—						
EE 300 ANSI	—	5.81	7.25	7.75	CF*	—	—	—	—						
F 150 ANSI	3.75	4.50	5.50	6.75	8.00	9.50	11.00	11.75	15.88	14.56	17.00	19.88	25.50	28.00	31.50
FF 300 ANSI	4.12	5.00	6.25	7.50	8.75	10.25	11.50	12.75	15.88	16.06	19.00	22.00	27.50	28.00	31.50
H NPT Body Tapping	.375	.50	.75	.75	1	1	1	1	1	1	1	1	2	2	2
J NPT Cover Center Plug	.50	.50	.75	.75	1	1	1.25	1.25	2	2	2	2	2	2	2
K NPT Cover Tapping	.375	.50	.75	.75	1	1	1	1	1	1	1	1	2	2	2
Stem Travel	0.6	0.8	1.1	1.7	2.3	2.8	3.4	3.4	4.5	4.5	4.5	6.5	7.5	8.5	8.5
Approx. Ship Wt. Lbs.	45	85	195	330	625	900	1250	1380	1500	2551	2733	6500	8545	12450	13100
X Pilot System	13	15	27	30	33	36	36	41	40	46	55	68	79	85	86
Y Pilot System	10	11	18	20	22	24	26	26	30	30	30	39	40	45	47
Z Pilot System	10	11	18	20	22	24	26	26	30	30	30	39	42	47	49

Note: The top two flange holes on valve sizes 36 thru 48 are threaded to 1 1/2"-6 UNC.

Model 131 Series (Uses Basic Valve Model 100-01)



The dark shaded portion of the chart illustrates the region where cavitation damage may occur. The lighter shaded portion is where significant cavitation noise and vibration may occur. Operating conditions inside the dark shaded area is permissible for infrequent periods of short duration. The guide is for modulating service valves. For on/off valves, consult factory.

The chart is based on cavitation index (sigma) values as defined by Utah State University Water Research Laboratory.

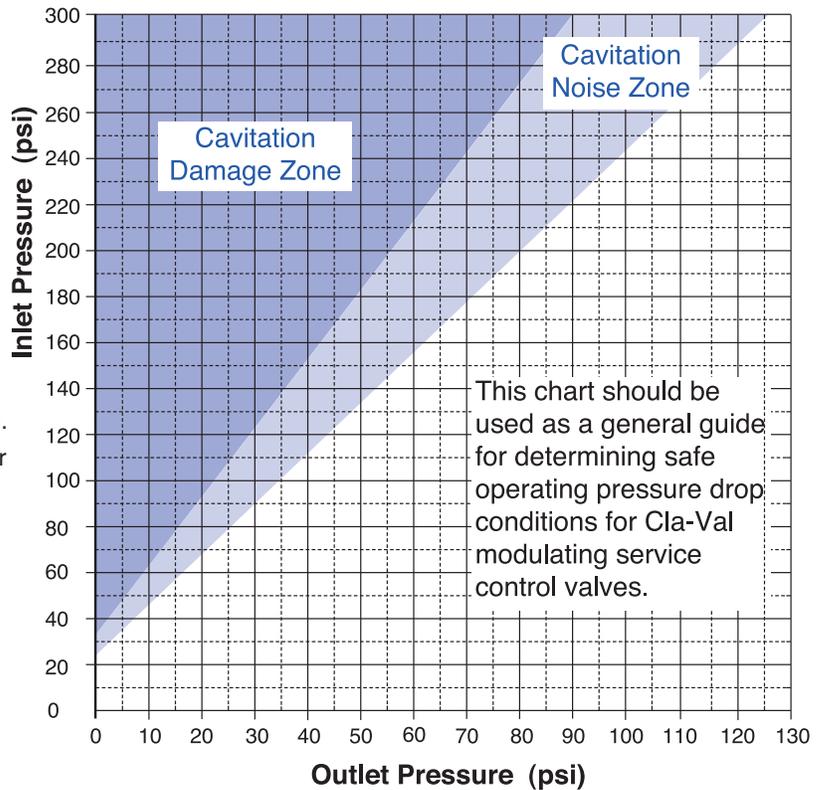
$$\sigma = \frac{(P_2 - P_v)}{(P_1 - P_2)} \quad \text{where}$$

σ = cavitation index, P_1 = inlet pressure (psi),
 P_2 = outlet pressure (psi), P_v = water vapor pressure (psia).

The dark shaded portion is below σ of 0.5 and the lighter shaded area is below σ of 0.8. The chart is to be used for typical valve operating conditions below 40% open at standard water temperature and elevation below 1000 feet.

More accurate cavitation conditions are determined from the **Cla-CAV** analysis program including static and dynamic inlet and outlet pressures, flow range, elevation, water temperature, and service conditions. If operation is inside the shaded areas, the **Cla-CAV** analysis can be used to determine whether added back pressure from an orifice plate, a second valve in series, or adding **KO** Anti-Cavitation trim (see 100-01KO data sheet) is necessary. Contact your Cla-Val representative for a free analysis.

Cavitation Zones 100-01/100-20



This chart should be used as a general guide for determining safe operating pressure drop conditions for Cla-Val modulating service control valves.

Valve 1 100-01 100-20

Valve size: 6"

Maximum flow rate: 1000 gpm
 Minimum flow rate: 500 gpm

Static inlet pressure: 120 psi
 Static outlet pressure: 25 psi
 Elevation above S.L.: 500 ft
 Water temperature: 60 deg F

Dynam. inlet pressure: 120.0 psi
 Dynam. outlet pressure: 25.0 psi

Back pressure orifice: Single
 Orifice backpressure: 61.9 psi
 Orifice discharge to: Downstream piping

100-01 100-20

Valve operation

Continuous (>50%)

Avoid operation near (within 10%) cavitation damage level of 1.0.

Convert Units

Dynamic Pressure

Change Orifice

Add Second Valve

For a more detailed cavitation analysis or if operation will be outside of the above chart, request a **Cla-CAV** computer analysis. **Cla-CAV** can evaluate what options best solve any potential cavitation problem. In the example shown, a 6 inch 100-01 modulating service valve requires an orifice plate downstream to prevent damaging cavitation. For wider flow range service, either an extra valve in series or the addition of **KO** Anti-Cavitation trim to the valve may be necessary (see 100-01KO data sheet). Consult factory for a free analysis for wide open or modulating service valves.

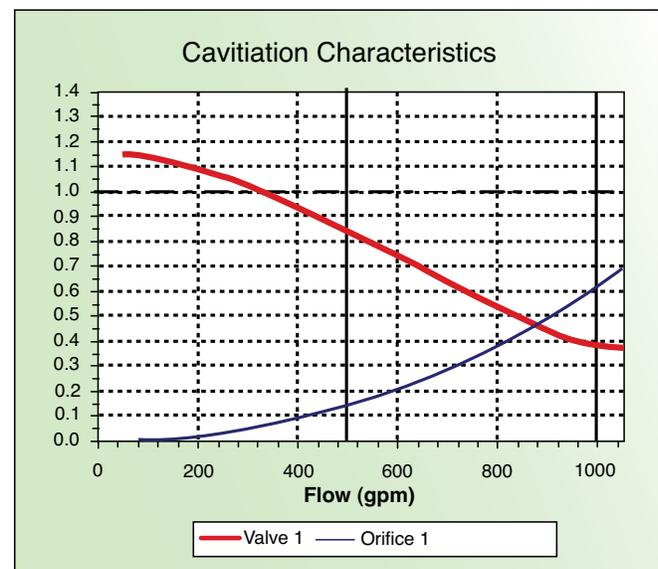
No damage

Caution - near damage

Damaging cavitation

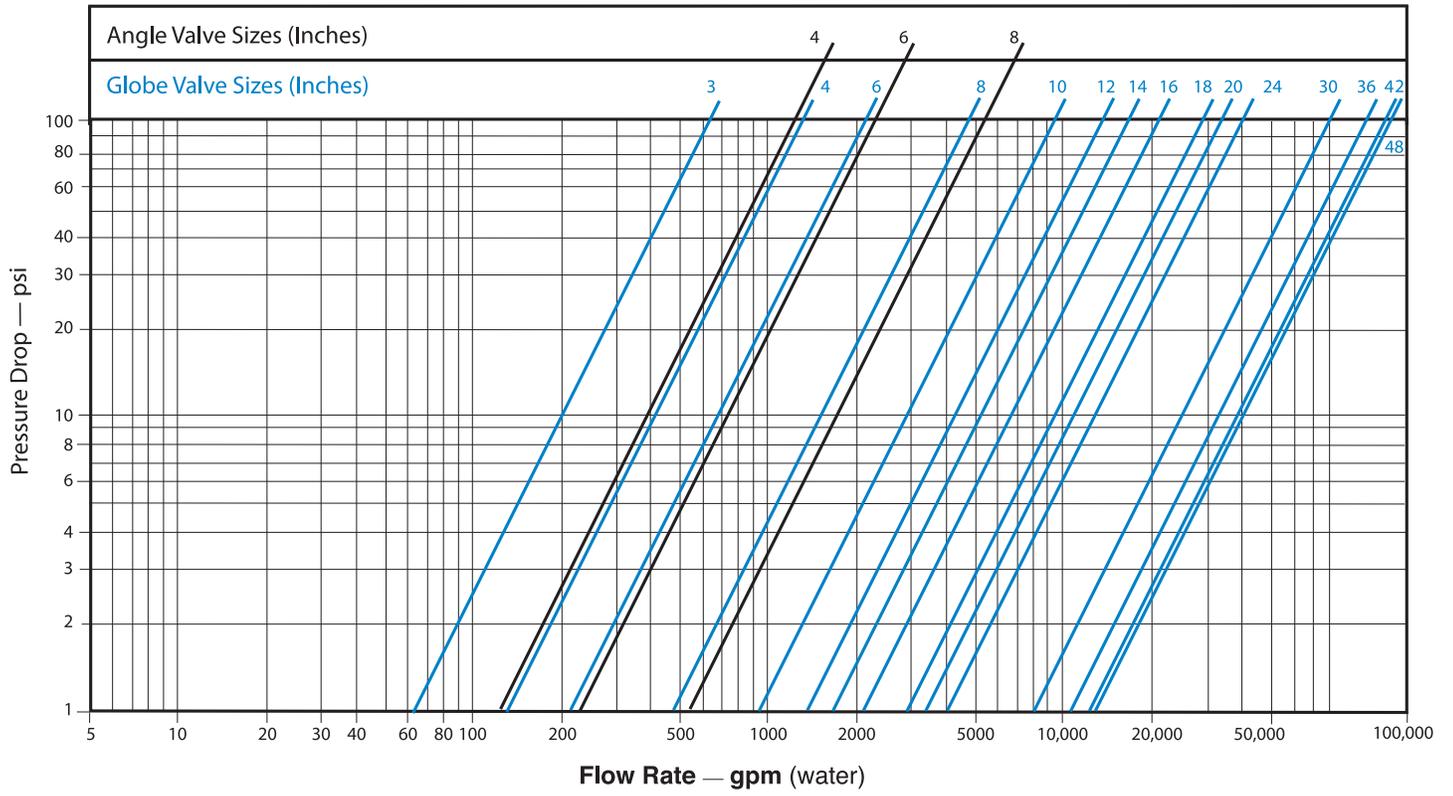
Valve damage occurs <20 psi.

Valve 1	Flow Rate GPM	Inlet (psi)	Outlet (psi)	% Open	Pipe Vel. (ft/s)	Cav Damage
	50	120.0	25.1	9.1	0.6	Yes
	250	120.0	27.3	19.9	2.8	Yes
	500	120.0	34.2	24.9	5.6	No
	750	120.0	45.8	30.7	8.3	No
	1000	120.0	61.9	37.2	11.1	No



If the lines go above 1.0 there will be cavitation damage.

Model 631Series (Uses Basic Valve Model 100-20)



131 Series Valve Selection	100-01 Pattern: Globe (G), Angle (A), End Connections: Threaded (T), Grooved (GR), Flanged (F) Indicate Available Sizes																		
	Inches	1	1¼	1½	2	2½	3	4	6	8	10	12	14	16	18	20	24	30	36
	mm	25	32	40	50	65	80	100	150	200	250	300	350	400	450	500	600	750	900
Basic Valve 100-01	Pattern	G, A	G, A	G, A	G, A	G, A	G, A	G, A	G, A	G, A	G, A	G, A	G, A	G, A	G	G	G, A	G	G
	End Detail	T	T	T, F, Gr*	T, F, Gr	T, F, Gr*	T, F, Gr	F, Gr	F, Gr*	F, Gr*	F	F	F	F	F	F	F	F	F
Suggested Flow (gpm)	Maximum	55	93	125	210	300	460	800	1800	3100	4900	7000	8400	11000	14000	17000	25000	42000	50000
	Maximum Intermittent	68	120	160	260	370	580	990	2250	3900	6150	8720	10540	13700	17500	21700	31300	48000	62500
	Minimum	1	1	1	1	2	2	4	10	15	35	50	70	95	120	150	275	450	650
Suggested Flow (Liters/Sec)	Maximum	3.5	6	8	13	19	29	50	113	195	309	442	530	694	883	1073	1577	2650	3150
	Maximum Intermittent	4.3	7.6	10	16	23	37	62	142	246	387	549	664	863	1104	1369	1972	3028	3940
	Minimum	.03	.03	.03	.06	.09	0.13	0.25	0.63	0.95	2.2	3.2	4.4	6.0	7.6	9.5	17.4	28.4	41.0

100-01 Series is the full internal port Hytrol.

For Lower Flows Consult Factory

*Globe Grooved Only

631 Series Valve Selection	100-20 Pattern: Globe (G), Angle (A), End Connections: Flanged (F) Indicate Available Sizes															
	Inches	3	4	6	8	10	12	14	16	18	20	24	30	36	42	48
	mm	80	100	150	200	250	300	350	400	450	500	600	750	900	1000	1200
Basic Valve 100-20	Pattern	G	G, A	G, A	G, A	G	G	G	G	G	G	G	G	G	G	G
	End Detail	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
Suggested Flow (gpm)	Maximum	260	580	1025	2300	4100	6400	9230	9230	16500	16500	16500	28000	33500	33500	33500
	Minimum	1	2	4	10	15	35	50	50	95	95	95	275	450	450	450
Suggested Flow (Liters/Sec)	Maximum	16	37	65	145	258	403	581	581	1040	1040	1040	1764	2115	2115	2115
	Minimum	.06	.13	.25	.63	.95	2.2	3.2	3.2	6.0	6.0	6.0	17.4	28.4	41.0	41.0

100-20 Series is the reduced internal port size version of the 100-01 Series.

For Lower Flows Consult Factory

131 Series/631 Series Pilot System Specifications

Temperature Range

Water: to 180°F

Rubber Parts:

Buna-N® Rubber Synthetic

Solenoid Control

Body:

Brass ASTM B283

Enclosure:

NEMA Type 1,2,3,3S,4,4X general purpose watertight*

NEMA Type 6,6P,7,9 watertight Explosion

Proof available.

Voltages:

110, 220, -50Hz Ac

24, 120, 240, 480 - 60Hz AC

6, 12, 24, 120, 240 - DC

Others available at extra cost

Max. operating pressure differential: 200 psi*

Coil:

Insulation molded Class F

Watts AC 6

AC Volt Amps Inrush 30

AC Volt Amps Holding 16

Watts DC 10.6

*Supplied unless otherwise specified

For specifications on other 131/631 series valves, please consult factory.

Pilot System Adjustment Ranges, Please Consult Factory

When Ordering Please Give Details When Vertical Installed

ELECTROMAGNETIC FLOWMETER

WaterMaster Electromagnetic flowmeter

Measurement made easy

The perfect fit for all water and
waste water applications



State-of-the-art technology

- revolutionary data storage enables transmitter interchange and commissioning without the need for re-configuration
- self-calibrating transmitter with ultra-low temperature coefficient for highest accuracy

Versatile and simple configuration

- 'Through-the-Glass' (TTG) configuration eliminating the need to remove the cover
- smart key based functionality
- 'Easy Setup' function

VeriMaster in situ verification software option

- enables the customer to perform in situ verification of the flowmeter system

Unparalleled service ability

- fault-finding Help texts on the display
- minimized downtime with replaceable electronics cartridges

MID and OIML R49 approved with R49 self-checking

- type-approved to accuracy Class 1 and Class 2 for any pipe orientation and bidirectional flows
- type P-approved continuous self-checking of the sensor and transmitter to ensure the highest accuracy and long term performance

Innovative sensors for all applications

- optimized full-bore series for optimum turndown / low pressure drop, irrigation applications
- full-bore series for general-purpose water metering applications
- reduced-bore series for high turn down applications, for example, leakage
- buriable sensors eliminate the need for costly chamber construction

HART, Profibus DP and Modbus

- full system and PLC integration

The Company

ABB is an established world force in the design and manufacture of instrumentation for industrial process control, flow measurement, gas and liquid analysis and environmental applications.

As a world leader in process automation technology our worldwide presence, comprehensive service and application-oriented know-how make ABB a leading supplier of flow measurement products.

Introduction

Setting the standard for the Water Industry

The WaterMaster range, available in sizes 10 to 2400 mm ($\frac{3}{8}$ to 96 in.), is designed specifically for use on the many diverse applications encountered in the Water and Waste-water industry. The modular design concept offers flexibility, cost-saving operation and reliability while providing a long service life and exceptionally low maintenance.

Integration into ABB asset management systems and use of the self-monitoring and diagnostic functions increase the plant availability and reduce downtimes.

VeriMaster – the verification tool

An easy-to-use utility, available through the infra red service port. Uses the advanced self-calibration and diagnostic capability of WaterMaster, coupled with fingerprinting technology, to determine the accuracy status of the WaterMaster flowmeter to within ± 1 % of its original factory calibration. VeriMaster also supports printing of calibration verification records for regulatory compliance.



Diagnostic functions

Using its diagnostic functions, the flowmeter monitors both its own operability and the process. Limit values for the diagnostic parameters can be set locally. When these limits are exceeded, an alarm is tripped. In the event of an error, diagnostic-dependent help text appears on the display. This considerably simplifies and accelerates the troubleshooting procedure.

In accordance with NAMUR NE107, alarms and warnings are classified with the status of 'Maintenance Required', 'Check Function', 'Failure' and 'Out of Specification'.

Flow performance

Utilizing its advanced filtering methods, the WaterMaster improves accuracy even under difficult conditions. WaterMaster has an operating flow range with ± 0.4 % accuracy as standard (± 0.2 % optional) in both forward and reverse flow directions.

Easy and quick commissioning

'Fit-and-Flow' data storage inside WaterMaster eliminates the need to match sensor and transmitter in the field. On initial installation, the self-configuration sequence automatically replicates into the transmitter all calibration factors, meter size and serial numbers, as well as customer site-specific settings, eliminating the potential for error.

Intuitive, convenient navigation

The 'Easy Setup' function reliably guides unpracticed users through the menu step by step. The smart key based functionality makes handling a breeze – it's just like using a cell phone. During configuration, the permissible range of each parameter is indicated on the display and invalid entries are rejected.

Universal transmitter – powerful and flexible

The backlit display can be rotated easily without the need for tools. The contrast is adjustable and the display fully-configurable. The character size, number of lines and display resolution (number of decimal points) can be set as required. In multiplex mode, several different display options can be pre-configured and invoked one after the other.

The smart modular design of the transmitter unit enables easy disassembly without the need to unscrew cables or unplug connectors. HART is used as the standard communications protocol. Optionally, the transmitter is available with PROFIBUS DP or MODBUS communication.

Assured quality

WaterMaster is designed and manufactured in accordance with international quality procedures (ISO 9001) and all flowmeters are calibrated on nationally-traceable calibration rigs to provide the end-user with complete assurance of both quality and performance of the flowmeter.



WaterMaster – always the first choice

WaterMaster sets the standard for the water industry. The specification, features and user benefits offered by this range are based on ABB's worldwide experience in this industry and they are all targeted specifically to the industry's requirements.

Submersible and buriable

WaterMaster sensors have a rugged, robust construction to ensure a long, maintenance-free life under the arduous conditions experienced in the Water and Waste Industry. The sensors are, as standard, inherently submersible (IP68, NEMA 6P), thus ensuring suitability for installation in chambers and metering pits that are susceptible to flooding.

A unique feature of the WaterMaster sensors is that sizes DN40 to DN2400 (1½ to 96 in. NB) are buriable; installation simply involves excavating to the underground pipe, fitting the sensor, cabling back to the transmitter and then backfilling the hole.



The WaterMaster family

Overview of the WaterMaster

A wide range of features and user benefits are built into WaterMaster as standard:

- bi-directional flow
- unique self-calibrating transmitter (patented) for the ultimate in stability and repeatability
- OIML-type continuous self-checking, with alarms, ensures both sensor and transmitter accuracy
- true electrode and coil impedance measurement
- comprehensive simulation mode
- universal switch-mode power supply (options are available for AC and DC supplies)
- comprehensive self-diagnostics compliant with NAMUR NE107
- programmable multiple-alarm capability
- bus options: HART (4 to 20 mA), PROFIBUS DP (RS485), MODBUS (RS485)
- 3 configurable pulse / frequency and alarm outputs
- advanced infrared service port supports remote HMI, HART, cyclic data out and parameter download
- VeriMaster in situ verification software available as option
- read-only switch and ultra-secure service password for total security



OIML / MID approved

WaterMaster has been type tested and Internationally approved to the highest accuracy class 1 and 2 for cold and hot potable water meters – OIML R49-1 (Organisation Internationale de Métrologie Légale). For full details, OIML R49 is available to download from www.oiml.org. Its requirements are very similar to other International standards, such as EN14154 and ISO4064.

WaterMaster has been assessed by type approval at the National Measurement Office (NMO) to OIML R49 and passed to the very highest accuracy designations for sizes DN40 to DN200 (1½ to 8 in. NB).

The approval is for:

- Class 1 and Class 2 accuracy (calibration option)
- Environmental class T50 for water temperatures of 0.1 to 50 °C (32.18 to 122 °F)
- Electromagnetic Environment E2 (10 V/m)
- Any pipe orientation
- 5 Diameters upstream pipe
- 0 Diameters downstream pipe
- Pressure Loss Class <0.25 bar (3.62 psi)
- Integral or remote transmitter (<200 m [<656 ft.] cable)
- DN40 to DN200 (1½ to 8 in. NB), bi-directional flow

A major advance in WaterMaster is the self-checking capabilities that meet and exceed the R49 requirements and is the first electromagnetic flowmeter to be approved to OIML Type P permanent self checking during normal operation (not just at startup) and alarm indication for:

- transmitter and sensor status, with an accuracy alarm
- program ROM and RAM status
- double, independent storage of totalizer values, in both the sensor and transmitter non-volatile memories
- display test

The OIML R49-1 certificate of conformity is available from:

<http://www.abb.com/product/seitp330/b42ec2377d3293cdc12573de003db93b.aspx>

WaterMaster is also approved under the EU Measuring Instruments Directive (MID) 2004/22/EC, that covers putting into use water flowmeters for certain applications. MID WaterMaster is secured against tampering and is available as an option, along with fingerprinting for ABB VeriMaster in situ verification product, with certificate printout to ± 1 % accuracy.

WaterMaster certificates of EC type-examination of a measuring instrument are available from:

<http://www.abb.com/product/seitp330/b42ec2377d3293cdc12573de003db93b.aspx>

Superior control through advanced sensor design

The innovative, patented octagonal sensor design improves flow profile and reduces up- and down-stream piping requirements for the most commonly used sizes of 40 to 200 mm (1½ to 8 in.). This optimized full bore meter provides impressive results in the most difficult of installation requirements.

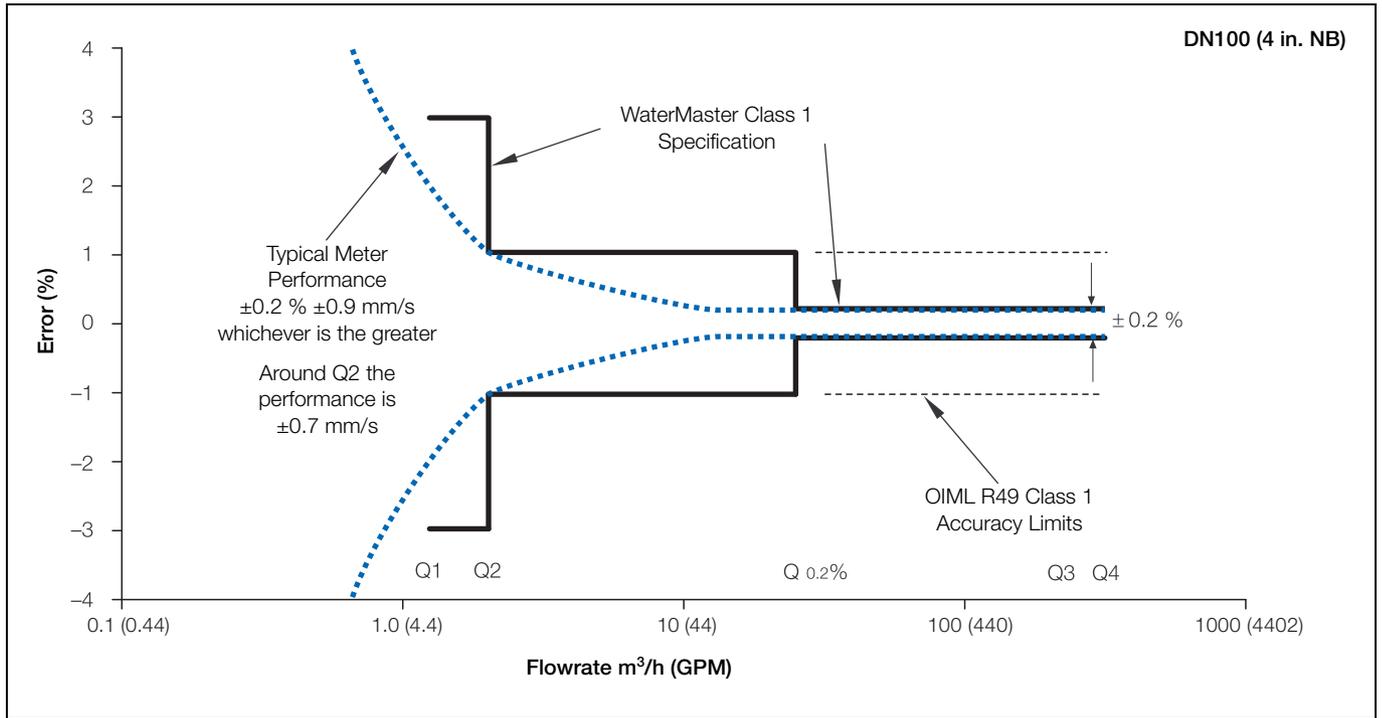


WaterMaster sensors are also available in reduced-bore geometries giving the ultimate in low-flow performance with a very high turn-down range.

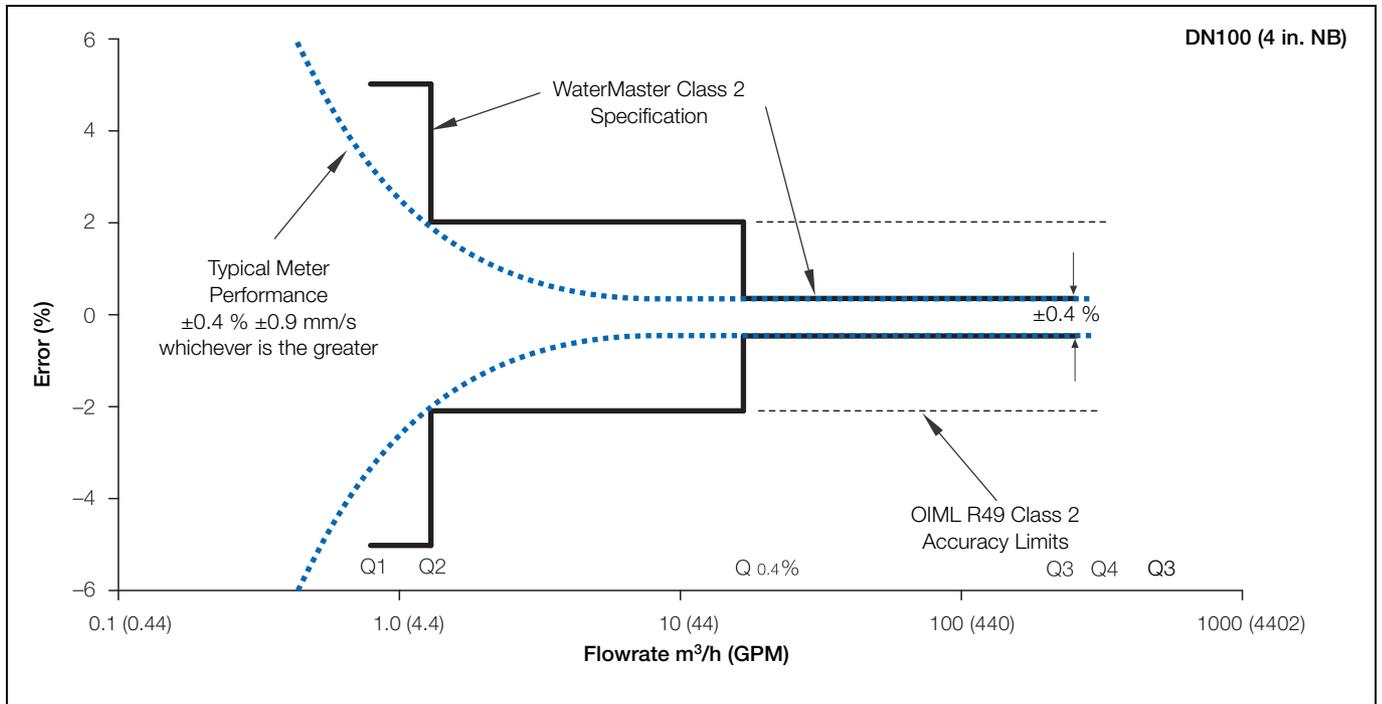
The unique design of the reduced-bore sensor conditions the flow profile in the measuring section so that distortions in the flow profile, either upstream or downstream, are flattened. The result is excellent in situ flowmeter performance, even with very bad hydraulic installation conditions.

Specification

WaterMaster specification to OIML R49 Class 1



WaterMaster specification to OIML R49 Class 2



Although OIML R49 does not define the flow accuracy below Q1, WaterMaster continues to measure flow at lower flow rates down to a cutoff velocity of $\pm 5 \text{ mm/s}$ ($\pm 0.2 \text{ in./s}$). The accuracy between cutoff and Q1 is typically $\pm 0.9 \text{ mm/s}$ ($\pm 0.04 \text{ in./s}$).

WaterMaster optimized full-bore meter (FEV) / full-bore meters (FEF, FEW) flow performance – m³/h

DN	Q4	Q3	Standard Calibration – 0.4 % Class 2			High Accuracy Calibration – 0.2 % Class 1		
			Q _{0.4%}	Q2	Q1	Q _{0.2%}	Q2	Q1
10	3.1	2.5	0.167	0.013	0.008	0.31	0.02	0.012
15	7.88	6.3	0.42	0.032	0.02	0.79	0.05	0.03
20	12.5	10	0.67	0.05	0.032	1.25	0.08	0.05
25	20	16	1.1	0.08	0.05	2	0.13	0.08
32	31.25	25	1.67	0.13	0.08	3	0.20	0.13
40*	50	40	4.2	0.2	0.13	6	0.32	0.2
50*	79	63	4.2	0.32	0.20	7.9	0.5	0.32
65*	125	100	6.7	0.5	0.32	12.5	0.8	0.5
80*	200	160	10.7	0.81	0.51	16	1.3	0.8
100*	313	250	16.7	1.3	0.79	25	2	1.25
125*	313	250	16.7	1.3	0.79	25	2	1.25
150*	788	630	42	3.2	2.0	63	5	3.2
200*	1,250	1,000	67	5.1	3.2	100	8	5
250	2,000	1,600	107	8.1	5.1	160	13	8
300	3,125	2,500	167	12.7	7.9	250	20	12.5
350	5,000	4,000	267	20.3	12.7	400	32	20
400	5,000	4,000	267	20.3	12.7	400	32	20
450	7,875	6,300	420	32	20	630	50	32
500	7,875	6,300	420	32	20	630	50	32
600	12,500	10,000	667	51	32	1000	80	50
700	20,000	16,000	1600	102	64	1600	160	100
750	20,000	16,000	1600	102	64	1600	160	100
30 in (750)	20,000	16,000	1600	102	64	1600	160	100
800	20,000	16,000	1600	102	64	1600	160	100
900	31,250	25,000	2500	160	100	2500	250	156
1000	31,250	25,000	2500	160	100	2500	250	156
42 in	31,250	25,000	2500	160	100	2500	250	156
1100	31,250	25,000	2500	160	100	2500	250	156
1200	50,000	40,000	4000	256	160	4000	400	250
1350	78,750	63,000	6300	403	252	6300	630	394
1400	78,750	63,000	6300	403	252	6300	630	394
1500	78,750	63,000	6300	403	252	6300	630	394
60 in (1500)	78,750	63,000	6300	403	252	6300	630	394
1600	78,750	63,000	6300	403	252	6300	630	394
1650	78,750	63,000	6300	403	252	6300	630	394
1800	125,000	100,000	10000	640	400	10000	1000	625
1950	125,000	100,000	10000	640	400	10000	1000	625
2000	125,000	100,000	10000	640	400	10000	1000	625
2200	200,000	160,000	16000	1024	640	16000	1600	1000
2400	200,000	160,000	16000	1024	640	16000	1600	1000

* OIML R49 Certificate of Conformance to Class 1 and Class 2, with OIML R49 and MID versions available.

Note. OIML R49–1 allow Class 1 only for meters with Q₃ ≥ 100 m³/h. Meters outside this range have been tested and conform to Class 1.

WaterMaster optimized full-bore meter (FEV) / full-bore meters (FEF, FEW) flow performance – gal/min

NPS/NB (DN)	Q4	Q3	Standard Calibration 0.4 % Class 2			High Accuracy Calibration 0.2 % Class 1		
			Q0.4%	Q2	Q1	Q0.2%	Q2	Q1
3/8 (10)	13.8	11	0.73	0.06	0.035	1.38	0.09	0.053
1/2 (15)	34.7	27.7	1.85	0.14	0.09	3.48	0.22	0.14
3/4 (20)	55	44	2.94	0.22	0.14	5.5	0.35	0.22
1 (25)	88	70.4	4.7	0.35	0.22	8.8	0.57	0.35
1 1/4 (32)	137.6	110	7.3	0.57	0.35	13.2	0.88	0.57
1 1/2 (40)	220	176	18.5	0.89	0.56	26.4	1.41	0.88
2 (50)	347	277	18.5	1.41	0.88	34.7	2.22	1.39
2 1/2 (65)	550	440	29.4	2.24	1.40	55.0	3.52	2.20
3 (80)	881	704	47.0	3.58	2.24	70.4	5.64	3.52
4 (100)	1,376	1,101	73.4	5.59	3.49	110	8.81	5.50
5 (125)	1,376	1,101	73.4	5.59	3.49	110	8.81	5.50
6 (150)	3,467	2,774	185	14.1	8.81	277	22.2	13.9
8 (200)	5,504	4,403	294	22.4	14.0	440	35.2	22.0
10 (250)	8,806	7,045	470	35.8	22.4	704	56.4	35.2
12 (300)	13,759	11,007	734	55.9	34.9	1,101	88.1	55.0
14 (350)	22,014	17,611	1,174	89.5	55.9	1,761	141	88.1
16 (400)	22,014	17,611	1,174	89.5	55.9	1,761	141	88.1
18 (450)	34,673	27,738	1,849	141	88.1	2,774	222	139
20 (500)	34,673	27,738	1,849	141	88.1	2,774	222	139
24 (600)	55,036	44,029	2,935	224	140	4,403	352	220
27/28" (700)	88,057	70,446	7,045	451	282	7,045	704	440
30 (750)	88,057	70,446	7,045	451	282	7,045	704	440
32 (800)	88,057	70,446	7,045	451	282	7,045	704	440
36 (900)	137,590	110,072	11,007	704	440	11,007	1,100	688
39/40" (1000)	137,590	110,072	11,007	704	440	11,007	1,100	688
42 (1050)	137,590	110,072	11,007	704	440	11,007	1,100	688
44 (1100)	137,590	110,072	11,007	704	440	11,007	1,100	688
48 (1200)	220,143	176,115	17,611	1,127	704	17,611	1,761	1,101
52 (1350)	346,726	277,381	27,738	1,775	1,110	27,738	2,773	1,733
54 (1400)	346,726	277,381	27,738	1,775	1,110	27,738	2,773	1,733
60 (1500)	346,726	277,381	27,738	1,775	1,110	27,738	2,773	1,733
66 (1600)	346,726	277,381	27,738	1,775	1,110	27,738	2,773	1,733
68 (1650)	346,726	277,381	27,738	1,775	1,110	27,738	2,773	1,733
77 (1800)	550,358	440,287	44,029	2,818	1,761	44,029	4,403	2,752
77 (1950)	550,358	440,287	44,029	2,818	1,761	44,029	4,403	2,752
78 (2000)	550,358	440,287	44,029	2,818	1,761	44,029	4,403	2,752
78 (2000)	550,358	440,287	44,029	2,818	1,761	44,029	4,403	2,752
84 (2200)	880,573	704,459	70,446	4,509	2,818	70,446	7,045	4,403
96 (2400)	880,573	704,459	70,446	4,509	2,818	70,446	7,045	4,403

*Size is dependent on flange specification

WaterMaster reduced-bore meter (FER) flow performance – m³/h (gal/min)

Size		Q4		Q3		Class 2 specification			Class 1 specification			
mm	in.	m ³ / h (Ugal / min)	R	m ³ / h (Ugal / min)	m ³ / h (Ugal / min)	m ³ / h (Ugal / min)	R					
40	1 1/2	31 (138)	25 (110)	0.83 (1.05)	0.063 (0.28)	0.04 (0.18)	630	1.7 (7.48)	0.1 (0.44)	0.063 (0.28)	400	
50	2	50 (220)	40 (176)	1.0 (4.40)	0.1 (0.44)	0.063 (0.28)	630	2.0 (8.8)	0.16 (0.7)	0.1 (0.44)	400	
65	2 1/2	79 (347)	63 (277)	1.6 (7.04)	0.16 (0.7)	0.1 (0.44)	630	3.2 (10.56)	0.25 (1.1)	0.16 (0.7)	400	
80	3	125 (550)	100 (440)	2.0 (8.80)	0.25 (1.1)	0.16 (0.7)	630	4.0 (17.6)	0.4 (1.76)	0.25 (1.1)	400	
100	4	200 (880)	160 (704)	3.2 (10.56)	0.41 (1.8)	0.25 (1.1)	630	6.4 (28)	0.64 (2.8)	0.4 (1.76)	400	
125	5	200 (880)	160 (704)	3.2 (10.56)	0.41 (1.8)	0.25 (1.1)	630	6.4 (28)	0.64 (2.8)	0.4 (1.76)	400	
150	6	500 (2200)	400 (1760)	8.0 (35.20)	1.0 (4.4)	0.63 (2.77)	630	16 (70.4)	1.6 (7)	1.0 (4.4)	400	
200	8	788 (3470)	630 (2770)	13.0 (57.2)	1.6 (7.04)	1.0 (4.4)	630	25 (110)	2.5 (11)	1.6 (7)	400	
250	10	1250 (5500)	1000 (4400)	20 (88)	2.5 (11.01)	1.6 (7)	630	40 (176)	4.0 (17.6)	2.5 (11)	400	
300	12	2000 (8810)	1600 (7045)	32 (140.8)	4.1 (18.05)	2.5 (11)	630	64 (281.6)	6.4 (28)	4.0 (17.6)	200	
350	14	2000 (8810)	1600 (7045)	32 (140.8)	6.4 (28.18)	4.0 (17.6)	400	64 (281.6)	12.8 (56)	8.0 (35.2)	200	
375	15	2000 (8810)	1600 (7045)	32 (140.8)	6.4 (28.18)	4.0 (17.6)	400	64 (281.6)	12.8 (56)	8.0 (35.2)	200	
400	16	3125 (13760)	2500 (11007)	50 (220)	10 (44)	6.3 (27.7)	400	100 (440)	20 (88)	12.5 (55)	200	
450	18	3125 (13760)	2500 (11007)	50 (220)	10 (44)	6.3 (27.7)	400	100 (440)	20 (88)	12.5 (55)	200	
500	20	5000 (22014)	4000 (17610)	80 (352)	16 (70.45)	10 (44)	400	160 (70.4)	32 (141)	20 (88)	200	
600	24	7875 (34670)	6300 (27740)	126 (554.4)	25.2 (110.9)	15.8 (70)	400	252 (1108)	50.4 (222)	31.5 (138.7)	200	

Specification – sensor

Functional specification

Pressure limitations

As per flange rating – non approved
PN16 for OIML R49, MID Approved

Pressure equipment directive 97/23/EC

This product is applicable in networks for the supply, distribution and discharge of water and associated equipment and is therefore exempt.

Temperature limitations

Ambient temperature
Remote transmitter –20 to 70 °C (–4 to 158 °F)
Integral transmitter –20 to 60 °C (–4 to 140 °F)

Process temperature See table below.
0.1 to 50 °C (32.2 to 122 °F) – OIML R49 T50
Approved

Code	Lining	Flange material	Medium temperature °C (°F)	
			Minimum	Maximum
FEF, FEW3	Hard rubber	Carbon steel	–10 (14)	80 (176)
		Stainless steel	–10 (14)	80 (176)
FEW1	PTFE	Carbon steel	–10 (14)	80 (176)
		Stainless steel	–25 (–13)	80 (176)
FEW3	PTFE	Carbon steel	–10 (14)	80 (176)
		Stainless steel	–10 (14)	80 (176)
FEW3	Elastomer	Carbon steel	–5 (23)	80 (176)
		Stainless steel	–5 (23)	80 (176)
FEF, FER	Elastomer	Carbon steel	–6 (21)	70 (158)
FEV	Polypropylene	Carbon steel	–6 (21)	70 (158)

IP rating

IP68 (NEMA 6) to 7 m (20 ft.) depth

Note. Not sizes DN10 to DN32 ($\frac{3}{8}$ – $1\frac{1}{4}$ in. NB)

IP67 (NEMA 4X) – DN10 to DN32 ($\frac{3}{8}$ – $1\frac{1}{4}$ in. NB)

Buriable (sensor only)

FEV, FEF and FEW – DN450 to 2400 (18 to 96 in. NB)
to 5 m (16 ft.) depth

Conductivity

>20 $\mu\text{S cm}^{-1}$

Transmitter mounting

Integral (not FEF) or remote

Electrical connections

20 mm glands

$\frac{1}{2}$ in. NPT

20 mm armored glands

Sensor cable

ABB WaterMaster cable available in two forms –
standard and armored
Maximum length 200 m (660 ft.)

Suspended solids

Suspended solids percentage of process medium should
not exceed 6 % of total volume

Physical specification

Wetted parts

Electrode material

Stainless steel 316 L / 316 Ti

Super-austenitic steel

Hastelloy® C-22 and Hastelloy C4

(other electrode materials available on request)

Potential equalizing rings

Minimum of 1 recommended

Lining material / potable water approvals

Code	Size Range	Liner	Potable Water Approvals					AZ/ NZZ 4020
			WRAS	WRAS 60°C	ACS	DVGW	NSF	
FEW1	DN10 – 32 ($\frac{3}{8}$ – $1\frac{1}{4}$ in. NB)	PTFE	✓					
FEW3	DN10 – 600 ($\frac{3}{8}$ – 24 in. NB)	PTFE						
FEW3	DN40 – 2400 (1½ – 96 in. NB)	Elastomer	✓					✓
FEW3	DN40 – 2400 (1½ – 96 in. NB)	Hard rubber	✓	✓		✓	NSF approved material	
FEV	DN40 – 200 (1½ – 8 in. NB)	Poly- propylene	✓		✓	✓	NSF-61	✓
FEF	DN250 – 600 (10 – 24 in. NB)	Elastomer	✓		✓	✓	NSF-61	✓
FEF	DN250 – 600 (10 – 24 in. NB)	Hard rubber	✓	✓		✓	NSF approved material	
FER	DN40 – 600 (1½ – 24 in. NB)	Elastomer	✓		✓	✓		✓

*Size is dependent on flange specification

Lining protection plates

Not required

Installation conditions (recommended)

Straight pipe requirements

Upstream Downstream

FEW / FEF 5 x DN 2 x DN

FEV 5x DN 0 x DN

FER 0 x DN 0 x DN

Pressure loss

Negligible at Q3 All full bore meters

<0.25 bar (<3.62 psi) at Q3 FEV (DN40 to 200 [1½ to 8 in. NB])

<0.63 bar (<9.13 psi) at Q3 FER (DN40 to 600 [1½ to 24in. NB])

WaterMaster
Electromagnetic flowmeter

Non-wetted parts

Flange material

Carbon steel	DN20 to DN2400 ($\frac{3}{4}$ to 96 in. NB)
Stainless steel	DN10 to DN2400 ($\frac{3}{8}$ to 96 in. NB)
SG iron	FEV – DN40 to DN150 [1 $\frac{1}{2}$ to 6 in. NB) FER – DN40 to DN150 [1 $\frac{1}{2}$ to 6 in. NB)

Housing material

Carbon steel	FEV – DN40 to 200 (1 $\frac{1}{2}$ to 8 in. NB) FEW – DN450 to 2400 (18 to 96 in. NB)
Plastic	FEF – DN250 to 600 (10 to 24 in. NB)
Aluminium	FEW – DN10 to 400 ($\frac{3}{8}$ to 16 in. NB)

Terminal box material

Polycarbonate

Cable gland material

Plastic, brass

Paint specification

Zinc-based primed (all sensors), paint coat ≥ 70 μm thick RAL 9002 (light grey), in accordance with C4 paint standard

Specification – transmitter

Functional specification

Power supply

Mains	85 to 265 V AC @ <7 VA
Low voltage	24 V AC +10 % / -30 % @ <7 VA
DC	24 V ±30 % @ <0.4 A

Supply voltage fluctuations within the specified range have no effect on accuracy

Digital Outputs (3)

- Rating 30 V @ 220 mA, open collector, galvanically isolated *
- Maximum output frequency 5250 Hz
- 1 off dedicated to Alarm / Logic, programmable function
- 2 off configurable to either Pulse / Frequency or Alarm/Logic function

Current output – HART FEX100 variant

- 4 to 20 mA or 4 to 12/20 mA, galvanically isolated *
- Maximum loop resistance 750 Ω
- HART protocol Version 5.7 (HART registered)
- Signal levels compliant with NAMUR NE 43 (3.8 to 20.5 mA)
- Low alarm 3.6 mA, High alarm 21.8 mA

Additional accuracy

- ±0.1 % of reading
- Temperature coefficient: typically <±20 ppm/°C

RS485 Communications – PROFIBUS FEX100-DP variant

- Registered name: FEX100-DP
- RS485 (9.6kbps to 1.5Mbps), galvanically isolated
- DPV0, DPV1
- PA Profile 3.01
- Standard idents: 9700, 9740, 9741
- FEX100-DP specific ident: 3431
- 3 Concurrent MS2 master connections

RS485 Communications – MODBUS FEX100-MB variant

- MODBUS RTU protocol
- RS485 (9.6kbps to 115.2kbps), galvanically isolated

Electrical connections

- 20 mm glands 1/2 in. NPT, 20 mm armored glands

Temperature limitations

- Ambient temperature -20 to 60 °C (-4 to 140 °F)
- Temperature coefficient Typically <±10 ppm/°C @ Vel ≥0.5 m/s

Environmental protection

- Humidity: 0 to 100 %
- Rating: IP67 (NEMA 4X) to 1m (3.3 ft.) depth

Tamper-proof security

- Write access prevented by internal switch combined with external security seals for MID applications

Languages

- English, French, German, Italian, Spanish, Polish

Infrared service port

- USB adapter (accessory), USB 1.1. and 2.0 compatible
- Driver software for Windows 2000, XP, 7 (32-bit) and Vista

Housing material

- Powder-coated aluminium with glass window

Paint specification

- Paint coat ≥70 µm thick RAL 9002 (light grey)

Transmitter vibration testing

- Vibration level: 7 m/s²
- Frequency range: 20 to 150 Hz
- No. of sweeps in 3 orthogonal planes: 20
- Undetectable shift in transmitter span or zero performance

Hazardous approvals

- FM & FMc Class 1 Div 2
- (FM listing NI / 1 / 2 / ABCD / T4, S / II, III / 2 / FG / T4, Ta=60°C; Type 4X, IP67 – for transmitter and integral mounting Ta=70°C, Type 6P, IP68 – for remote sensor type, IP67 on DN10 to 32 [3/8 to 1 1/4 in.NB])
- (FMc listing NI / 1 / 2 / ABCD / T4, DIP / II, III / 2 / FG / T4, Ta=60°C; Type 4X, IP67 – for transmitter and integral mounting Ta=70°C, Type 6P, IP68 – for remote sensor type, IP67 on DN10 to 32 [3/8 to 1 1/4 in.NB])

FET, FEV, FEW and FEF DN700 to 2200 (27/28* to 84 in. NB) only

*Size is dependent on flange specification

ATEX* Zone 2, 21 & 22

- II 3 G Ex nA IIC T5 Gc
- II 2 D Ex tb IIIC T100°C Db
- TA = -20°C to +60°C (integral transmitter)
- TA = -20°C to +70°C (remote sensor)

IECEX* Zone 2, 21 & 22

- Ex tb IIIC T100°C Db
- Ex nA IIC T5 Gc
- TA = -20°C to +60°C (integral transmitter)
- TA = -20°C to +70°C (remote sensor)

*FEW, FEV, FET and FEF ≥700 (27/28 in. NB) only

Declaration of Conformance

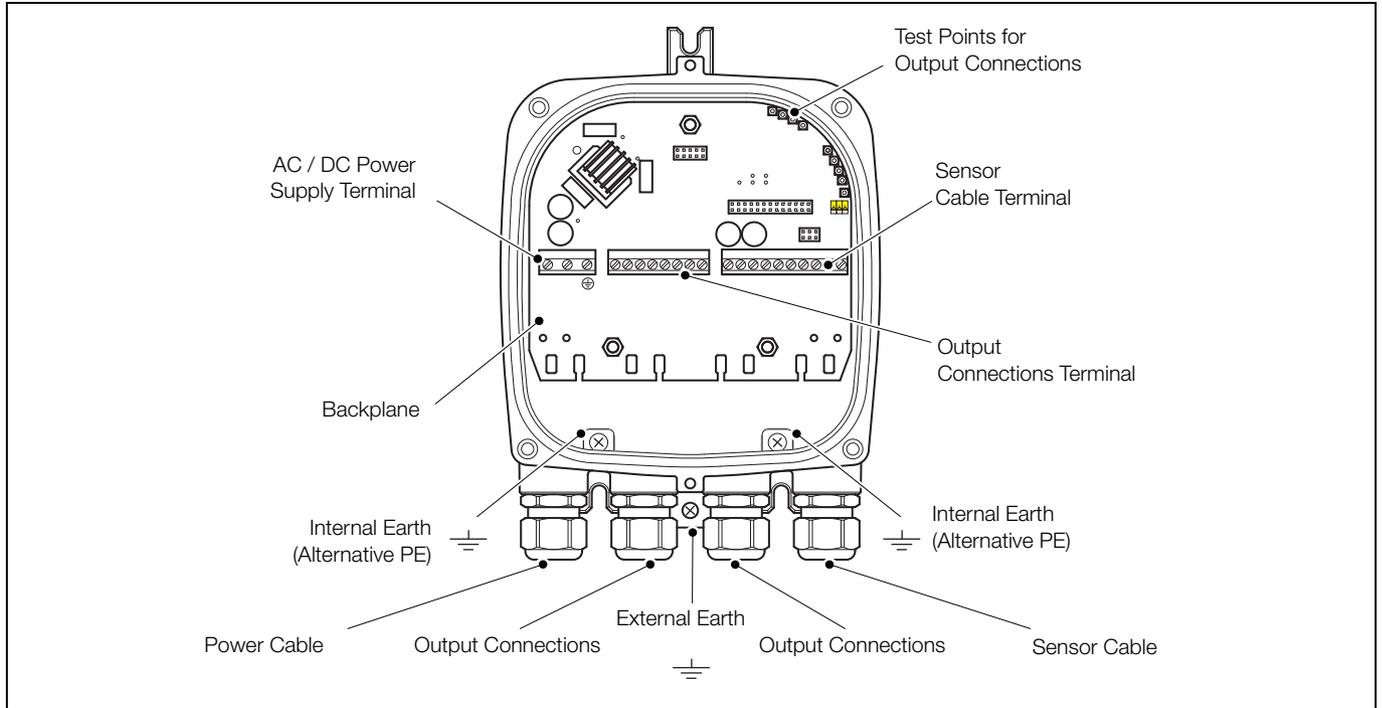
- Copies of CE certification will be available on request.
- WaterMaster has OIML R49 Certificate of Conformity to accuracy class 1 and 2 (FEV DN40 to 200 [1 1/2 to 8 in.NB]). Copies of accuracy certification are available on request.
- WaterMaster (FEV DN40 to 200 [1 1/2 to 8 in.NB]) has been type examined under directive MID 2004/22/EC, Annex MI-001. Copies of this certificate are available on request.

* When installed, do not leave galvanically isolated circuits (pulse and current) floating.

Transmitter connections

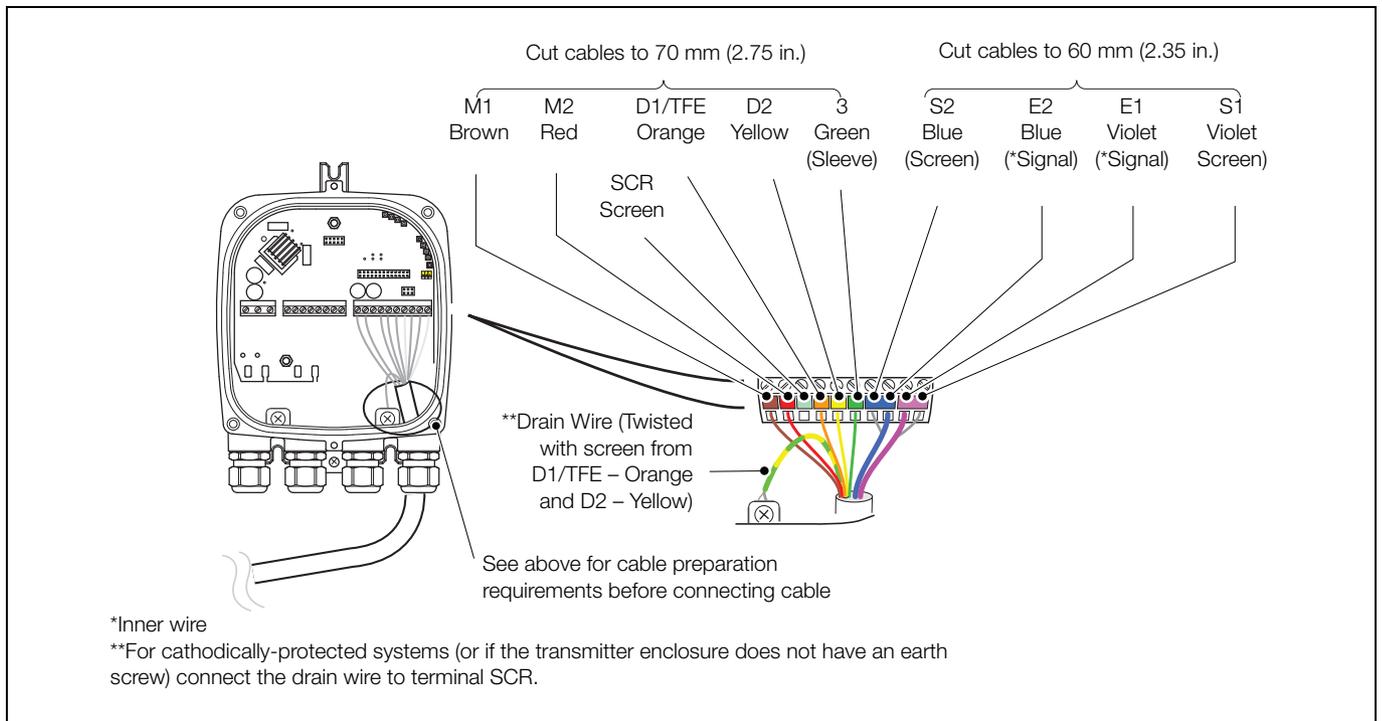
Transmitter terminal connections overview

This section is intended to give an overview of installation of a flowmeter. For Installation requirements, technical information and Health and safety precautions – refer to the User Guide OI/FET100–EN.



Cable gland / conduit entry (Remote transmitter shown)

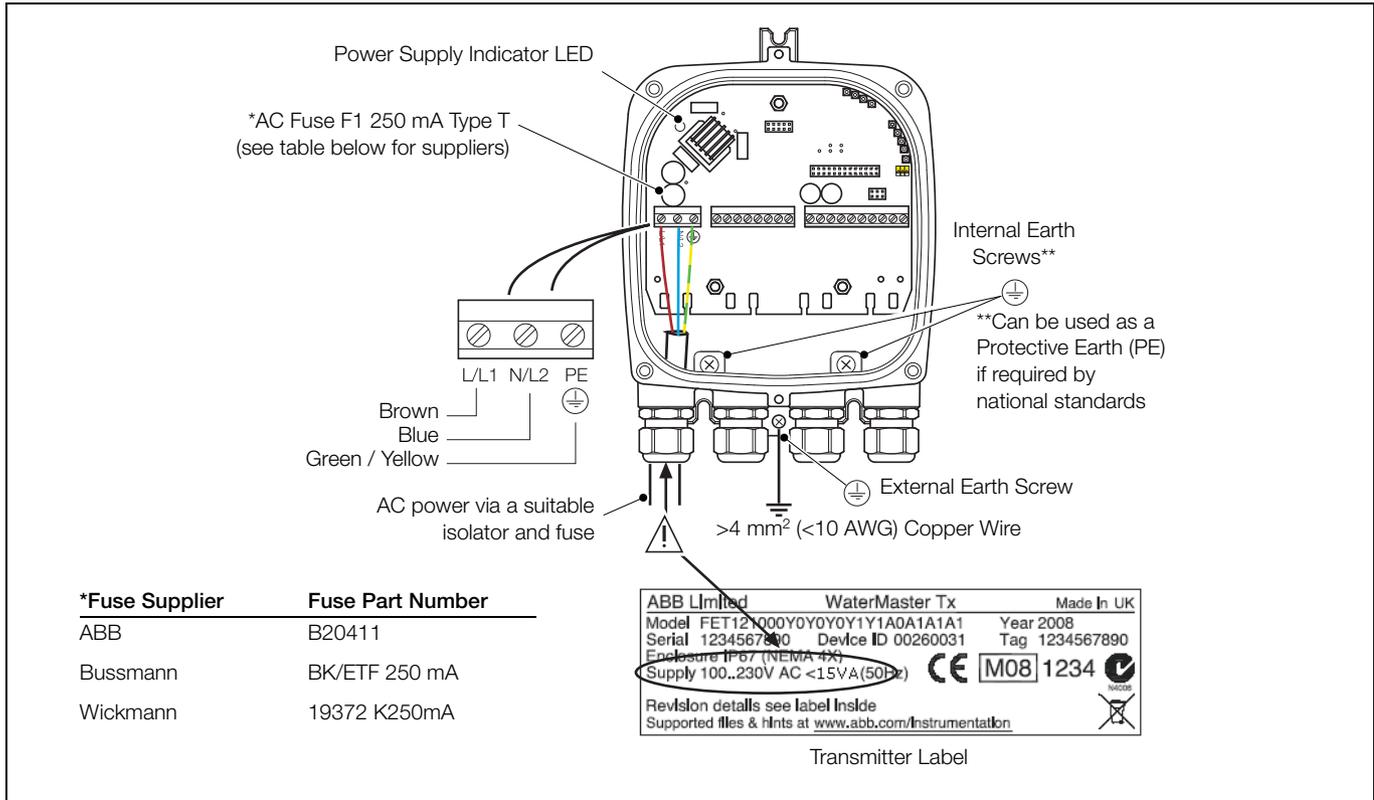
Sensor cable terminal connections and recommended cable lengths



Sensor cable connections at transmitter terminal block – remote transmitter

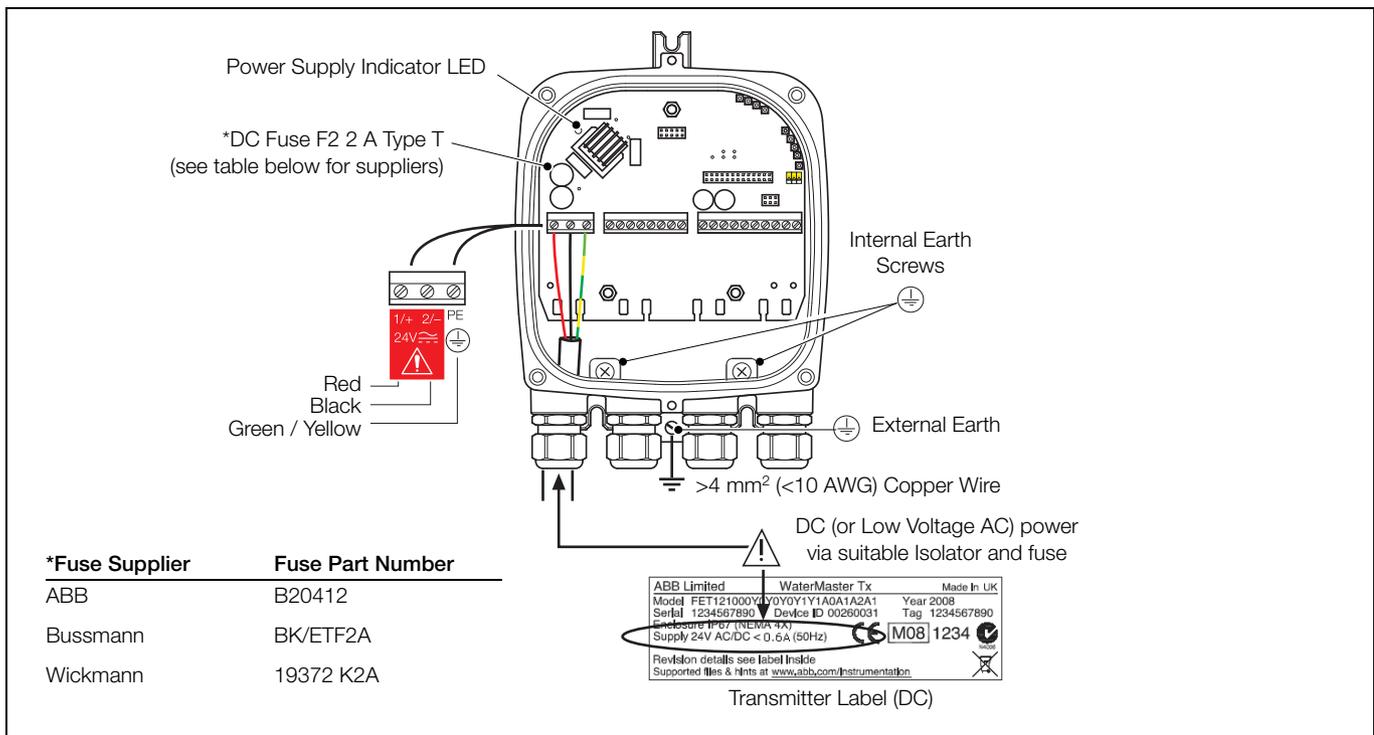
Power supply connections

AC power supply



AC power supply connections

DC (and low voltage AC) power supply



DC (and low voltage AC) power supply connections

Configuration DIP switches

Three configuration DIP switches are mounted on the transmitter backplane board.

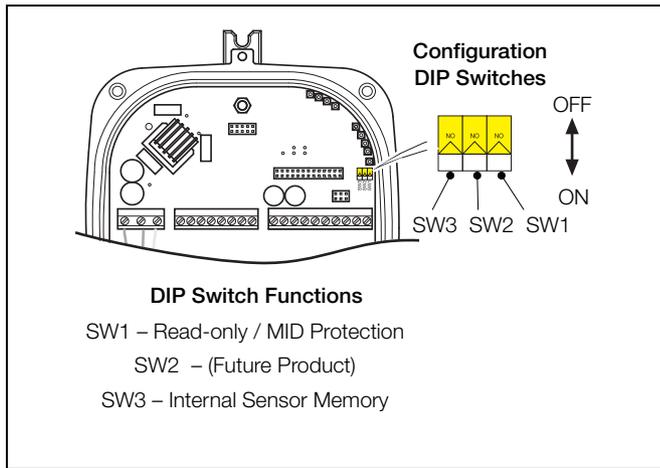
These are factory-set as follows:

- Remote transmitter – all OFF
- Integral transmitter – SW3 ON

For MID-compliant flowmeters the read-only / MID protection switch is set to 'ON' to ensure the meter is secure from tampering.

For HART software versions prior to 01.02.XX, this switch (set after commissioning) prevents login via the keypad or bus at any security level.

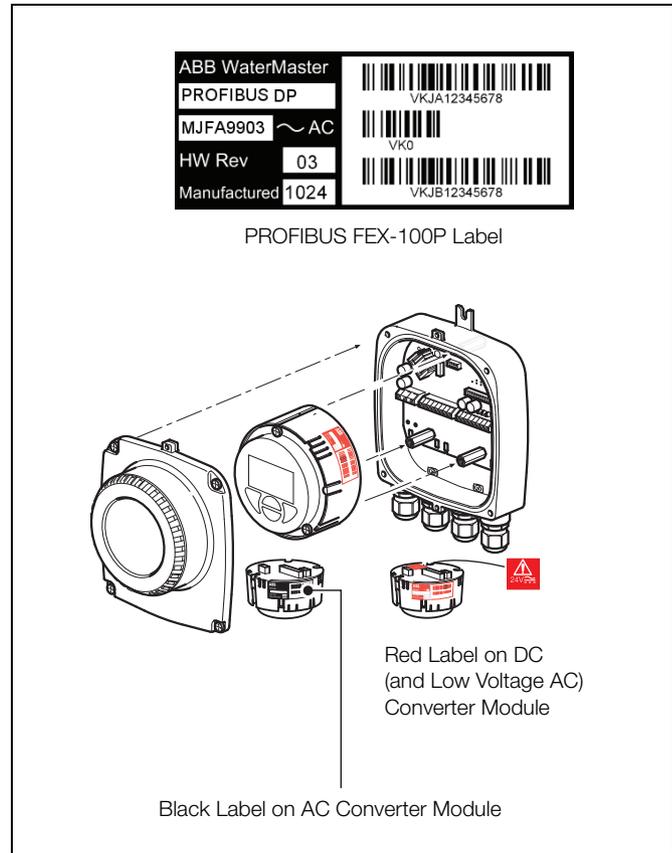
From HART software version 01.03.XX onwards and for all PROFIBUS software versions, on MID meters, all metrological-related parameters are locked and inaccessible at the Service level. Standard and Advanced user level parameters can still be modified via the HMI or bus.



Configuration DIP switches

Transmitter module identification

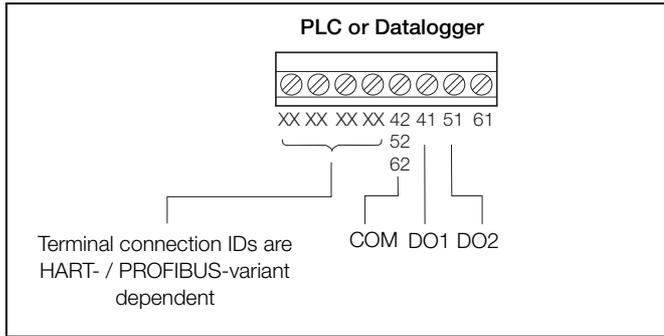
Note. The communications bus type is HART FEX100 if not specified on the transmitter module label. An example of the PROFIBUS FEX100-DP variant transmitter module label is shown below.



Transmitter module identification

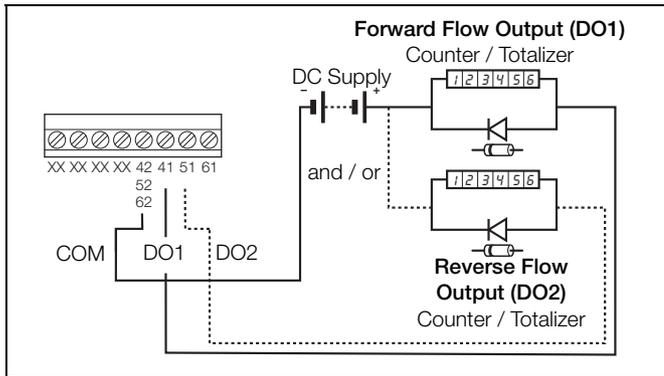
Output connections

Frequency outputs

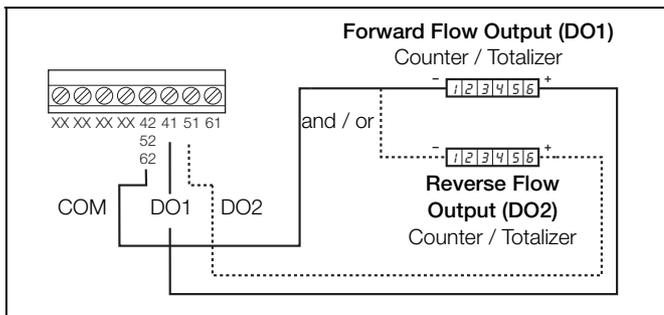


PLC / Datalogger connections

Note. Digital outputs DO1 and DO2 are polarity sensitive. The common (negative) connection for these outputs is designated 'COM'.

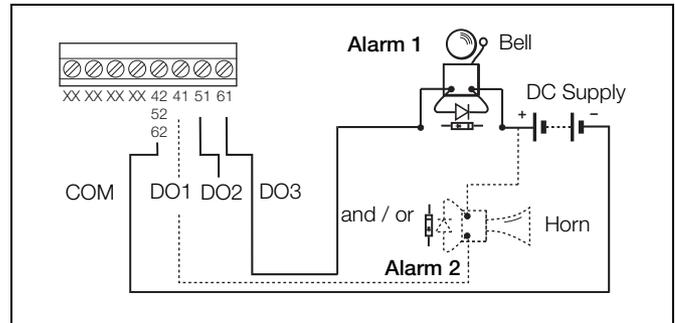
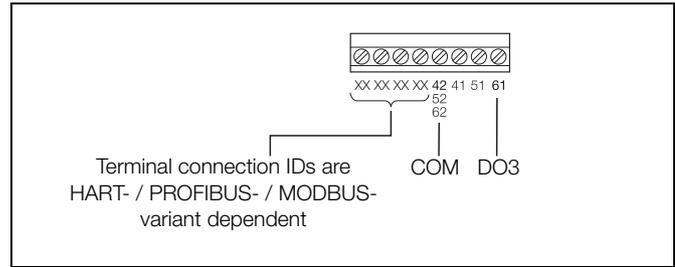


Electromechanical connections



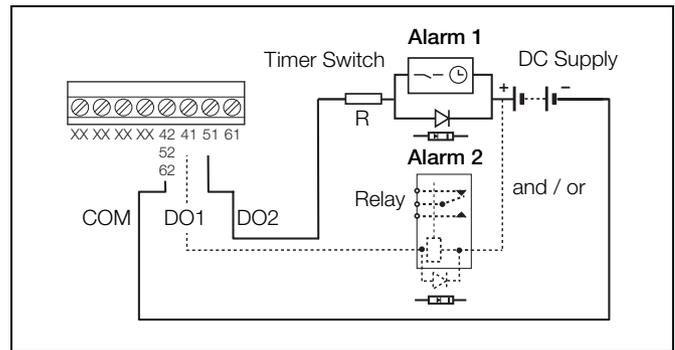
Telemetry / Electronic counters connections

Alarm outputs



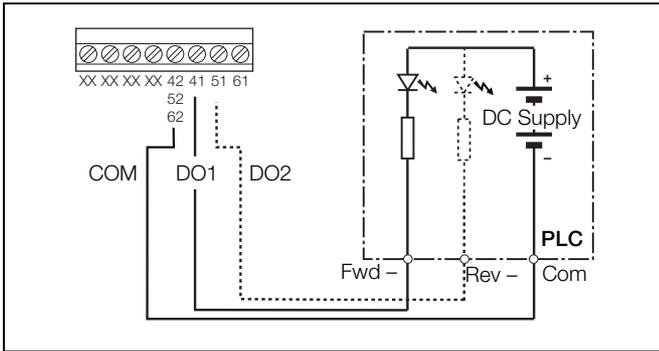
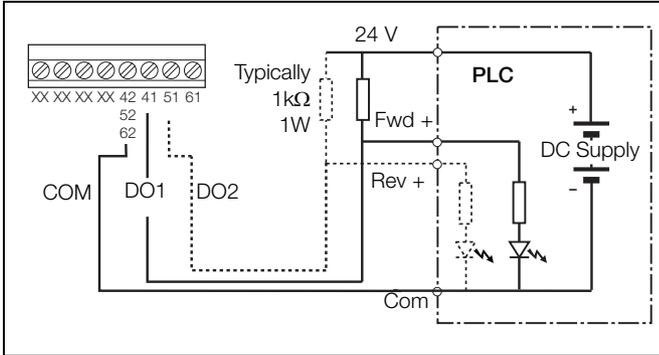
Note.

- Normal alarm / logic output is from DO3 (terminal 61). DO1 (41) and DO2 (51) can also be configured as alarms if required but are then NOT available as frequency / pulse outputs as shown in *Electromechanical connections* and *Telemetry / Electronic counters connections*, opposite.
- Bell and horn shown for example only. Any suitable alarm device may be used (for example, lamp, siren, buzzer etc.).



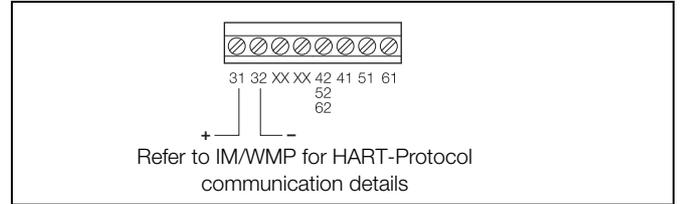
Note. Relay and timer switch shown for example only.

PLC interface



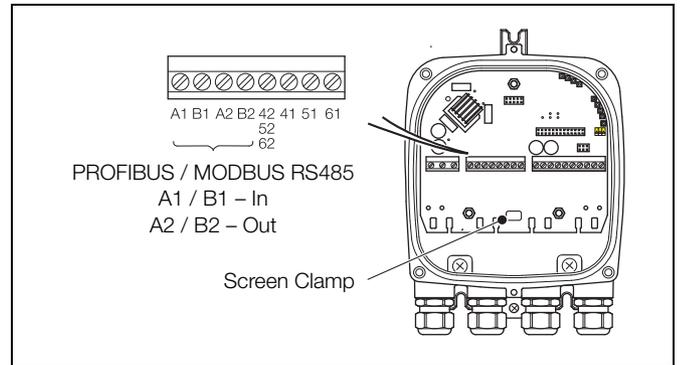
- Note.**
- WaterMaster digital outputs are NPN optocoupled transistors used as switches.
 - Maximum allowed voltage at collector is 30 V DC
 - Maximum allowed current across transistor is 220 mA.

Current output (4 to 20 ma) – HART (FEX100) variant



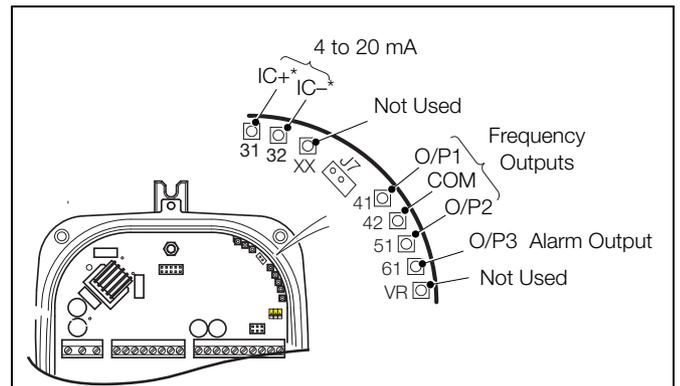
Current output (4 to 20 mA) – HART (FEX100) variant

RS485 communications – PROFIBUS (FEX100-DP) and MODBUS (FEX100-MB) variants



Test point access

- Note.** A typical DVM probe can access (fit) the PCB's test holes.



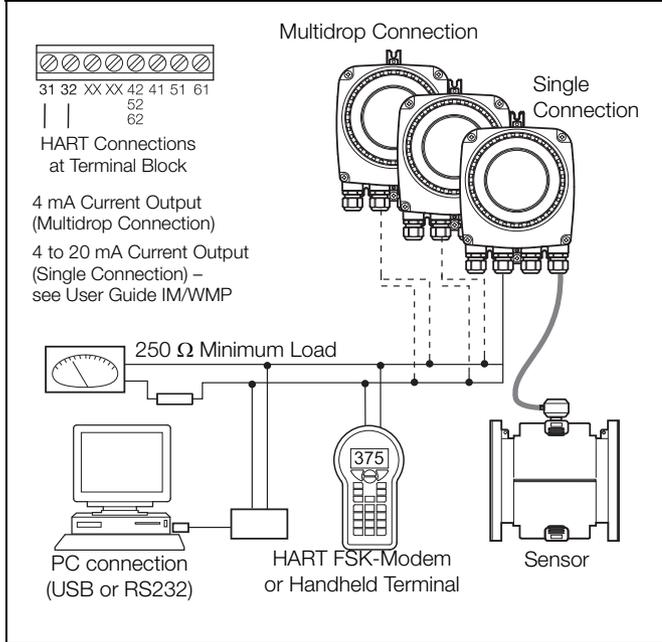
*These 2 test points are connected on the HART FEX100 backplane only (they are present on the PROFIBUS FEX100-DP / MODBUS FEX100-MB backplane but not connected)

Digital communication

The transmitter has the following options for digital communication.

HART protocol

The unit is registered with HART Communication Foundation.



HART protocol	
Configuration	Directly on the Device Software Asset Vision Basic (+ HART -DTM)
Transmission	Install a HART modem (FSK [Frequency Shift Keyed]-Modem) for HART-Communication when connecting to a PC. The HART-Modem converts the analog 4 to 20 mA signal into a digital output signal (Bell Standard 202) and connects to the PC using a USB (or RS232C) connector
Max. signal amplitude	1.2 mA
Current output load	Min. 250Ω, max. = 560Ω
Cable	AWG 24 twisted
Max. cable length	1500 m (4921 ft.)
Baud rate	1.200 baud

System integration

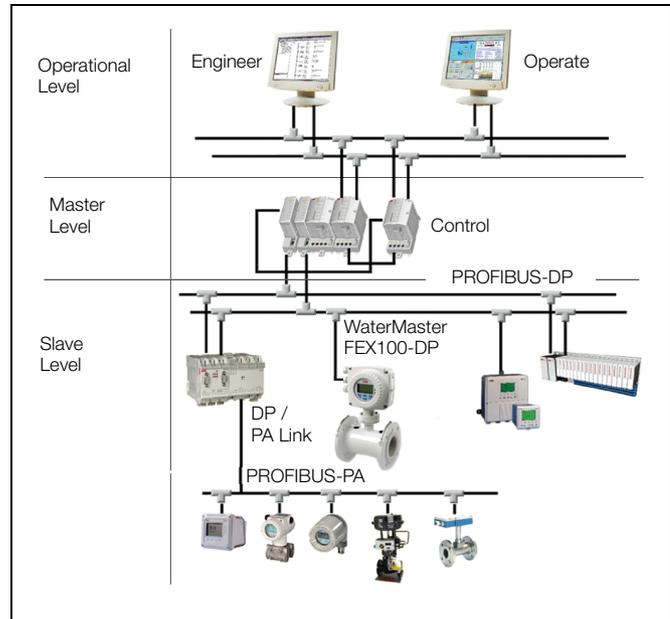
WaterMaster can be integrated into control systems and configuration devices using any Frame application, such as ABB AssetVision or similar third-party applications. ABB Device Type Managers (DTMs) for WaterMaster provide a unified structure for accessing device parameters, configuring and operating the devices and diagnosing problems. FDT (Field Device Tool) technology standardizes the communication and configuration interface between all field devices and host systems.

PROFIBUS DP protocol

PROFIBUS is a manufacturer-independent, open Fieldbus standard for a wide range of applications in manufacturing, process and building automation. Manufacturer independence and openness are ensured by the international standard EN 50170.

PROFIBUS DP ID no.	0x3431
Alternative standard ID no.	0x9701 or 0x9741
Configuration	Directly on the device Software Asset Vision Basic (+PROFIBUS DP-DTM)
Transmission signal	Accuracy to IEC 61158-2
Cable	Shielded, twisted cable (accurate to IEC 61158-2, types A or B)

All devices are connected in a bus structure ('line') as shown in below. Up to 32 stations (master or slaves) can be linked to create one 'segment', although it is recommended not to install more than 16 devices on a single segment. Each end of a segment must be terminated by an active bus terminating resistor. Both bus terminators must always be powered to ensure fault-free operation, therefore it is strongly recommended that they are connected to a back-up power supply. The use of bus amplifiers (repeaters) and segment couplers can be used to extend the network.



System integration

The GSD file for WaterMasters specifies the device-specific Ident No. 3431. It conforms to the PROFIBUS standard, providing a clear and comprehensive description of each instrument in a precisely defined format.

This enables the system configuration tool to use the information automatically when configuring a PROFIBUS bus system.

The ABB GSD file (Ident No. 3431) is divided into 2 sections:

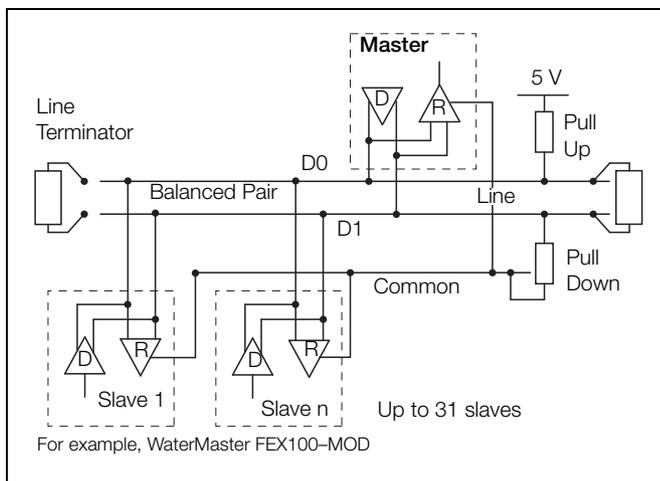
- General specifications
Identification of the device, together with hardware and software versions, baud rates supported and the possible time intervals for monitoring times.
- DP slave-related specifications
Information about the user parameter block for device-specific configuration and modules containing details of the input and output data that can be exchanged cyclically with a PROFIBUS master.

The WaterMaster GSD file (ABB_3431.gsd) is available for download from the ABB website at: www.abb.com/fieldbus (follow the link for PROFIBUS DP field devices).

MODBUS protocol

MODBUS is an open standard that is owned and administered by an independent group of device manufacturers called the Modbus Organization (www.modbus.org).

Using the MODBUS protocol, devices from different manufacturers exchange information on the same communications bus without the need for special interface equipment. WaterMaster FEX100-MB follows the specification for Modbus Over Serial Line V1.02, using 2-wire TIA/EIA-485 (RS485) physical layer.



Cable Properties

The end-to-end length of the trunk cable must be limited. The maximum length depends on the Baud rate, the cable (gauge, capacitance or characteristic impedance), the number of loads on the daisy chain and the network configuration (2-wire or 4-wire).

For 9600 Baud rate and AWG26 (or wider) gauge, the maximum length is 1000 m (3280 ft.). Where 4-wire cabling is used as a 2-wire cabling system the maximum length must be divided by 2. The tap cables must be short, never more than 20 m (65.6 ft.). If a multi-port tap is used with n derivations, each one must have a maximum length of 40 m (131 ft.) divided by n.

The maximum serial data transmission line length for RS485 systems is 1200 m (3937 ft.). The lengths of cable that can be used are determined by the cable type, typically:

- Up to 6 m (19.7 ft.) – standard screened or twisted pair cable.
- Up to 300 m (984 ft.) – twin twisted pair with overall foil screen and an integral drain wire – for example, Belden 9502 or equivalent.
- Up to 1200 m (3937 ft.) – twin twisted pair with separate foil screens and integral drain wires – for example, Belden 9729 or equivalent.

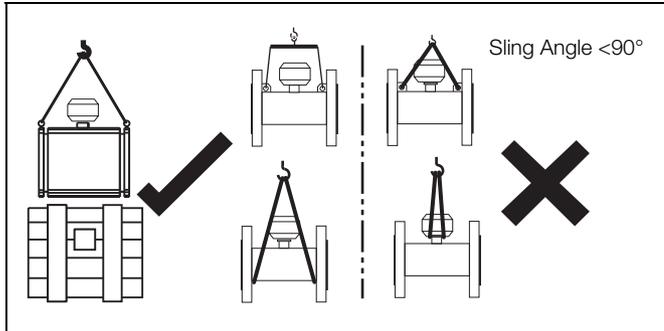
Category 5 cables may be used for RS485-MODBUS to a maximum length of 600 m (1968 ft.). For the balanced pairs used in an RS485-system, a characteristic impedance with value higher than 100Ω is preferred especially for 19200 and higher Baud rates.

Installation requirements

This section is intended to give an overview of installation of a flowmeter. For Installation requirements, technical information and Health and Safety precautions refer to User Guide OI/FEF/FEV/FEW-EN.

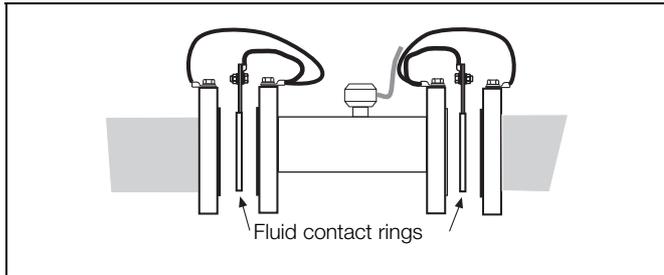
Unpacking the flowmeter

Care must be taken when lifting the flowmeter to use the lifting hooks provided or sling under the body of the meter. Never lift using the terminal connection box of the sensor cable as this will cause damage and invalidate warranty.



Grounding

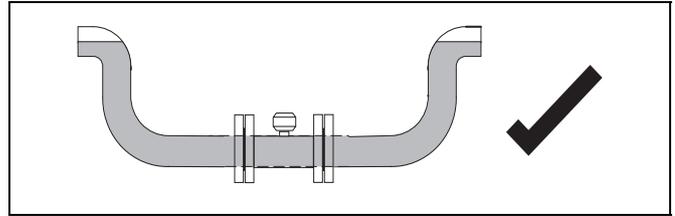
The flowmeter sensor must be cross-bonded to the upstream and downstream pipes and fluid. For technical reasons, this potential should be identical to the potential of the metering fluid. For plastic or insulated lined pipelines, the fluid is grounded by installing a minimum of 1 earthing rings. When there are stray potentials present in the pipeline, an earthing ring is recommended on both ends of the meter sensor.



Mounting

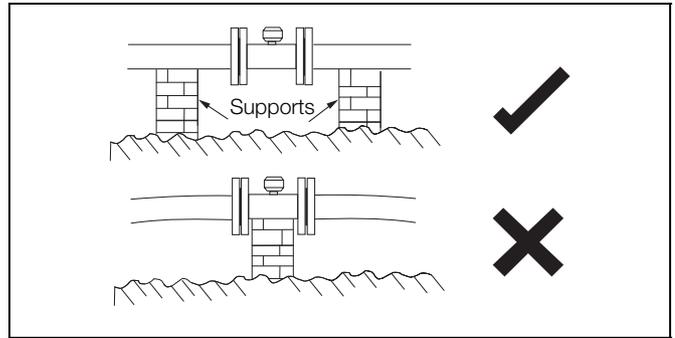
The installation conditions shown below must be observed to achieve the best operational results.

The sensor tube must always be completely full.

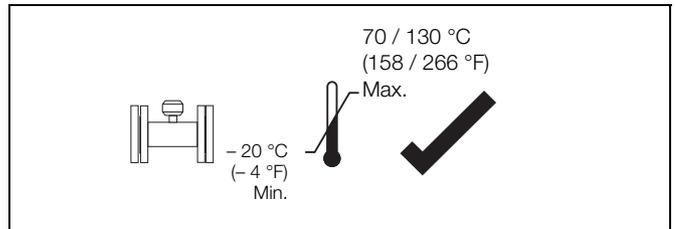


The flow direction must correspond to the identification plate. The device measures the flowrate in both directions. Forward flow is the factory setting.

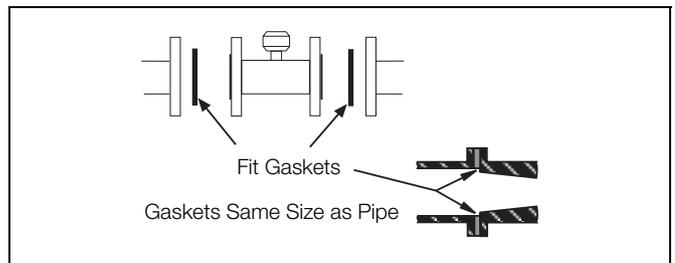
The devices must be installed without mechanical tension (torsion, bending). If required support the pipeline.



The flange seals must be made from a compatible material for the fluid and fluid temperatures if required.

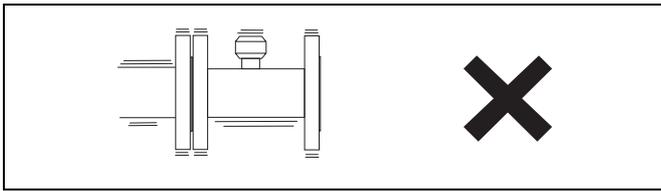


Seals must not extend into the flow area since possible turbulence could influence the device accuracy.

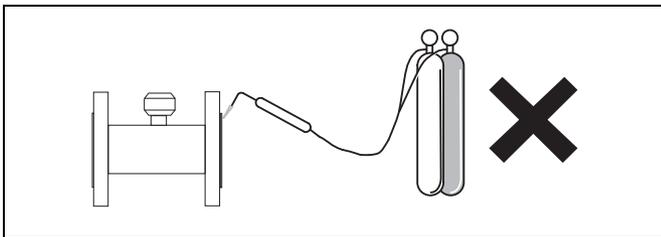


WaterMaster
Electromagnetic flowmeter

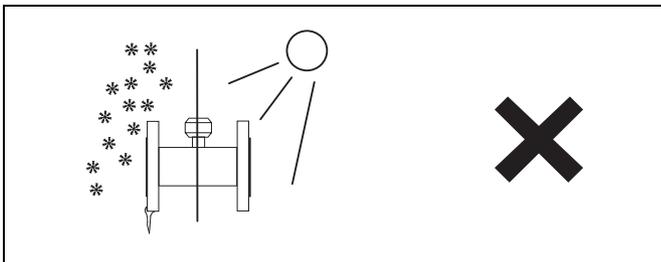
The pipeline may not exert any unallowable forces and torques on the device, such as vibration.



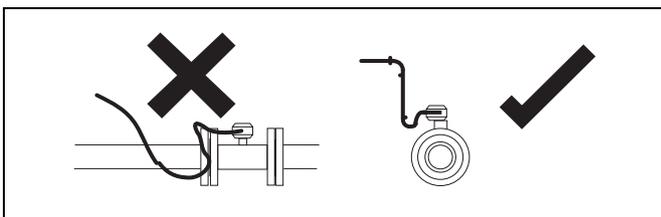
The flowmeter must not be submitted to any localized heat during installation; take care to remember this is a measuring instrument.



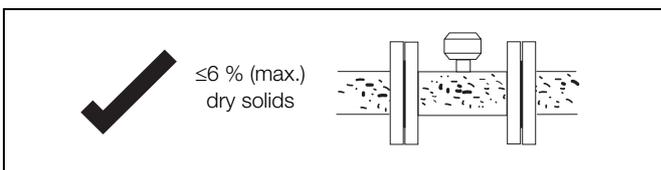
The flowmeter must not be exposed to direct sunlight or provide for appropriate sun protection where necessary.



The cable to the flowmeter should be installed neatly or within a conduit, both loose or conduit should have a u shape below the terminal connection box height to allow any water run off to avoid any capillary action into the flowmeter sensor.

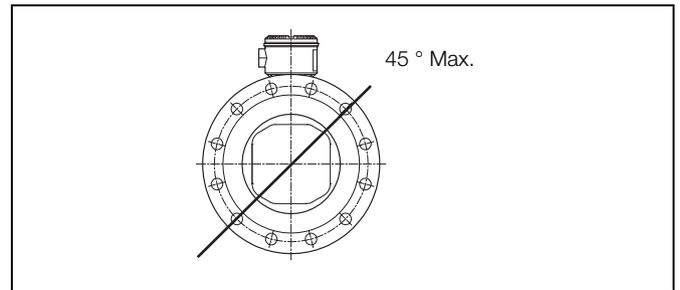


Ensure a maximum 6 % dry solids content flow through pipe – for higher dry solids content, refer to ABB's ProcessMaster range.



Electrode axis

Electrode axis should be horizontal if at all possible or no more than 45° from horizontal.



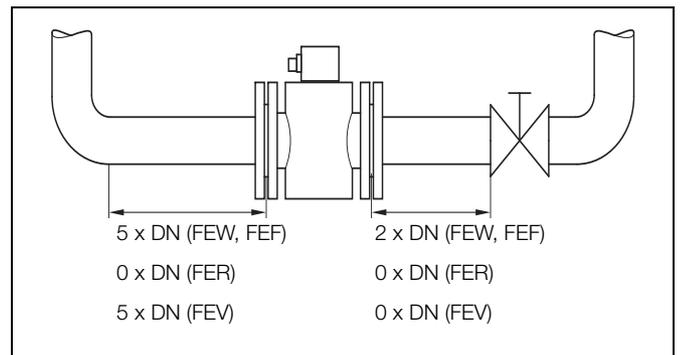
Upstream and Downstream pipe sections

The metering principle is tolerant of the flow profile.

- Wherever possible do not install fittings (for example, manifolds, valves) directly in front of the flowmeter sensor.
- Butterfly valves should be installed so that the valve plate does not extend into the flowmeter sensor.
- Valves or other turn-off components should be installed in the Downstream pipe section.

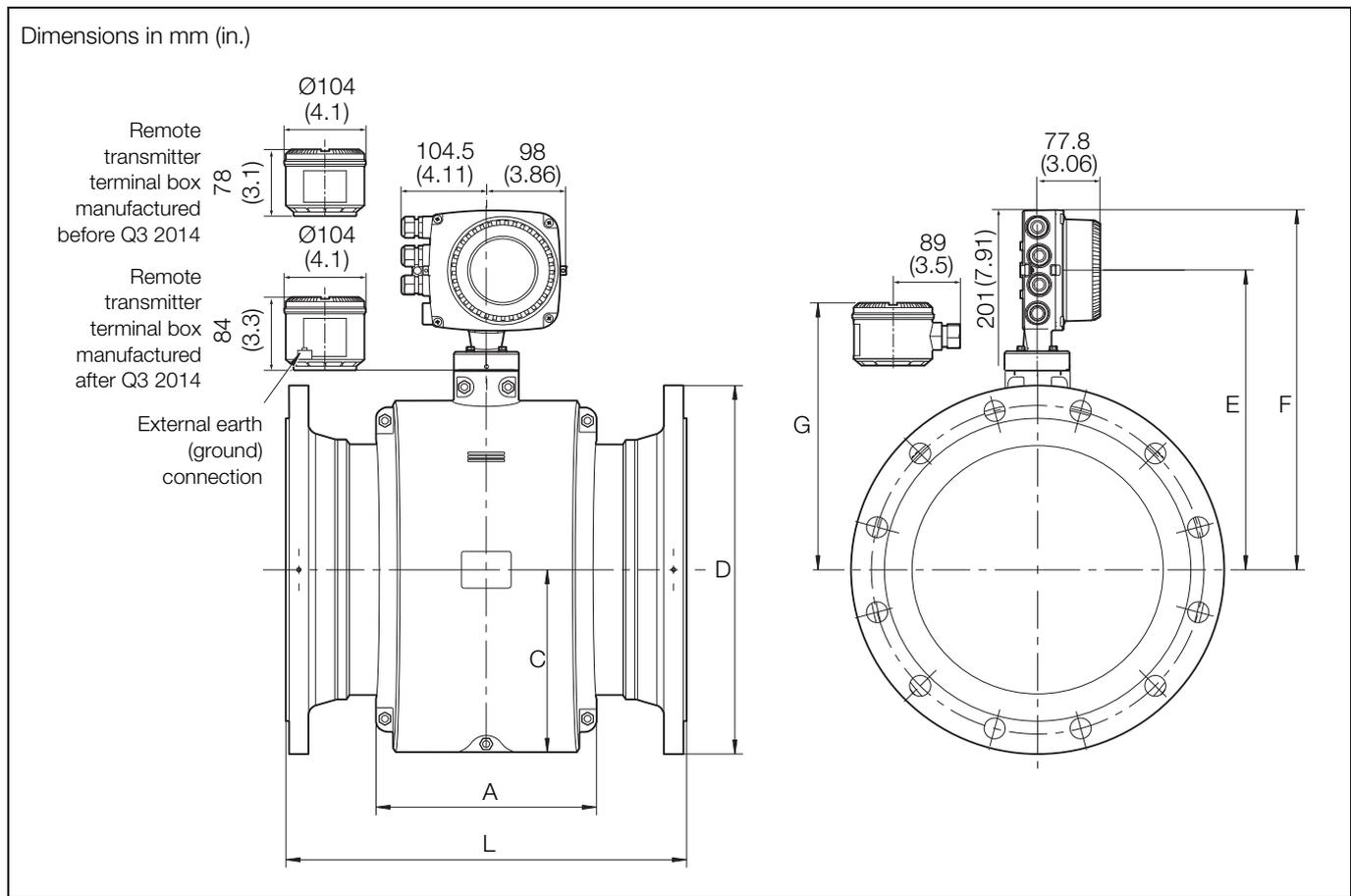
Experience has shown that, in most installations, straight upstream sections 3 x DN long and straight downstream sections 2 x DN long are normally sufficient. We would recommend conditions of 5 x DN straight upstream and 2 x DN straight downstream where possible.

For reduced-bore meters (FER), these straight pipe sections are often not necessary.



DN	Process connection type	Dimensions in mm (in.)							Approx. weight in kg (lb)	
		D	L	F	C	E	G	A	Integral	Remote
DN10 (³ / ₈ in.)	JIS10K	90 (3.54)	200 (7.87)	268 (10.55)	82 (3.23)	193 (7.6)	148 (5.83)	113 (4.45)	6 (13)	4 (9)
	PN10 to 40	90 (3.54)								
	ASME B16.5 CL150	90 (3.54)								
	ASME B16.5 CL300	96 (3.78)								
DN15 (¹ / ₂ in.)	PN10 to 40	95 (3.74)	200 (7.87)	268 (10.55)	82 (3.23)	193 (7.6)	148 (5.83)	113 (4.45)	8 (18)	6 (13)
	JIS5K	80 (3.15)								
	JIS10K	95 (3.74)								
	ASME B16.5 CL300	95 (3.74)								
DN20 (³ / ₄ in.)	PN10 to 40	105 (4.13)	200 (7.87)	268 (10.55)	82 (3.23)	193 (7.6)	148 (5.83)	113 (4.45)	9 (20)	7 (15)
	JIS5K	85 (3.35)								
	JIS10K	100 (3.94)								
	ASME B16.5 CL300	115 (4.53)								
DN25 (1 in.)	PN10 to 40	115 (4.53)	200 (7.87)	268 (10.55)	82 (3.23)	193 (7.6)	148 (5.83)	113 (4.45)	10 (22)	8 (18)
	JIS5K	95 (3.74)								
	JIS10K	125 (4.88)								
	ASME B16.5 CL300	125 (4.88)								
DN32 (1 ¹ / ₄ in.)	PN10 to 40	140 (5.51)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	19 (42)	17 (37)
	JIS5K	115 (4.53)								
	JIS10K	135 (5.31)								
	ASME B16.5 CL300	135 (5.31)								
DN40 (1 ¹ / ₂ in.)	PN10 to 40	150 (5.91)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	JIS5K	120 (4.72)								
	JIS10K	140 (5.51)								
	ASME B16.5 CL150	117 (4.61)								
DN50 (2 in.)	PN10 to 40	165 (6.5)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	19 (42)	17 (37)
	JIS5K	130 (5.12)								
	JIS10K	155 (6.10)								
	AS4087 PN16	150 (5.91)								
DN65 (2 ¹ / ₂ in.)	PN10 to 40	185 (7.28)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	JIS5K	155 (6.10)								
	JIS10K	175 (6.89)								
	AS4087 PN16	165 (6.50)								
DN80 (3 in.)	PN10 to 40	200 (7.87)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	JIS5K	180 (7.09)								
	JIS10K	185 (7.28)								
	AS4087 PN16	185 (7.28)								
DN100 (4 in.)	PN10 to 40	220 (8.66)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	PN25 to 40	235 (9.25)								
	JIS5K	200 (7.87)								
	JIS10K	210 (8.27)								
DN125 (5 in.)	PN10 to 40	250 (9.84)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	PN25 to 40	270 (10.63)								
	JIS5K	235 (9.25)								
	JIS10K	250 (9.84)								
DN150 (6 in.)	PN10 to 40	270 (10.63)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	PN25 to 40	290 (11.42)								
	JIS5K	255 (10.04)								
	JIS10K	270 (10.63)								
DN200 (8 in.)	PN10 to 40	300 (11.81)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	PN25 to 40	320 (12.60)								
	JIS5K	270 (10.63)								
	JIS10K	285 (11.22)								
DN250 (10 in.)	PN10 to 40	330 (12.99)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	PN25 to 40	350 (13.78)								
	JIS5K	285 (11.22)								
	JIS10K	300 (11.81)								
DN300 (12 in.)	PN10 to 40	360 (14.17)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	PN25 to 40	380 (14.96)								
	JIS5K	300 (11.81)								
	JIS10K	315 (12.39)								
DN350 (14 in.)	PN10 to 40	390 (15.35)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	PN25 to 40	410 (16.14)								
	JIS5K	315 (12.39)								
	JIS10K	330 (12.99)								
DN400 (16 in.)	PN10 to 40	420 (16.54)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	PN25 to 40	440 (17.33)								
	JIS5K	330 (12.99)								
	JIS10K	345 (13.58)								
DN450 (18 in.)	PN10 to 40	450 (17.72)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	PN25 to 40	470 (18.51)								
	JIS5K	345 (13.58)								
	JIS10K	360 (14.17)								
DN500 (20 in.)	PN10 to 40	480 (18.90)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	PN25 to 40	500 (19.69)								
	JIS5K	360 (14.17)								
	JIS10K	375 (14.76)								
DN600 (24 in.)	PN10 to 40	540 (21.26)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	PN25 to 40	560 (22.05)								
	JIS5K	375 (14.76)								
	JIS10K	390 (15.35)								
DN700 (28 in.)	PN10 to 40	600 (23.62)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	PN25 to 40	620 (24.41)								
	JIS5K	390 (15.35)								
	JIS10K	405 (15.94)								
DN800 (32 in.)	PN10 to 40	660 (25.98)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	PN25 to 40	680 (26.77)								
	JIS5K	405 (15.94)								
	JIS10K	420 (16.54)								
DN900 (36 in.)	PN10 to 40	720 (28.34)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	PN25 to 40	740 (29.13)								
	JIS5K	420 (16.54)								
	JIS10K	435 (17.13)								
DN1000 (40 in.)	PN10 to 40	780 (30.70)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	PN25 to 40	800 (31.49)								
	JIS5K	435 (17.13)								
	JIS10K	450 (17.72)								
DN1100 (44 in.)	PN10 to 40	840 (33.06)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	PN25 to 40	860 (33.85)								
	JIS5K	450 (17.72)								
	JIS10K	465 (18.31)								
DN1200 (48 in.)	PN10 to 40	900 (35.42)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	PN25 to 40	920 (36.21)								
	JIS5K	465 (18.31)								
	JIS10K	480 (18.90)								
DN1300 (52 in.)	PN10 to 40	960 (37.78)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	PN25 to 40	980 (38.57)								
	JIS5K	480 (18.90)								
	JIS10K	495 (19.49)								
DN1400 (56 in.)	PN10 to 40	1020 (40.14)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	PN25 to 40	1040 (40.93)								
	JIS5K	495 (19.49)								
	JIS10K	510 (20.08)								
DN1500 (60 in.)	PN10 to 40	1080 (42.50)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	PN25 to 40	1100 (43.29)								
	JIS5K	510 (20.08)								
	JIS10K	525 (20.68)								
DN1600 (64 in.)	PN10 to 40	1140 (44.86)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	PN25 to 40	1160 (45.65)								
	JIS5K	525 (20.68)								
	JIS10K	540 (21.27)								
DN1700 (68 in.)	PN10 to 40	1200 (47.22)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	PN25 to 40	1220 (48.01)								
	JIS5K	540 (21.27)								
	JIS10K	555 (21.87)								
DN1800 (72 in.)	PN10 to 40	1260 (49.58)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	PN25 to 40	1280 (50.37)								
	JIS5K	555 (21.87)								
	JIS10K	570 (22.46)								
DN1900 (76 in.)	PN10 to 40	1320 (51.94)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	PN25 to 40	1340 (52.73)								
	JIS5K	570 (22.46)								
	JIS10K	585 (23.05)								
DN2000 (80 in.)	PN10 to 40	1380 (54.30)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	PN25 to 40	1400 (55.09)								
	JIS5K	585 (23.05)								
	JIS10K	600 (23.64)								
DN2100 (84 in.)	PN10 to 40	1440 (56.66)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	PN25 to 40	1460 (57.45)								
	JIS5K	600 (23.64)								
	JIS10K	615 (24.23)								
DN2200 (88 in.)	PN10 to 40	1500 (59.02)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	PN25 to 40	1520 (59.81)								
	JIS5K	615 (24.23)								
	JIS10K	630 (24.82)								
DN2300 (92 in.)	PN10 to 40	1560 (61.38)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	PN25 to 40	1580 (62.17)								
	JIS5K	630 (24.82)								
	JIS10K	645 (25.41)								
DN2400 (96 in.)	PN10 to 40	1620 (63.74)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	PN25 to 40	1640 (64.53)								
	JIS5K	645 (25.41)								
	JIS10K	660 (26.00)								
DN2500 (100 in.)	PN10 to 40	1680 (66.10)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	PN25 to 40	1700 (66.89)								
	JIS5K	660 (26.00)								
	JIS10K	675 (26.59)								
DN2600 (104 in.)	PN10 to 40	1740 (68.46)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	PN25 to 40	1760 (69.25)								
	JIS5K	675 (26.59)								
	JIS10K	690 (27.18)								
DN2700 (108 in.)	PN10 to 40	1800 (70.82)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	PN25 to 40	1820 (71.61)								
	JIS5K	690 (27.18)								
	JIS10K	705 (27.77)								
DN2800 (112 in.)	PN10 to 40	1860 (73.18)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	PN25 to 40	1880 (73.97)								
	JIS5K	705 (27.77)								
	JIS10K	720 (28.36)								
DN2900 (116 in.)	PN10 to 40	1920 (75.54)	250 (9.84)	314 (12.36)	122 (4.8)	239 (9.41)	194 (7.64)	125 (4.92)	23 (51)	21 (46)
	PN25 to 40									

FEW – DN150 to 400 (6 to 16 in. NB)

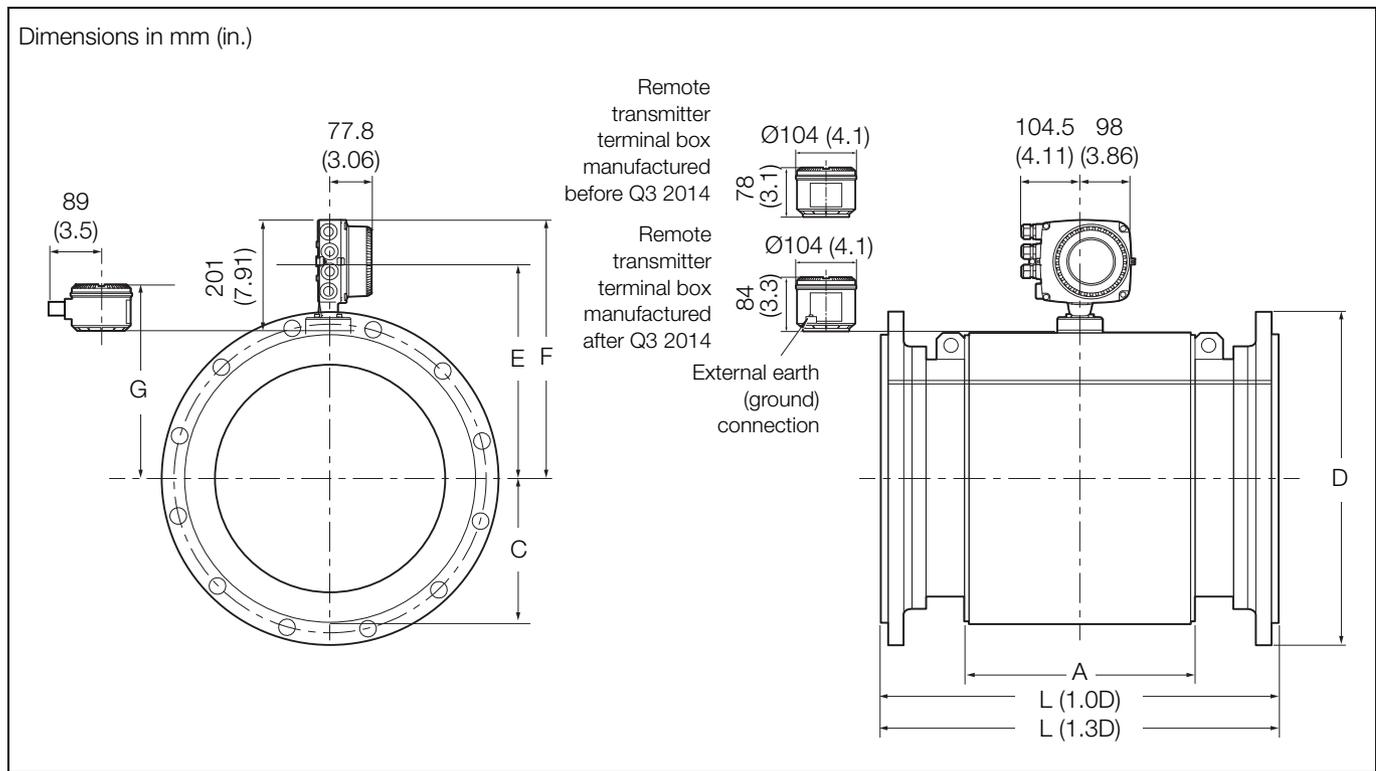


DN150 to 400 (6 to 16 in. NB) (FEW)

DN	Process connection type	Dimensions in mm (in.)							Approx. weight in kg (lb)	
		D	L	F	C	E	G	A	Integral	Remote
DN150 (6 in.)	PN10 to 16	285 (11.22)	300 (11.81)	371 (14.61)	146 (9.88)	296 (11.65)	251 (9.88)	166 (6.54)	33 (73)	31 (68)
	PN25 to 40	300 (11.81)							39 (86)	37 (81)
	JIS5K	265 (10.43)							33 (73)	31 (68)
	JIS10K	280 (11.02)								
	AS4087 PN16	280 (11.02)								
	AS4087 PN35	305 (11.81)							39 (86)	37 (81)
	ASME B16.5 CL300	320 (12.60)							47 (103)	45 (99)
ASME B16.5 CL150	279 (10.98)	33 (73)	31 (68)							
DN200 (8 in.)	PN10	340 (13.39)	350 (13.78)	411 (16.18)	170 (6.69)	336 (13.23)	291 (11.46)	200 (7.87)	41 (90)	39 (86)
	PN16	340 (13.39)								
	PN25	360 (14.17)							55 (121)	53 (117)
	PN40	375 (14.76)							65 (143)	63 (139)
	AS4087 PN16	335 (13.19)							41 (90)	39 (86)
	AS4087 PN35	370 (14.57)							65 (143)	63 (139)
	JIS5K	320 (12.60)							41 (90)	39 (86)
	JIS10K	330 (12.99)								
	ASME B16.5 CL300	380 (14.96)							72 (158)	70 (154)
	ASME B16.5 CL150	345 (13.58)							50 (110)	48 (106)
DN250 (10 in.)	PN10	395 (15.55)	450 (17.72)	426 (16.77)	198 (7.80)	351 (13.82)	306 (12.05)	235 (9.62)	61 (134)	59 (130)
	PN16	405 (15.94)							65 (143)	63 (139)
	PN25	425 (16.73)							84 (185)	82 (180)
	PN40	450 (17.72)							95 (209)	93 (205)
	AS4087 PN16	405 (15.94)							65 (143)	63 (139)
	AS4087 PN35	430 (16.93)							95 (209)	93 (205)
	JIS5K	385 (15.16)							65 (143)	63 (139)
	JIS10K	400 (15.75)								
	ASME B16.5 CL300	445 (17.52)							105 (231)	103 (227)
	ASME B16.5 CL150	405 (15.94)							70 (154)	68 (150)
DN300 (12 in.)	PN10	445 (17.52)	500 (19.69)	449 (17.68)	228 (8.98)	374 (14.72)	329 (12.95)	272 (10.71)	74 (163)	72 (158)
	PN16	460 (18.11)							80 (176)	78 (172)
	PN25	485 (19.09)							100 (220)	98 (216)
	JIS5K	430 (16.93)							80 (176)	78 (172)
	JIS10K	445 (17.52)								
	AS4087 PN16	455 (17.91)								
	AS4087 PN35	490 (19.29)							130 (286)	128 (282)
	ASME B16.5 CL300	520 (20.47)							150 (330)	148 (326)
	ASME B16.5 CL150	485 (19.09)							105 (231)	103 (227)
	PN40	515 (20.28)							600 (23.62)	130 (286)
DN350 (14 in.)	PN10	505 (19.88)	550 (21.65)	464 (18.27)	265 (10.43)	389 (15.31)	344 (13.54)	322 (12.68)	95 (209)	93 (205)
	PN16	520 (20.47)							110 (242)	108 (238)
	PN25	555 (21.85)							145 (319)	143 (315)
	JIS5K	480 (18.90)							95 (209)	93 (205)
	JIS10K	490 (19.29)								
	AS4087 PN16	525 (20.67)							130 (286)	128 (282)
	AS4087 PN35	550 (21.65)							185 (407)	183 (403)
	ASME B16.5 CL300	585 (23.03)							140 (308)	138 (304)
	ASME B16.5 CL150	535 (21.06)							105 (231)	103 (227)
	PN40	580 (22.83)							650 (25.59)	195 (429)
DN400 (16 in.)	PN10	565 (22.24)	600 (23.62)	506 (19.92)	265 (10.43)	431 (16.97)	386 (15.20)	322 (12.68)	103 (227)	101 (222)
	PN16	580 (22.83)							126 (277)	124 (273)
	PN25	620 (24.41)							170 (374)	168 (370)
	JIS5K	540 (21.26)							103 (227)	101 (223)
	JIS10K	560 (22.05)							116 (255)	114 (251)
	AS4087 PN16	580 (22.83)							154 (339)	152 (335)
	AS4087 PN35	610 (24.02)							302 (664)	300 (660)
	ASME B16.5 CL300	650 (25.59)							265 (583)	263 (578)
	ASME B16.5 CL150	600 (23.62)							175 (385)	173 (381)
	PN40	660 (25.98)							650 (25.59)	258 (568)

DN150 to 400 (6 to 5 in. NB) (FEW) dimensions / weights

FEW – DN450 to 2400 (18 to 96 in. NB)



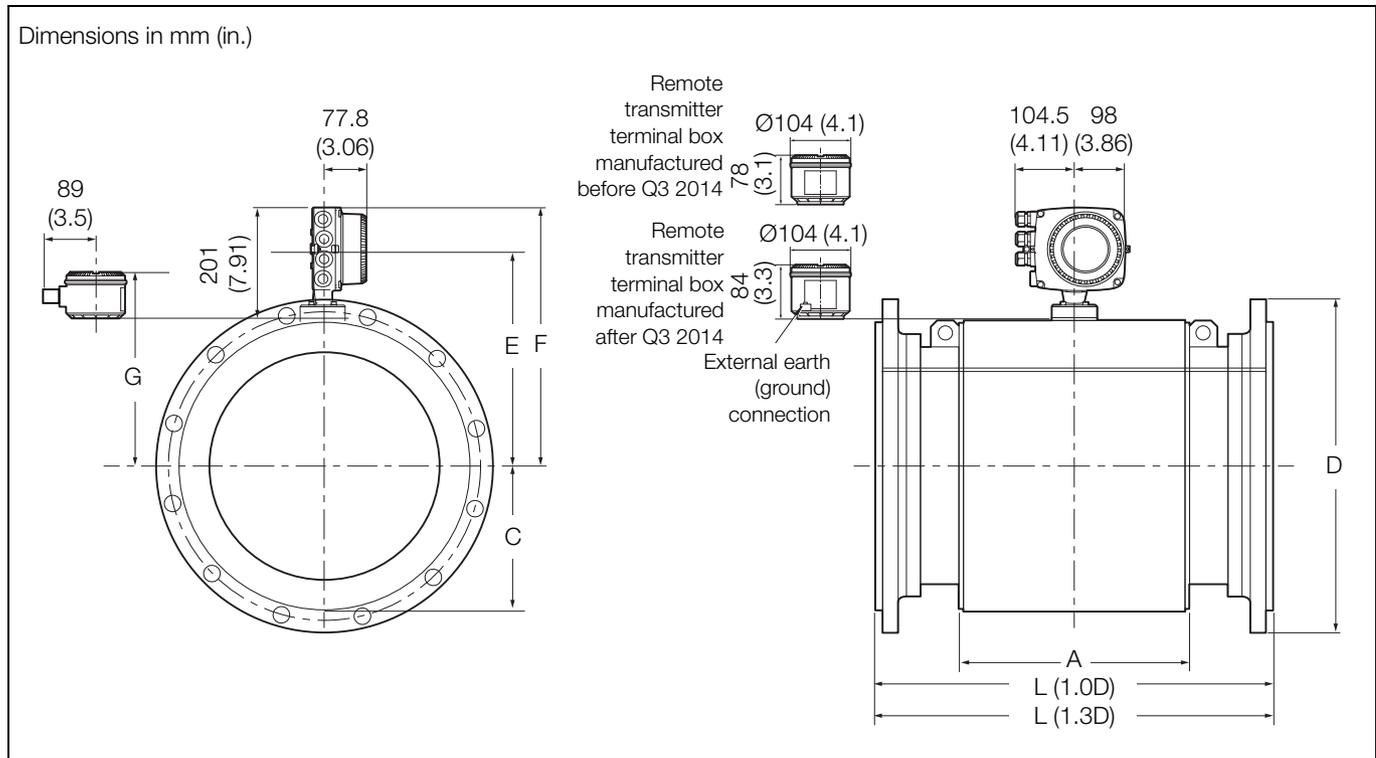
DN450 to 2400 (18 to 96 in. NB) (FEW)

DN	Process connection type	Dimensions in mm (in.)								Approx. weight in kg (lb)	
		D	L (1.0D)	L (1.3D)	F	C	E	G	A	Integral	Remote
DN450 (18 in.)	PN10	615 (24.21)	N/A	600 (23.62)	514 (20.24)	310 (12.20)	439 (17.28)	394 (15.51)	328 (12.91)	173 (381)	171 (377)
	PN16	640 (25.20)								188 (414)	186 (410)
	JIS5K	605 (23.82)								165 (364)	163 (359)
	JIS10K	620 (24.41)								177 (390)	175 (386)
	AS4087 PN16	640 (25.20)								232 (511)	230 (507)
	AS4087 PN35	675 (26.57)								328 (723)	326 (718)
	ASME B16.5 CL300	710 (27.95)								368 (811)	366 (807)
	ASME B16.5 CL150	635 (25.00)								250 (551)	248 (547)
	PN25	670 (26.38)	N/A	686 (27.01)						245 (540)	243 (536)
PN40	685 (26.97)								315 (694)	313 (690)	
DN500 (20 in.)	PN10	670 (26.38)	N/A	600 (23.62)	514 (20.24)	310 (12.20)	439 (17.28)	394 (15.51)	367 (14.45)	190 (418)	188 (413)
	PN16	715 (28.15)								240 (528)	238 (524)
	JIS5K	655 (25.79)								190 (418)	188 (413)
	JIS10K	675 (26.57)									
	AS4087 PN16	705 (27.76)								290 (638)	288 (634)
	AS4087 PN35	735 (28.94)								435 (957)	433 (953)
	ASME B16.5 CL150	700 (27.56)								300 (660)	298 (656)
	ASME B16.5 CL300	775 (30.51)	N/A	762						490 (1080)	488 (1076)
	PN25	730 (28.74)	N/A	700						300 (661)	298 (657)
PN40	755 (29.72)	N/A	762						392 (864)	390 (860)	
DN600 (24 in.)	PN10	780 (30.71)	N/A	800 (31.50)	565 (22.24)	361 (14.21)	490 (19.29)	445 (17.52)	469 (18.46)	284 (626)	282 (622)
	PN16	840 (33.07)								318 (700)	316 (695)
	PN25	845 (33.27)								460 (1012)	458 (1008)
	JIS5K	770 (30.31)								275 (605)	273 (600)
	JIS10K	795 (31.30)								306 (673)	304 (668)
	AS4087 PN16	825 (32.48)								382 (840)	380 (835)
	AS4087 PN35	850 (33.46)								452 (994)	450 (990)
	ASME B16.5 CL300	915 (36.02)								550 (1210)	548 (1205)
	ASME B16.5 CL150	815 (32.09)								425 (935)	423 (930)
	PN40	890 (35.04)	N/A	890						600 (1320)	598 (1316)

DN450 to 2400 (18 to 96 in. NB) (FEW) dimensions / weights

DN	Process connection type	Dimensions in mm (in.)								Approx. weight in kg (lb)									
		D	L (1.0D)	L (1.3D)	F	C	E	G	A	Integral	Remote								
DN700 (28 in.)	JIS 5K	875 (34.45)	700 (27.56)	910 (35.83)	604 (23.77)	403 (15.87)	528 (20.79)	488 (19.21)	444 (17.48)	216 (475)	214 (471)								
	JIS 10K	905 (35.63)								282 (620)	280 (616)								
	PN6	860 (33.86)								225 (495)	223 (491)								
	PN10	895 (35.24)								303 (667)	301 (662)								
	PN16	910 (35.83)								337 (741)	335 (737)								
	AWWA C207 CLASS B	927 (36.50)								249 (548)	247 (543)								
	AWWA C207 CLASS D	927 (36.50)								280 (616)	278 (612)								
	AS4087 PN16	910 (35.83)								359 (790)	357 (785)								
	AS2129 TABLE-D	910 (35.83)								263 (579)	261 (574)								
	AS2129 TABLE-E	910 (35.83)								337 (741)	335 (737)								
	PN25	960 (37.80)								471 (1036)	469 (1032)								
	PN40	995 (39.17)								586 (1289)	584 (1285)								
	AWWA C207 CLASS E	927 (36.50)								472 (1038)	470 (1034)								
	AWWA C207 CLASS F	1035 (40.75)								715 (1573)	713 (1569)								
	AS4087 PN35	935 (36.80)								539 (1186)	537 (1181)								
	ASME CL150 SERIES A	925 (36.42)								503 (1107)	501 (1102)								
ASME CL150 SERIES B	835 (32.87)	323 (711)	321 (706)																
ASME CL300 SERIES B	920 (36.22)	631 (1388)	629 (1384)																
DN750 (30 in.)	JIS 5K	945 (37.20)	750 (29.52)	990 (38.98)	630 (24.79)	429 (16.89)	554 (21.81)	514 (20.23)	444 (17.48)	251 (552)	249 (548)								
	JIS 10K	970 (38.19)								327 (719)	325 (715)								
	AWWA C207 CLASS B	984 (38.74)								273 (601)	271 (596)								
	AWWA C207 CLASS D	984 (38.74)								344 (757)	342 (752)								
	AS4087 PN16	995 (39.17)								467 (1027)	465 (1023)								
	AS2129 TABLE-D	995 (39.17)								340 (748)	338 (744)								
	AS2129 TABLE-E	995 (39.17)								454 (999)	452 (994)								
	AWWA C207 CLASS E	984 (38.74)								496 (1091)	494 (1087)								
	AWWA C207 CLASS F	1092 (43.99)								790 (1738)	788 (1734)								
	AS4087 PN35	1015 (39.96)								663 (1459)	661 (1454)								
	ASME CL150 SERIES A	985 (38.78)								544 (1197)	542 (1192)								
	ASME CL150 SERIES B	885 (34.84)								320 (704)	318 (700)								
	ASME CL300 SERIES B	990 (38.98)								748 (1646)	746 (1641)								
	DN800 (32 in.)	JIS 5K								995 (39.17)	800 (31.49)	1040 (40.04)	654 (25.74)	453 (17.83)	578 (22.76)	538 (21.18)	542 (21.34)	280 (616)	278 (612)
		JIS 10K								1020 (40.16)								364 (801)	362 (796)
		PN6								975 (38.39)								294 (647)	292 (642)
PN10		1015 (39.96)	406 (893)	404 (889)															
PN16		1025 (40.35)	469 (1032)	467 (1027)															
AWWA C207 CLASS B		1060 (41.73)	328 (722)	326 (717)															
AWWA C207 CLASS D		1060 (41.73)	408 (898)	406 (893)															
AS4087 PN16		1060 (41.73)	530 (1166)	528 (1162)															
AS2129 TABLE-D		1060 (41.73)	386 (849)	384 (845)															
AS2129 TABLE-E		1060 (41.73)	519 (1142)	517 (1137)															
PN25		1085 (42.72)	615 (1353)	613 (1349)															
PN40		1140 (44.88)	866 (1905)	864 (1901)															
AWWA C207 CLASS E		1060 (41.73)	634 (1395)	632 (1390)															
AWWA C207 CLASS F		1150 (45.28)	897 (1973)	895 (1969)															
AS4087 PN35		1060 (41.73)	751 (1652)	749 (1648)															
ASME CL150 SERIES A		1060 (41.73)	700 (1540)	698 (1536)															
ASME CL150 SERIES B	940 (37.01)	406 (893)	404 (889)																
ASME CL300 SERIES B	1055 (41.54)	933 (2053)	931 (2048)																
DN900 (36 in.)	JIS 5K	1095 (43.11)	900 (35.43)	1170 (46.06)	705 (27.7)	504 (19.84)	629 (24.76)	589 (23.19)	570 (22.44)	369 812)	367 (807)								
	JIS 10K	1120 (44.09)								445 (979)	443 (975)								
	PN6	1075 (42.32)								390 (858)	388 (854)								
	PN10	1115 (43.90)								502 (1104)	500 (1100)								
	PN16	1125 (44.29)								589 (1296)	587 (1291)								
	AWWA C207 CLASS B	1168 (45.98)								417 (917)	415 (913)								
	AWWA C207 CLASS D	1168 (45.98)								493 (1085)	491 (1080)								
	AWWA C207 CLASS E	1168 (45.98)								827 (1819)	825 (1815)								
	AWWA C207 CLASS F	1270 (50.00)								1150 (2530)	1148 (2526)								
	AS4087 PN16	1175 (46.26)								706 (1553)	704 (1549)								
	AS2129 TABLE-D	1175 (46.26)								514 (1131)	512 (1126)								
	AS2129 TABLE-E	1175 (46.26)								694 (1527)	692 (1522)								
	PN25	1185 (46.65)								819 (1802)	817 (1797)								
	PN40	1250 (49.21)								1158 (2548)	1156 (2543)								
	AS4087 PN35	1185 (46.65)								1044 (2297)	1042 (2292)								
	ASME CL150 SERIES A	1170 (46.06)								961 (2114)	959 (2110)								
ASME CL150 SERIES B	1055 (41.54)	595 (1309)	593 (1305)																
ASME CL300 SERIES B	1170 (46.06)	1147 (2523)	1145 (2519)																

DN450 to 2400 (18 to 96 in. NB) (FEW) dimensions / weights (Continued)



...DN450 to 2400 (18 to 96 in. NB) (FEW)

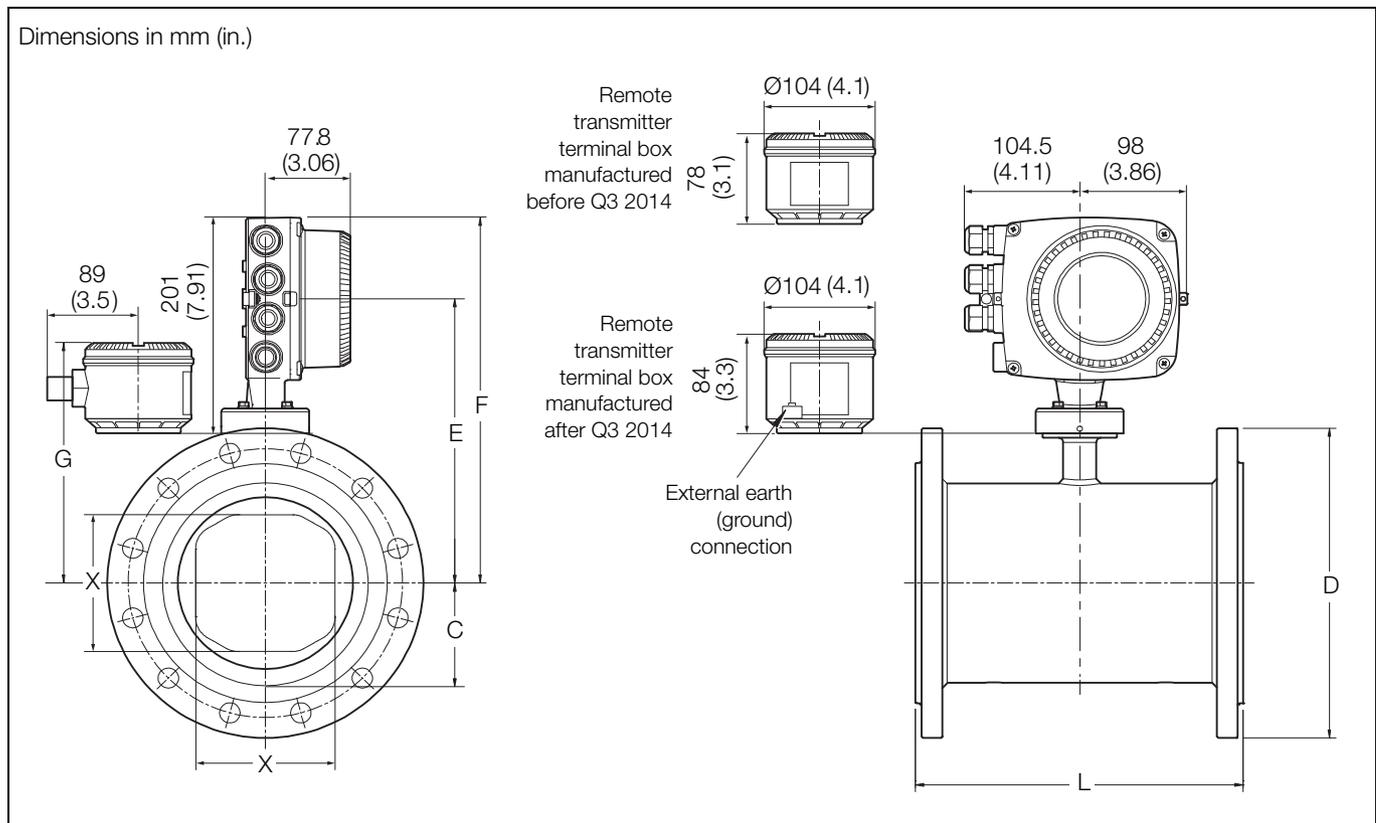
DN	Process connection type	Dimensions in mm (in.)								Approx. weight in kg (lb)	
		D	L (1.0D)	L (1.3D)	F	C	E	G	A	Integral	Remote
DN1000 (40 in.)	JIS 5K	1195 (47.05)	1000 (39.37)	1300 (51.18)	755 (29.71)	554 (21.81)	679 (26.73)	639 (25.16)	624 (24.57)	441 (970)	439 (966)
	JIS 10K	1235 (48.62)								572 (1258)	570 (1254)
	PN6	1175 (46.26)								466 (1025)	464 (1021)
	PN10	1230 (48.43)								674 (1483)	672 (1478)
	PN16	1255 (49.41)								879 (1934)	877 (1929)
	AWWA C207 CLASS B	1289 (50.75)								503 (1107)	501 (1102)
	AWWA C207 CLASS D	1289 (50.75)								659 (1450)	657 (1445)
	AWWA C207 CLASS E	1289 (50.75)								1028 (2262)	1026 (2257)
	AWWA C207 CLASS F	1378 (54.25)								1367 (3007)	1365 (3003)
	AS4087 PN16	1255 (49.41)								831 (1828)	829 (1824)
	AS2129 TABLE-D	1255 (49.41)								610 (1342)	608 (1338)
	AS2129 TABLE-E	1255 (49.41)								833 (1833)	831 (1028)
	PN25	1320 (51.97)								1207 (2655)	1205 (2651)
	PN40	1360 (53.54)								1413 (3109)	1411 (3104)
	AS4087 PN35	1275 (50.20)								1244 (2737)	1242 (2732)
	ASME CL150 SERIES A	1290 (50.79)								1149 (2528)	1147 (2523)
ASME CL300 SERIES A	1240 (48.82)	1349 (2968)	1347 (2963)								
ASME CL150 SERIES B	1175 (46.26)	738 (1624)	736 (1619)								
ASME CL300 SERIES B	1275 (50.20)	1487 (3271)	1485 (3267)								
DN1050 (42 in.)	AWWA C207 CLASS B	1346 (52.99)	1050 (41.33)	1365 (53.74)	808 (31.82)	608 (23.92)	733 (28.84)	693 (27.28)	624 (24.57)	564 (1241)	562 (1236)
	AWWA C207 CLASS D	1346 (52.99)								669 (1472)	667 (1467)
	AWWA C207 CLASS E	1346 (52.99)								1143 (2515)	1141 (2510)
	AWWA C207 CLASS F	1448 (57.01)								1568 (3450)	1566 (3445)
	ASME CL150 SERIES B	1225 (48.23)								809 (1780)	807 (1775)
	ASME CL150 SERIES A	1345 (52.95)								1289 (2836)	1287 (2831)
	ASME CL300 SERIES A	1290 (50.79)								1527 (3359)	1525 (3355)
	ASME CL300 SERIES B	1335 (52.56)								1704 (3749)	1702 (3744)
DN1100 (44 in.)	JIS 5K	1305 (51.38)	1100 (43.30)	1430 (56.30)						510 (1122)	508 (1118)
	JIS 10K	1345 (52.95)								689 (1516)	687 (1511)
	AWWA C207 CLASS B	1403 (55.24)								615 (1353)	613 (1349)
	AWWA C207 CLASS D	1403 (55.24)								807 (1775)	805 (1771)
	AWWA C207 CLASS E	1404 (55.26)								1205 (2651)	1203 (2647)
	AWWA C207 CLASS F	1505 (59.25)								1719 (3782)	1717 (3777)

...DN450 to 2400 (18 to 96 in. NB) (FEW) dimensions / weights

DN	Process connection type	Dimensions in mm (in.)								Approx. weight in kg (lb)	
		D	L (1.0D)	L (1.3D)	F	C	E	G	A	Integral	Remote
DN1200 (48 in.)	JIS 5K	1420 (55.91)	1200 (47.24)	1560 (61.42)	860 (33.85)	659 (25.94)	784 (30.87)	744 (29.29)	802 (31.57)	651 (1432)	649 (1428)
	JIS 10K	1465 (57.68)								967 (2127)	965 (2123)
	PN6	1405 (55.31)								710 (1562)	708 (1558)
	PN10	1455 (57.28)								1107 (2435)	1105 (2431)
	PN16	1485 (58.46)								1363 (2999)	1361 (2994)
	AWWA C207 CLASS B	1511 (59.49)								772 (1698)	770 (1694)
	AWWA C207 CLASS D	1511 (59.49)								999 (2198)	997 (2193)
	AWWA C207 CLASS E	1511 (59.49)								1458 (3208)	1456 (3203)
	AWWA C207 CLASS F	1651 (65.00)								2400 (5280)	2398 (5276)
	AS4087 PN16	1490 (58.66)								1253 (2757)	1251 (2752)
	AS2129 TABLE-D	1490 (58.66)								1023 (2251)	1021 (2246)
	AS2129 TABLE-E	1490 (58.66)								1272 (2798)	1270 (2794)
	PN25	1530 (60.24)								1559 (3430)	1557 (3425)
	PN40	1575 (62.01)								2133 (4693)	2131 (4688)
	AS4087 PN35	1530 (60.24)								2115 (4653)	2113 (4649)
	ASME CL150 SERIES A	1510 (59.45)								1707 (3755)	1705 (3751)
ASME CL300 SERIES A	1465 (57.68)	2163 (4759)	2161 (4754)								
ASME CL150 SERIES B	1390 (54.72)	1085 (2387)	1083 (2383)								
ASME CL300 SERIES B	1510 (59.45)	2352 (5174)	2350 (5170)								
DN1350 (54 in.)	AWWA C207 CLASS B	1683 (66.26)	1350 (53.15)	1755 (69.09)	955 (37.59)	754 (29.69)	879 (34.61)	839 (33.03)	902 (35.51)	981 (2158)	979 (2154)
	AWWA C207 CLASS D	1683 (66.26)								1213 (2669)	1211 (2664)
	AWWA C207 CLASS E	1683 (66.26)								1942 (4272)	1940 (4268)
DN1400 (56 in.)	PN6	1630 (64.17)	1400 (55.11)	1820 (71.65)						1085 (2387)	1083 (2383)
	PN10	1675 (65.94)								1731 (3808)	1729 (3804)
	PN16	1685 (66.34)								1770 (3894)	1768 (3890)
	ASME CL150 SERIES B	1600 (62.99)								1593 (3505)	1591 (3500)
	PN25	1755 (69.09)								2368 (5210)	2366 (5205)
	PN40	1795 (70.67)								3086 (6789)	3084 (6785)
	ASME CL150 SERIES A	1745 (68.70)								2556 (5623)	2554 (5619)
	ASME CL300 SERIES A	1710 (67.32)								3376 (7427)	3374 (7423)
ASME CL300 SERIES B	1765 (69.49)	3758 (8268)	3756 (8263)								
DN1500 (60 in.)	JIS 5K	1730 (68.11)	1500 (59.05)	1950 (76.77)	1065 (41.92)	864 (34.02)	989 (38.94)	949 (37.36)	910 (35.83)	1029 (2264)	1027 (2259)
	JIS 10K	1795 (70.67)								1504 (3309)	1502 (3304)
	ASME CL150 SERIES B	1725 (67.91)								2031 (4468)	2029 (4464)
	AWWA C207 CLASS B	1854 (72.99)								1229 (2704)	1227 (2699)
	AWWA C207 CLASS D	1854 (72.99)								1514 (3331)	1512 (3326)
	AWWA C207 CLASS E	1854 (72.99)								2544 (5597)	2542 (5592)
	ASME CL150 SERIES A	1855 (73.03)								3084 (6785)	3082 (6780)
	ASME CL300 SERIES A	1810 (71.26)								3875 (8525)	3873 (8521)
ASME CL300 SERIES B	1880 (74.02)	4181 (9198)	4179 (9194)								
DN1600 (64 in.)	PN6	1830 (72.05)	1600 (62.99)	2080 (81.89)	1066 (41.96)	865 (34.06)	990 (38.98)	950 (37.4)	1000 (39.37)	1434 (3155)	1432 (3150)
	PN10	1915 (75.39)								2525 (5555)	2523 (5551)
	PN25	1975 (77.76)								3201 (7042)	3199 (7038)
	PN16	1930 (75.98)								2768 (6090)	2766 (6085)
	PN40	2025 (79.72)								4375 (9625)	4373 (9621)
DN1650 (66 in.)	AWWA C207 CLASS B	2032 (80.00)	N/A	2145 (84.45)	1116 (43.94)	915 (36.02)	1040 (40.94)	1000 (39.37)	1000 (39.37)	1504 (3309)	1502 (3304)
	AWWA C207 CLASS D	2032 (80.00)								2025 (4455)	2023 (4451)
DN1800 (72 in.)	PN6	2045 (80.51)	N/A	2340 (92.13)	1181 (46.50)	980 (38.58)	1105 (43.50)	1065 (41.93)	1100 (43.31)	1853 (4077)	1851 (4072)
	PN10	2115 (83.27)								3180 (6996)	3178 (6992)
	PN16	2130 (83.86)								3657 (8045)	3655 (8041)
	PN25	2195 (86.42)								4422 (9728)	4420 (9724)
	AWWA C207 CLASS B	2197 (86.50)								1773 (3901)	1771 (3896)
	AWWA C207 CLASS D	2197 (86.50)								2387 (5251)	2385 (5247)
DN1950 (78 in.)	AWWA C207 CLASS B	2362 (92.99)	N/A	2535 (99.80)	1291 (50.81)	1090 (42.91)	1215 (47.83)	1175 (46.26)	1180 (46.46)	2309 (5080)	2307 (5075)
	AWWA C207 CLASS D	2362 (92.99)								3037 (6681)	3035 (6677)
DN2000 (80 in.)	PN6	2265 (89.17)	N/A	2600 (102.36)						2581 (5678)	2579 (5674)
	PN10	2325 (91.54)								4254 (9359)	4252 (9354)
	PN16	2345 (92.32)								4556	4554
	PN25	2425 (95.47)								5896	5894
DN2100 (84 in.)	AWWA C207 CLASS B	2534 (99.76)	N/A	2730 (107.48)	1395 (54.91)	1194 (47.01)	1319 (51.93)	1279 (50.35)	1180 (46.46)	2641 (5810)	2639 (5806)
	AWWA C207 CLASS D	2534 (99.76)								3487 (7671)	3485 (7667)
DN2200 (88 in.)	PN6	2475 (97.44)	N/A	2860 (112.60)					1330 (52.36)	3363 (7399)	3361 (7394)
	PN10	2550 (100.39)								5795	5793
DN2400 (96 in.)	PN6	2685 (105.71)	N/A	3120 (122.83)	1495 (58.85)	1294 (50.94)	1419 (55.87)	1379 (54.29)	1450 (57.09)	4100 (9020)	4098 (9016)
	PN10	2760 (108.66)								6968	6966

...DN450 to 2400 (18 to 96 in. NB) (FEW) dimensions / weights (Continued)

FEV – DN40 to 200 (1½ to 8 in. NB)



DN40 to 200 (1½ to 8 in. NB) (FEV)

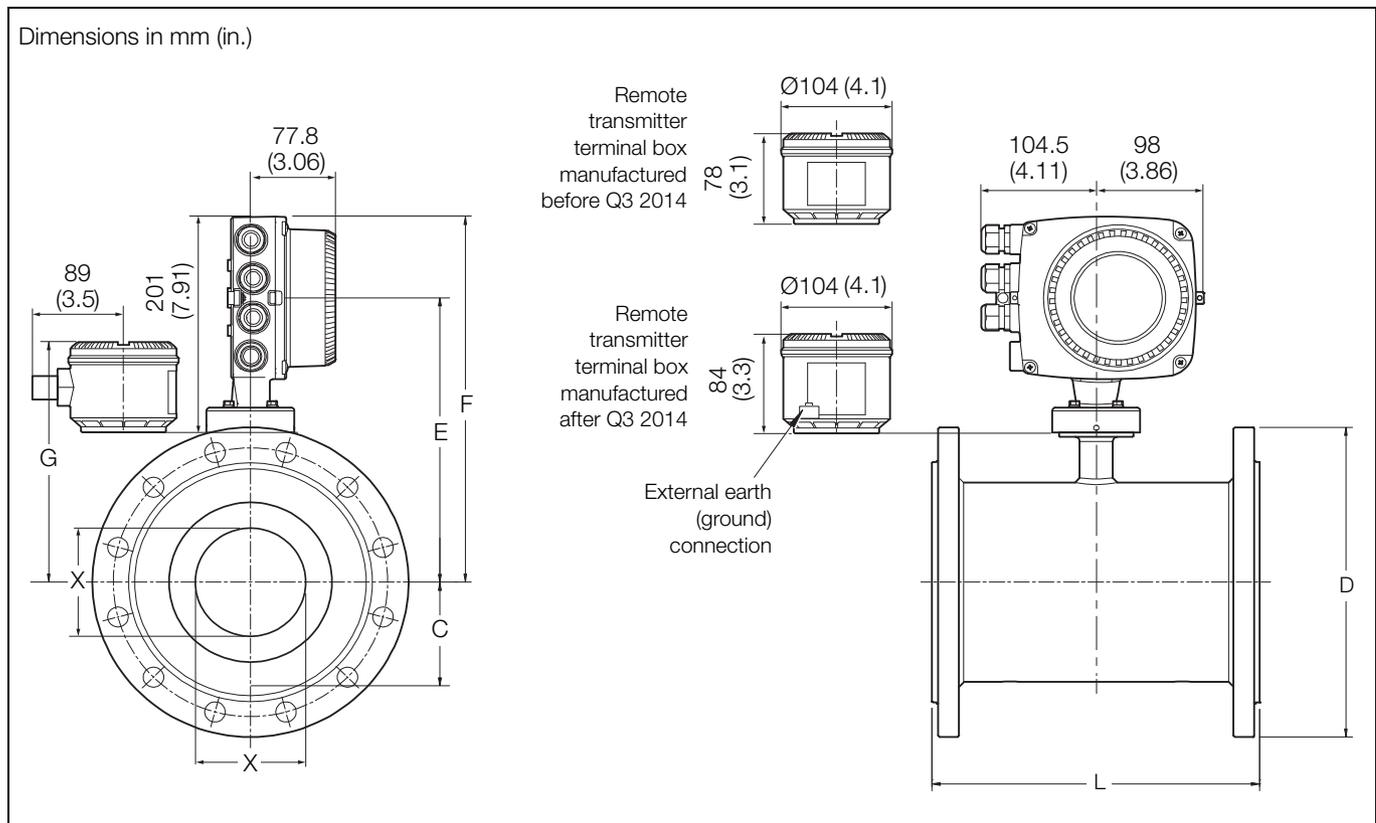
DN	Process connection type	Dimensions in mm (in.)						Approx. weight in kg (lb)	
		D	L	F	E	G	X	Integral	Remote
DN40 (1½ in.)	EN1092-1 PN10, 16, 25, 40	150 (5.91)	200 (7.87)	260 (10.24)	185 (7.28)	137 (5.39)	30 (1.18)	12.8 (28.16)	11.8 (25.96)
	ASME B16.5 CLASS 150								
	AS2129 TABLE D, E, F								
DN50 (2 in.)	EN1092-1 PN10, 16, 25, 40	165 (6.50)	200 (7.87)	261 (10.28)	186 (7.32)	138 (5.43)	38 (1.5)	13.75 (30.25)	12.75 (28.05)
	ASME B16.5 CLASS 150								
	AS4087 PN16, 21								
DN80 (3 in.)	EN1092-1 PN10, 16, 25, 40	200 (7.87)	200 (7.87)	280 (11.04)	205.5 (8.09)	157.5 (6.2)	61 (2.4)	17.2 (37.84)	16.2 (35.64)
	ASME B16.5 CLASS 150								
	AS2129 TABLE D, E, F								
DN100 (4 in.)	EN1092-1 PN10, 16, 25, 40	225 (8.86)	250 (9.84)	300.5 (11.83)	225.5 (8.88)	177.5 (6.98)	70 (2.76)	19.3 (42.5)	18.3 (40.3)
	ASME B16.5 CLASS 150								
	AS4087 PN16								
DN150 (6 in.)	EN1092-1 PN10, 16, 25, 40	300 (11.81)	300 (11.81)	333.5 (13.13)	258.5 (10.18)	210.5 (8.29)	103 (4.06)	35.1 (77.2)	34.1 (75)
	ASME B16.5 CLASS 150								
	AS4087 PN16								
DN200 (8 in.)	EN1092-1 PN10, 16	375 (11.76)	350 (13.78)	358.7 (14.12)	283.7 (11.17)	235.7 (9.28)	150 (5.91)	67 (147.4)	66 (145.2)
	ASME B16.5 CLASS 150								
	AS2129 TABLE C, D, E, F								
	AS4087 PN14, 16, 21								

WaterMaster integral / remote FEV – DN40 to 200 (1½ to 8 in.) cast iron sensor dimensions / weights

DN	Process connection type	Dimensions in mm (in.)							Approx. weight in kg (lb)	
		D	L	F	C	E	G	X	Integral	Remote
DN40 (1½ in.)	EN1092-1 PN10, PN40	150 (5.91)	200 (7.87)	260 (10.24)	30.4 (1.20)	185 (7.28)	138 (5.43)	30 (1.18)	12 (27)	11 (24)
	ASME B16.5 CLASS 150	127 (5.00)								
	JIS 10K	140 (5.51)								
	AS2129 TABLE F	140 (5.51)								
	AS2129 TABLE C D E	135 (5.31)								
	AS4087 PN14	135 (5.31)								
DN50 (2 in.)	EN1092-1 PN10, PN16	165 (6.50)	200 (7.87)	270 (10.63)	38.3 (1.51)	195 (7.68)	146 (5.75)	38 (1.50)	13 (29)	12 (27)
	ASME B16.5 CLASS 150	152.4 (6.00)								
	JIS 10K	155 (6.10)								
	AS4087 PN21	165 (6.50)								
	AS2129 TABLE F	165 (6.50)								
	AS2129 TABLE C D E	150 (5.91)								
	AS4087 PN14, PN16	150 (5.91)								
DN65 (2½ in.)	AS4087 PN14, PN16	165 (6.50)	200 (7.87)	275 (10.83)	45.2 (1.78)	200 (7.87)	152 (5.98)	48 (1.89)	15 (33)	14 (31)
	AS2129 TABLE C D E	165 (6.50)								
	EN1092-1 PN10	185 (7.28)								
	EN1092-1 PN16	185 (7.28)								
DN80 (3 in.)	EN1092-1 PN10, PN16	200 (7.87)	200 (7.87)	280 (11.02)	51.5 (2.03)	205 (8.07)	156 (6.14)	61 (2.40)	16 (36)	15 (33)
	ASME B16.5 CLASS 150	190 (7.48)								
	JIS 7.5K	211 (8.31)								
	JIS 10K	185 (7.28)								
	AS2129 TABLE C D E	185 (7.28)								
	AS4087 PN14, PN16	185 (7.28)								
	AS2129 TABLE F	205 (8.07)								
	AS4087 PN21	205 (8.07)								
DN100 (4 in.)	EN1092-1 PN10, PN16	220 (8.66)	250 (9.84)	320 (12.60)	63.75 (2.51)	245 (9.65)	196.8 (7.75)	70 (2.76)	19 (42)	18 (40)
	ASME B16.5 CLASS 150	228.6 (9.00)								
	JIS 7.5K	238 (9.37)								
	JIS 10K	210 (8.27)								
	AS2129 TABLE C D	215 (8.46)								
	AS4087 PN14, PN16	215 (8.46)								
	AS2129 TABLE E	215 (8.46)								
	AS4087 PN21	230 (9.06)								
	AS2129 TABLE F	230 (9.06)								
DN125 (5 in.)	EN1092-1 PN10, PN16	250 (9.84)	250 (9.84)	320 (12.60)	63.75 (2.51)	245 (9.65)	197 (7.76)	70 (2.76)	20 (44)	19 (42)
	ASME B16.5 CLASS 150	254 (10.00)								
	JIS 10K	250 (9.84)								
	AS2129 TABLE C D E	255 (10.04)								
	AS2129 TABLE F	280 (11.02)								
DN150 (6 in.)	EN1092 PN10, PN16	285 (11.22)	300 (11.81)	340 (13.39)	84.4 (3.32)	265 (10.43)	217 (8.54)	103 (4.06)	32 (70)	31 (68)
	ASME B16.5 CLASS 150	279 (10.98)								
	JIS 7.5k	290 (11.42)								
	JIS 10K	280 (11.02)								
	AS2129 TABLE C D	280 (11.02)								
	AS4087 PN14, PN16	280 (11.02)								
	AS2129 TABLE E	280 (11.02)								
	AS2129 TABLE F	305 (12.01)								
	AS4087 PN21	305 (12.01)								
DN200 (8 in.)	EN1092-1 PN10	340 (13.39)	350 (13.78)	365 (14.37)	109.8 (4.32)	290 (11.42)	243 (9.57)	150 (5.91)	49 (108)	48 (105)
	EN1092-1 PN16	340 (13.39)								
	ASME B16.5 CLASS 150	345 (13.58)								
	JIS 7.5K	342 (13.46)								
	JIS 10K	330 (12.99)								
	AS2129 TABLE C D	335 (13.19)								
	AS4087 PN14, PN 16	335 (13.19)								
	AS2129 TABLE E	335 (13.19)								
	AS2129 TABLE F	370 (14.57)								
	AS4087 PN21	370 (14.57)								

DN40 to 200 (1½ to 8 in. NB) (FEV) dimensions / weights

FER – DN40 to 300 (1½ to 12 in. NB)



DN40 to 300 (1½ to 12 in. NB) (FER)

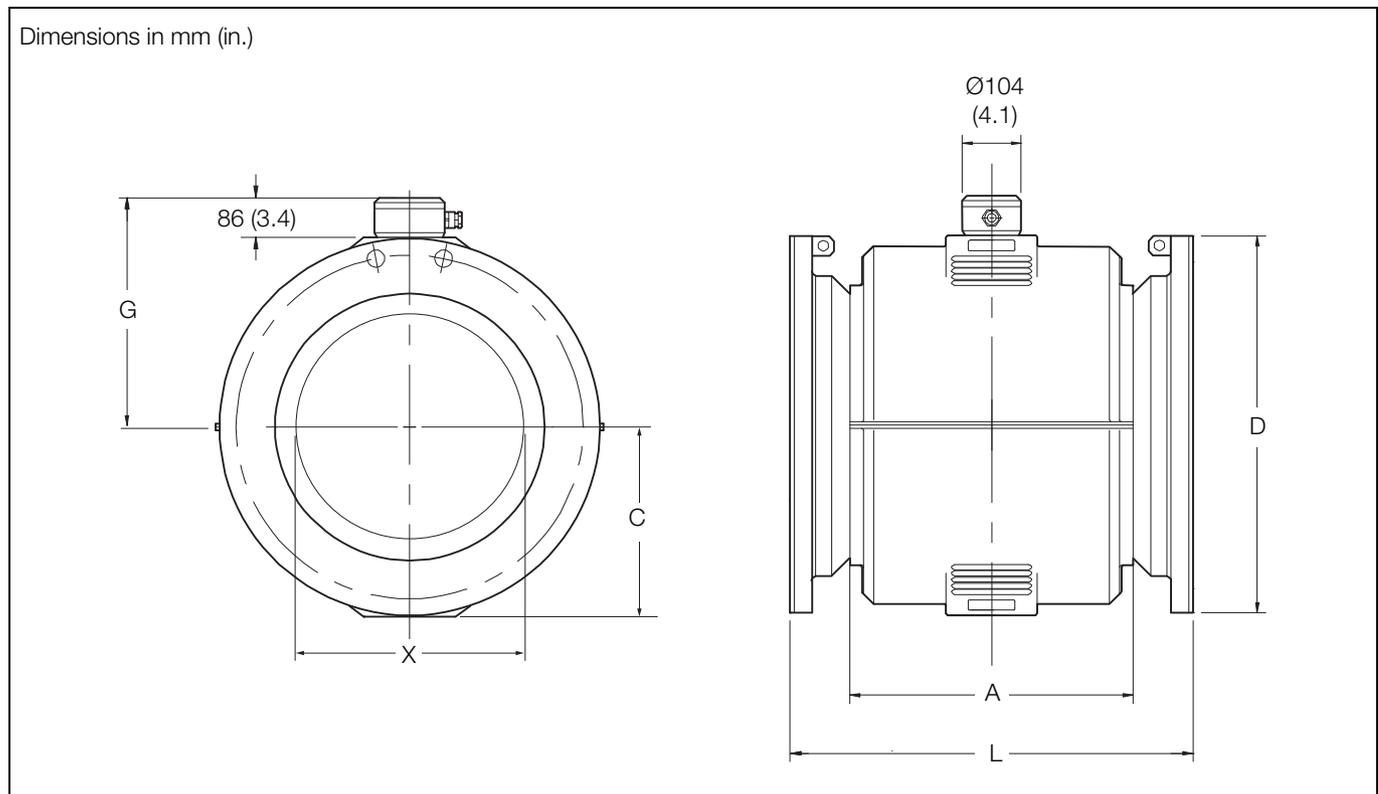
DN	Process connection type	Dimensions in mm (in.)						Approx. weight in kg (lb)	
		D	L	F	E	G	X	Integral	Remote
DN40 (1½ in.)	EN1092-1 PN10, 16, 25, 40	150 (5.91)	200 (7.87)	260 (10.24)	185 (7.28)	137 (5.39)	23.5 (0.93)	13.4 (29.5)	12.4 (27.3)
	ASME B16.5 CLASS 150								
	AS2129 TABLE D, E, F								
DN50 (2 in.)	EN1092-1 PN10, 16, 25, 40	165 (6.50)	200 (7.87)	261 (10.28)	186 (7.32)	138 (5.43)	29 (1.14)	14.75 (32.45)	13.75 (30.25)
	ASME B16.5 CLASS 150								
	AS4087 PN16, 21								
DN80 (3 in.)	EN1092-1 PN10, 16, 25, 40	200 (7.87)	200 (7.87)	280 (11.04)	205.5 (8.09)	157.5 (6.2)	47 (1.85)	21.2 (46.64)	20.2 (44.4)
	ASME B16.5 CLASS 150								
	AS2129 TABLE D, E, F								
DN100 (4 in.)	EN1092-1 PN10, 16, 25, 40	225 (8.86)	250 (9.84)	300.5 (11.83)	225.5 (8.88)	177.5 (6.98)	64 (2.52)	27.3 (60)	26.3 (58)
	ASME B16.5 CLASS 150								
	AS4087 PN16								
DN150 (6 in.)	EN1092-1 PN10, 16, 25, 40	300 (11.81)	300 (11.81)	333.5 (13.13)	258.5 (10.18)	210.5 (8.29)	100.2 (3.94)	27.3 (60)	26.3 (58)
	ASME B16.5 CLASS 150								
	AS4087 PN16								
DN200 (8 in.)	EN1092-1 PN10, 16	375 (11.76)	350 (13.78)	358.7 (14.12)	283.7 (11.17)	235.7 (9.28)	126.7 (5.00)	68 (150)	67 (147.4)
	ASME B16.5 CLASS 150								
	AS2129 TABLE C, D, E, F								
	AS4087 PN14, 16, 21								

DN40 to 200 (1½ to 8 in.) (FER) cast iron sensor dimensions / weights

DN	Process connection type	Dimensions in mm (in.)							Approx. weight in kg (lb)	
		D	L	F	C	E	G	X	Integral	Remote
DN40 (1½ in.)	EN1092-1 PN10, 16, 25, 40	150 (5.91)	200 (7.87)	260 (10.24)	30.4 (1.20)	185 (7.28)	138 (5.43)	23.5 (0.93)	13 (29)	11 (24)
	ASME B16.5 CLASS 150	127 (5.00)								
	JIS 10K	140 (5.51)								
	AS2129 TABLE C D E	135 (5.31)								
	AS2129 TABLE F	140 (5.51)								
AS4087 PN14	135 (5.31)									
DN50 (2 in.)	EN1092-1 PN10, 16, 25, 40	165 (6.50)	200 (7.87)	270 (10.63)	38.3 (1.51)	195 (7.68)	146 (5.75)	29 (1.14)	14 (31)	12 (27)
	ASME B16.5 CLASS 150	152.4 (6.00)								
	JIS 10K	155 (6.10)								
	AS4087 PN21	165 (6.50)								
	AS2129 TABLE F	165 (6.50)								
	AS2129 TABLE C D E	150 (5.91)								
AS4087 PN14, PN16	150 (5.91)									
DN65 (2½ in.)	EN1092-1 PN10, 16, 25, 40	185 (7.28)	200 (7.87)	275 (10.83)	45.2 (1.78)	200 (7.87)	152 (5.98)	37 (1.46)	15 (33)	13 (29)
	ASME B16.5 CLASS 150	178 (7.00)								
	JIS10K	175 (6.89)								
	AS2129 TABLE C D E	165 (6.50)								
	AS2129 TABLE F	185 (7.28)								
	AS4087 PN14, 16	165 (6.50)								
AS4087 PN21	185 (7.28)									
DN80 (3 in.)	EN1092-1 PN10, 16, 25, 40	200 (7.87)	200 (7.87)	280 (11.02)	51.5 (2.03)	205 (8.07)	156 (6.14)	47 (1.85)	20 (44)	18 (40)
	ASME B16.5 CLASS 150	190 (7.48)								
	JIS 10K	185 (7.28)								
	AS2129 TABLE C D E	185 (7.28)								
	AS4087 PN14, 16	185 (7.28)								
	AS2129 TABLE F	205 (8.07)								
AS4087 PN21	205 (8.07)									
DN100 (4 in.)	EN1092-1 PN10, 16	220 (8.66)	250 (9.84)	320 (12.60)	63.75 (2.51)	245 (9.65)	196.8 (7.75)	64 (2.52)	27 (59)	25 (55)
	EN1092-1 PN25, 40	235 (9.25)								
	ASME B16.5 CLASS 150	228.6 (9.00)								
	JIS 7.5K	238 (9.37)								
	JIS 10K	210 (8.27)								
	AS2129 TABLE C D	215 (8.46)								
	AS4087 PN14, 16	215 (8.46)								
	AS4087 PN21	230 (9.06)								
DN125 (5 in.)	EN1092-1 PN10, 16	250 (9.84)	250 (9.84)	320 (12.60)	63.75 (2.51)	245 (9.65)	197 (7.76)	64 (2.52)	27 (59)	25 (55)
	EN1092-1 PN25, 40	270 (10.63)								
	ASME B16.5 CLASS 150	254 (10.00)								
	JIS 10K	250 (9.84)								
AS2129 TABLE C D	255 (10.04)									
DN150 (6 in.)	EN1092 PN10, 16	285 (11.22)	300 (11.81)	340 (13.39)	84.4 (3.32)	265 (10.43)	217 (8.54)	100.2 (3.94)	33 (72)	31 (68)
	EN1092 PN25, 40	300 (11.81)								
	ASME B16.5 CLASS 150	279 (10.98)								
	JIS 7.5k	290 (11.42)								
	JIS 10K	280 (11.02)								
	AS2129 TABLE C D	280 (11.02)								
	AS4087 PN14, 16	280 (11.02)								
AS4087 PN21	305 (12.01)									
DN200 (8 in.)	EN1092-1 PN10, 16	340 (13.39)	350 (13.78)	365 (14.37)	109.8 (4.32)	290 (11.42)	243 (9.57)	126.7 (4.99)	50 (110)	48 (106)
	EN1092-1 PN25, 40	360 (14.17)								
	ASME B16.5 CLASS 150	345 (13.58)								
	JIS 7.5K	342 (13.46)								
	JIS 10K	330 (12.99)								
	AS2129 TABLE C D	335 (13.19)								
	AS4087 PN14, 16	335 (13.19)								
AS4087 PN21	370 (14.57)									
DN250 (10 in.)	EN1092-1 PN10	395 (15.55)	450 (17.72)	389 (15.31)	136.8 (5.39)	313 (12.33)	268 (10.55)	153.5 (6.04)	77 (169)	75 (165)
	EN1092-1 PN16	405 (15.94)								
	EN1092-1 PN25	425 (16.73)								
	ASME B16.5 CLASS 150	405 (15.94)								
	JIS 7.5K	400 (15.75)								
	JIS 10K	400 (15.75)								
	AS2129 TABLE C D	405 (15.94)								
	AS4087 PN14, 16	405 (15.94)								
AS4087 PN21	430 (16.93)									
DN300 (12 in.)	EN1092-1 PN10	445 (17.52)	500 (19.69)	414 (16.30)	162.2 (6.39)	338.6 (13.33)	294 (11.57)	203.5 (8.01)	114 (251)	112 (247)
	EN1092-1 PN16	460 (18.11)								
	EN1092-1 PN25	485 (19.09)								
	ASME B16.5 CLASS 150	485 (19.09)								
	JIS 10K	445 (17.52)								
	AS2129 TABLE C D	455 (17.91)								
	AS4087 PN14, 16	455 (17.91)								
AS4087 PN21	490 (19.29)									

DN40 to 300 (1½ to 12 in. NB) (FER) dimensions / weights

FER – DN350 to 600 (14 to 24 in. NB) remote sensor

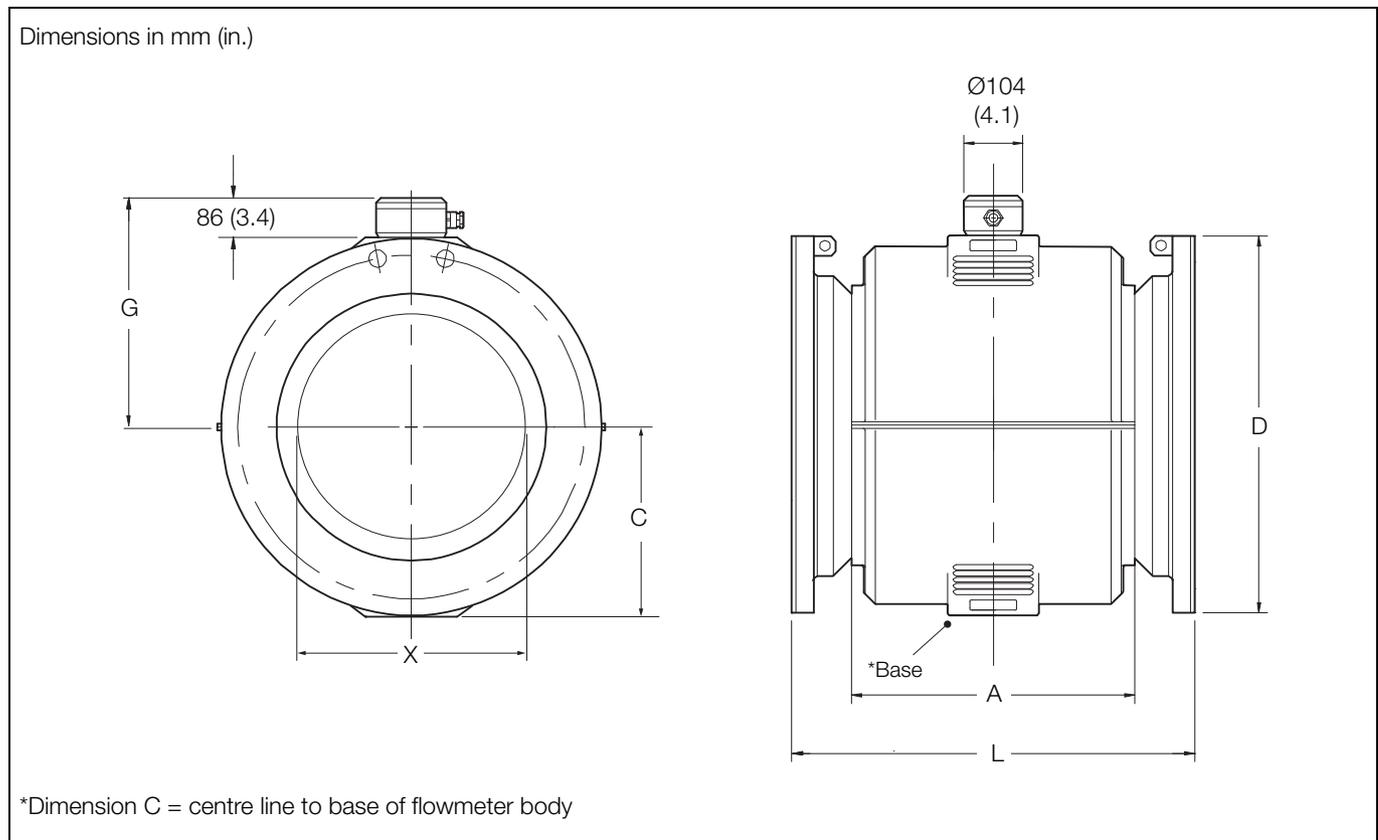


DN350 to 600 (14 to 24 in. NB) (FER) remote sensor

DN	Process connection type	Dimensions in mm (in.)								Approx. weight in kg (lb)
		D	L	F	C	E	G	A	X	Remote
DN350 (14 in.)	EN1092-1 PN10	505 (19.88)	550 (21.65)	472 (18.58)	231 (9.09)	402 (15.83)	325 (12.80)	376 (14.80)	293 (11.53)	100 (220)
	EN1092-1 PN16	520 (20.47)								
	EN1092-1 PN25	555 (21.85)								
	EN1092-1 PN40	580 (22.83)								
	JIS 5K	480 (18.90)								
	JIS 10K	490 (19.29)								
	AS2129 TABLE C D E	525 (20.67)								
	AS2129 TABLE F	550 (21.65)								
	AS4087 PN14, PN16	525 (20.67)								
AS4087 PN21	550 (21.65)									
DN400 (16 in.)	EN1092-1 PN10	565 (22.24)	600 (23.62)	502 (19.76)	257.5 (10.14)	432 (17.01)	355 (13.98)	420 (16.54)	343 (13.50)	115 (253)
	EN1092-1 PN16	580 (22.83)								
	EN1092-1 PN25	620 (24.41)								
	EN1092-1 PN40	660 (25.98)								
	JIS 5K	540 (21.26)								
	JIS 10K	560 (22.05)								
	AS2129 TABLE C D E	580 (22.83)								
	AS2129 TABLE F	610 (24.02)								
	AS4087 PN14, PN16	580 (22.83)								
AS4087 PN21	610 (24.02)									
DN450 (18 in.)	EN1092-1 PN10	615 (24.21)	700 (27.56)	537 (21.14)	285 (11.22)	467 (18.39)	390 (15.35)	480 (18.90)	394 (15.52)	160 (352)
	EN1092-1 PN16	640 (25.20)								
	EN1092-1 PN25	670 (26.38)								
	EN1092-1 PN40	685 (26.97)								
	JIS 5K	605 (23.82)								
	JIS 10K	620 (24.41)								
	AS2129 TABLE C D E	640 (25.20)								
	AS2129 TABLE F	675 (26.57)								
	AS4087 PN14, PN16	640 (25.20)								
AS4087 PN21	675 (26.57)									
DN500 (20 in.)	EN1092-1 PN10	670 (26.38)	770 (30.31)	557 (21.93)	317.5 (12.50)	487 (19.17)	410 (16.14)	520 (20.47)	443 (17.44)	217 (477)
	EN1092-1 PN16	715 (28.15)								
	EN1092-1 PN25	730 (28.74)								
	EN1092-1 PN40	755 (29.72)								
	JIS 5K	655 (25.79)								
	JIS 10K	675 (26.57)								
	AS2129 TABLE C D E	705 (27.76)								
	AS2129 TABLE F	735 (28.94)								
	AS4087 PN14, PN16	705 (27.76)								
AS4087 PN21	735 (28.94)									
DN600 (24 in.)	EN1092-1 PN10	780 (30.71)	920 (36.22)	602 (23.70)	345 (13.58)	532 (20.94)	455 (17.91)	610 (24.02)	494 (19.45)	315 (693)
	EN1092-1 PN16	840 (33.07)								
	EN1092-1 PN25	845 (33.27)								
	EN1092-1 PN40	890 (35.04)								
	JIS 5K	770 (30.31)								
	JIS 10K	795 (31.30)								
	AS2129 TABLE C D E	825 (32.48)								
	AS2129 TABLE F	850 (33.46)								
	AS4087 PN14, PN16	825 (32.48)								
AS4087 PN21	850 (33.46)									

DN350 to 600 (14 to 24 in. NB) (FER) remote sensor dimensions / weights

FEF – DN250 to 600 (10 to 24 in. NB)

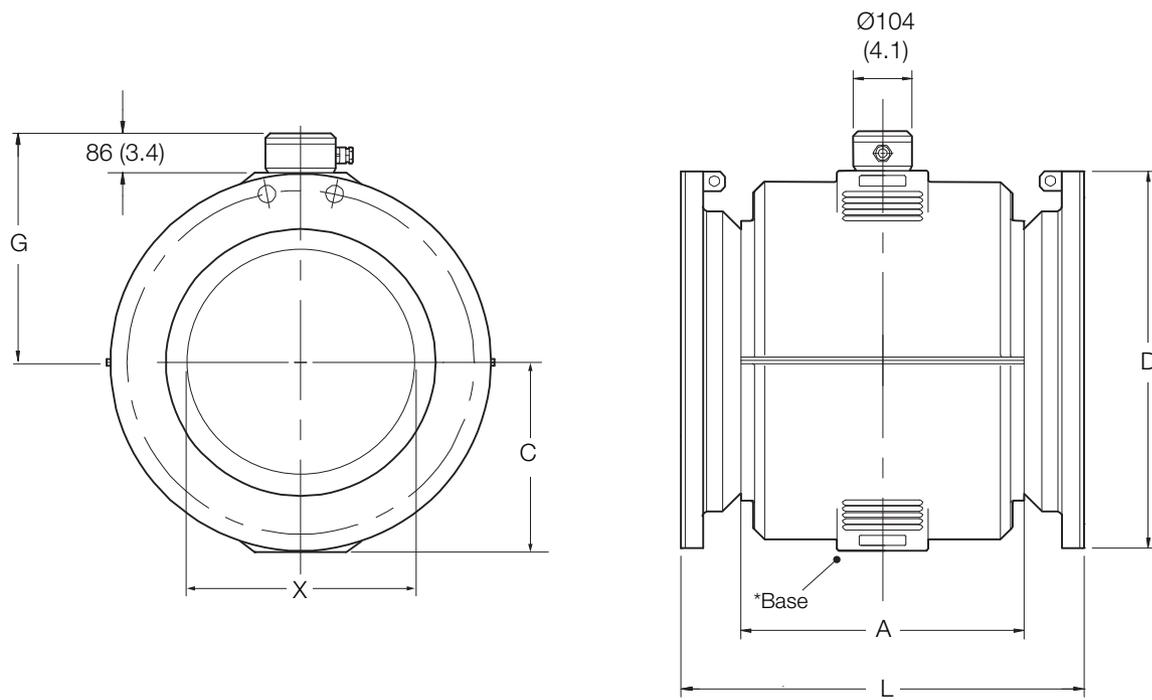


DN250 to 600 (10 to 24 in. NB) (FEF)

DN	Process connection type	Dimensions in mm (in.)						Approx. weight in kg (lb)
		D	L	C	G	A	X	
DN250 (10 in.)	ASME B16.5 CLASS 150	405 (15.94)	450 (17.72)	215 (8.46)	301 (11.85)	300 (11.81)	250 (9.84)	88 (194)
	ASME B16.5 CLASS 300	445 (17.52)	490 (19.29)					
	EN1092 -1 PN10	395 (15.55)	450 (17.72)					
	EN1092 - 1 PN16	405 (15.94)	490 (19.29)					
	EN1092 - 1 PN25	425 (16.73)						
	EN1092 - 1 PN40	450 (17.72)	450 (17.72)					
	JIS 5K	385 (15.16)						
	JIS 10K	400 (15.75)						
	AS4087 PN14, PN16	405 (15.94)						
	AS2129 TABLE C D							
	AS2129 TABLE E							
	AS4087 PN21							
AS2129 TABLE F	430 (16.93)							
DN300 (12 in.)	ASME B16.5 CLASS 150	485 (19.09)	500 (19.69)	231 (9.09)	317 (12.48)	352 (13.86)	300 (11.81)	128 (282)
	ASME B16.5 CLASS 300	520 (20.47)	540 (21.26)					
	EN1092 - 1 PN10	445 (17.52)	500 (19.69)					
	EN1092 - 1 PN16	460 (18.11)	500 (19.69)					
	EN1092 - 1 PN25	485 (19.09)	540 (21.26)					
	EN1092 - 1 PN40	515 (20.28)	540 (21.26)					
	JIS 5K	430 (16.93)	500 (19.69)					
	JIS 10K	445 (17.52)	500 (19.69)					
	AS4087 PN14, PN16	455 (17.91)	500 (19.69)					
	AS2129 TABLE TABLE C D	455 (17.91)	500 (19.69)					
	AS2129 TABLE E	455 (17.91)	500 (19.69)					
	AS4087 PN21	490 (19.29)	500 (19.69)					
AS2129 TABLE F	490 (19.29)	500 (19.69)						
DN350 (14 in.)	ASME B16.5 CLASS 150	535 (21.06)	550 (21.65)	257.5 (10.14)	346 (13.62)	376 (14.80)	350 (13.78)	100 (220)
	ASME B16.5 CLASS 300	585 (23.03)	570 (22.44)					
	EN1092 - 1 PN10	505 (19.88)	550 (21.65)					
	EN1092 - 1 PN16	520 (20.47)	550 (21.65)					
	EN1092 - 1 PN25	555 (21.85)	570 (22.44)					
	EN1092 - 1 PN40	580 (22.83)	570 (22.44)					
	JIS 5K	480 (18.90)	550 (21.65)					
	JIS 7.5K	530 (20.87)	550 (21.65)					
	JIS 10K	490 (19.29)	550 (21.65)					
	AS4087 PN14, PN16	525 (20.67)	550 (21.65)					
	AS2129 TABLE C D E	525 (20.67)	550 (21.65)					
	AS4087 PN21	550 (21.65)	550 (21.65)					
	AS2129 TABLE F	550 (21.65)	550 (21.65)					
	AS4087 PN35	550 (21.65)	570 (22.44)					
AS2129 TABLE H	550 (21.65)	570 (22.44)						
DN375 (15 in.)	AS4087 PN14, PN16	550 (21.65)	550 (21.65)	257.5 (10.14)	346 (13.62)	376 (14.80)	350 (13.78)	115 (253)
	AS2129 TABLE C	550 (21.65)	550 (21.65)					
	AS4087 PN35	580 (22.83)	570 (22.44)					
DN400 (16 in.)	ASME B16.5 CLASS 150	600 (23.62)	600 (23.62)	285 (11.22)	371 (14.61)	420 (16.54)	400 (15.75)	115 (253)
	ASME B16.5 CLASS 300	650 (25.59)	620 (24.41)					
	EN1092 - 1 PN10	565 (22.24)	600 (23.62)					
	EN1092 - 1 PN16	580 (22.83)	600 (23.62)					
	EN1092 - 1 PN25	620 (24.41)	620 (24.41)					
	EN1092 - 1 PN40	660 (25.98)	620 (24.41)					
	JIS 5K	540 (21.26)	600 (23.62)					
	JIS 7.5K	582 (22.91)	600 (23.62)					
	JIS 10K	560 (22.05)	600 (23.62)					
	AS4087 PN14, PN16	580 (22.83)	600 (23.62)					
	AS2129 TABLE C D E	580 (22.83)	600 (23.62)					
	AS4087 PN21	610 (24.02)	600 (23.62)					
	AS2129 TABLE F	610 (24.02)	600 (23.62)					
	AS4087 PN35	610 (24.02)	620 (24.41)					
AS2129 TABLE H	610 (24.02)	620 (24.41)						

DN250 to 600 (10 to 24 in. NB) (FEF) dimensions / weights

Dimensions in mm (in.)



*Dimension C = centre line to base of flowmeter body

...DN250 to 600 (10 to 24 in. NB) (FEF)

DN	Process connection type	Dimensions in mm (in.)					X	Approx. weight in kg (lb)
		D	L	C	G	A		
DN450 (18 in.)	ASME B16.5 CLASS 150	635 (25.00)	700 (27.56)	317.5 (12.50)	402 (15.83)	480 (18.90)	450 (17.72)	160 (352)
	ASME B16.5 CLASS 300	710 (27.95)						
	EN1092 – 1 PN10	615 (24.21)						
	EN1092 – 1 PN16	640 (25.20)						
	EN1092 – 1 PN25	670 (26.38)						
	EN1092 – 1 PN40	685 (26.97)						
	JIS 5K	605 (23.82)						
	JIS 7.5K	652 (25.67)						
	JIS 10K	620 (24.41)						
	AS4087 PN14, PN16	640 (25.20)						
	AS2129 TABLE C D	640 (25.20)						
	AS2129 TABLE E	640 (25.20)						
	AS4087 PN21	675 (26.57)						
	AS2129 TABLE F	675 (26.57)						
AS4087 PN35	675 (26.57)							
AS2129 TABLE H	675 (26.57)							
DN500 (20 in.)	ASME B16.5 CLASS 150	700 (27.56)	770 (30.31)	345 (13.58)	429 (16.89)	520 (20.47)	500 (19.69)	217 (455)
	ASME B16.5 CLASS 300	775 (30.51)						
	EN1092 – 1 PN10	670 (26.38)						
	EN1092 – 1 PN16	715 (28.15)						
	EN1092 – 1 PN25	730 (28.74)						
	EN1092 – 1 PN40	755 (29.72)						
	JIS 5K	655 (25.79)						
	JIS 7.5K	706 (27.80)						
	JIS 10K	675 (26.57)						
	AS4087 PN 14, PN16	705 (27.76)						
	AS2129 TABLE C D E	705 (27.76)						
	AS4087 PN21	735 (28.94)						
	AS2129 TABLE F	735 (28.94)						
	AS4087 PN35	735 (28.94)						
AS2129 TABLE H	735 (28.94)							
DN600 (24 in.)	ASME B16.5 CLASS 150	815 (32.09)	920 (36.22)	387.5 (15.25)	472 (18.58)	610 (24.02)	600 (23.62)	315 (693)
	ASME B16.5 CLASS 300	915 (36.02)						
	EN1092 – 1 PN10	780 (30.71)						
	EN1092 – 1 PN16	840 (33.07)						
	EN1092 – 1 PN25	845 (33.27)						
	EN1092 – 1 PN40	890 (35.04)						
	JIS 5K	770 (30.31)						
	JIS 7.5K	810 (31.89)						
	JIS 10K	795 (31.30)						
	AS4087 PN14, PN16	825 (32.48)						
	AS2129 TABLE C D	825 (32.48)						
	AS2129 TABLE E	825 (32.48)						
	AS4087 PN21	850 (33.46)						
	AS2129 TABLE F	850 (33.46)						
AS4087 PN35	850 (33.46)							
AS2129 TABLE H	850 (33.46)							

...DN250 to 600 (10 to 24 in. NB) (FEF) dimensions / weights

Ordering information

Electromagnetic flowmeter WaterMaster – FEW11, FEW12 and FEW18

Product coding field number		1	...	5	6	7	...	9	10	11	12	13	14, 15	16	17	18	19	20	21	22	23	24	25	26	27	Options			
Flowmeter system – full bore, integral mount (DN10 to DN32 only)		FEW11																											
Flowmeter system – full bore, remote mount		FEW12				X	XXX		X	X	X	X		XX	X	X	X	X	X	X	X	X	X	X	X	X			
Full bore sensor only – for use with WaterMaster transmitter / remote		FEW18																											
Design																													
Non-hazardous areas						1																							
Hazardous areas						5																							
Bore diameter																													
DN10 (3/8 in.)									010																				
DN15 (1/2 in.)									015																				
DN20 (3/4 in.)									020																				
DN25 (1 in.)									025																				
DN32 (1 1/4 in.)									032																				
Liner material																													
PTFE – DN10 to 32 (3/8 to 1 1/4 in. NB)									A																				
Electrode design																													
Standard											1																		
Other											9																		
Measuring electrodes material																													
Hastelloy® C-4 (2.4610)																													
Grounding accessories																													
Not required																													
One potential equalizing ring (stainless steel)																													
Two potential equalizing rings (stainless steel)																													
Other																													
Process connection type (refer to pages 21 and 20)																													
ASME B16.5 B class 150																													
ASME B16.5 B class 300																													
ISO / EN PN40																													
DIN PN40																													
Other																													
Process connection material																													
Carbon steel flanges – DN20 to 32 (3/4 to 1 1/4 in. NB)																													
Stainless steel flange 1.4571 (316 Ti) – DN10 to 15 (3/8 to 1/2 in. NB)																													
Other																													
Usage certifications																													
Standard (without PED)																													
Other																													
Calibration type																													
Class 2 calibration – standard accuracy 0.4 %																													
Class 1 calibration – high accuracy 0.2 %																													
Extended range, class 1 calibration – high accuracy 0.2 %																													
Extended range, class 2 calibration – standard accuracy 0.4 %																													
Temperature range installation / ambient temperature range																													
Standard design / –20 ... 60 °C (–4 ... 140 °F)																													
Nameplate																													
Adhesive																													
Signal cable length and type																													
Without signal cable																													
5 m (15 ft.) cable																													
10 m (30 ft.) cable																													
20 m (60 ft.) cable																													
30 m (100 ft.) cable																													
50 m (165 ft.) cable																													
80 m (260 ft.) cable																													
100 m (325 ft.) cable																													
150 m (490 ft.) cable																													
Special length or cable type																													
Explosion protection certification																													
General purpose (non-Ex design)																													
FM Class 1 Div. 2																													
usFMc Class 1 Div. 2																													
ATEX / IECEx Zone 2, 21 & 22																													

Continued on next page...

WaterMaster
Electromagnetic flowmeter

Product coding field number		1	...	5	6	7	...	9	10	11	12	13	14, 15	16	17	18	19	20	21	22	23	24	25	26	27	Options																								
Flowmeter system – full bore, integral mount (DN10 to DN32 only)		FEW11																																																
Flowmeter system – full bore, remote mount		FEW12				X	XXX		X	X	X	X		XX	X	X	X	X	X	X	X	X	X	X	X	X																								
Full bore sensor only – for use with WaterMaster transmitter / remote		FEW18																																																
Protection class transmitter / protection class sensor																																																		
IP67 (NEMA 4X) / IP67 (NEMA 4X) – cable not fitted and potted to sensor																						1																												
IP67 (NEMA 4X) / IP67 (NEMA 4X) – cable fitted and potted to sensor																						7																												
Cable conduits*																																																		
M20 x 1.5 (plastic)																																																		
NPT 1/2 in. (blanked when cable not fitted)																																																		
M20 SWA (armored)																																																		
M20 SWA sensor, M20 x 1.5 (plastic) power / output																																																		
Without																																																		
Power supply																																																		
Without																																																		
100... 230 V AC, 50 Hz																																																		
24 V AC or 24 V DC, 50 Hz																																																		
100... 230 V AC, 60 Hz																																																		
24 V AC or 24 V DC, 60 Hz																																																		
Input and output signal type																																																		
HART + 20 mA + pulse + contact output																																																		
PROFIBUS DP RS485 physical layer + pulse + contact output (general-purpose design only)																																																		
MODBUS RTU RS485 physical layer + pulse + contact output (general-purpose design only)																																																		
Without																																																		
Configuration type / diagnostics type																																																		
Not required																																																		
Factory default/ standard																																																		
Options**																																																		
Accessories																																																		
Configuration lead																																																		
Documentation language																																																		
German		M1				Chinese				M6																																								
Italian		M2				Swedish				M7																																								
Spanish		M3				Finnish				M8																																								
French		M4				Portuguese				MA																																								
English		M5 (default)				Danish				MF																																								
						Norwegian				MN																																								
Verification type																																																		
Without fingerprint																																																		
VeriMaster																																																		
Potable water approval																																																		
WRAS cold water approval																																																		
Without																																																		
Power supply frequency (FEW 18 only)																																																		
50 Hz																																																		
60 Hz																																																		
Number of testpoints (FEW 10 to 32 only)																																																		
1 Point																																																		
3 Points																																																		

* For FM or FMC Approved versions, NPT only permitted.

** Add codes for options.

Electromagnetic flowmeter WaterMaster FEV11, FEV12 and FEV18

Product coding field number		1	2	3	4	5	6	7 ... 9	10	11	12	13	14, 15	16	17	18	19	20	21	22	23	24	25	26	27	Options
Flowmeter system, optimized full bore, integral mount		FEV11																								
Flowmeter system, optimized full bore, remote mount		FEV12																								
Optimized full bore sensor only, for use with WaterMaster transmitter / remote		FEV18																								
Design																										
Non-hazardous areas		1																								
Hazardous areas		5																								
Bore diameter																										
DN40 (1½ in.)		040																								
DN50 (2 in.)		050																								
DN65 (2½ in.)		065																								
DN80 (3 in.)		080																								
DN100 (4 in.)		100																								
DN125 (5 in.)		125																								
DN150 (6 in.)		150																								
DN200 (8 in.)		200																								
Liner material																										
Polypropylene – DN40 to 200 (1½ to 8 in. NB)		V																								
Electrode design																										
Standard		1																								
Measuring electrodes material																										
Stainless steel 316		S																								
Hastelloy® C-22		C																								
Super-austenitic steel		U																								
Grounding accessories																										
Standard		1																								
One potential equalizing ring (stainless steel)		3																								
Two potential equalizing rings (stainless steel)		4																								
Process connection type (refer to pages 29 and 28)																										
Flanges ASME B16.5 class 150		A1																								
Flanges AS 4087 PN21 (≥ DN50 [2 in. NB])		E0																								
Flanges AS 4087 PN16 (≥ DN50 [2 in. NB])		E1																								
Flanges AS 4087 PN14		E2																								
Flanges AS 2129 Table F		E3																								
Flanges AS 2129 Table E		E4																								
Flanges AS 2129 Table D		E5																								
Flanges AS 2129 Table C		E6																								
Flanges JIS G5527 7.5K (³ DN100 [4 in. NB])		J0																								
Flanges JIS B2220 10K		J1																								
ISO/EN PN10		S1																								
ISO / EN PN16 (≥ DN50 [2 in. NB])		S2																								
ISO / EN PN40 (DN40 [1½ in. NB] only) 16 bar rated		S4																								
Process connection material																										
Carbon steel flanges		B																								
Usage certifications																										
Standard		1																								
Calibration type																										
Class 2 Calibration – standard accuracy 0.4 %		A																								
Class 1 Calibration – high accuracy 0.2 %		B																								
Extended range, class 1 calibration – high accuracy 0.2 %		N																								
Extended range, class 2 calibration – standard accuracy 0.4 %		P																								

Continued on next page...

WaterMaster
Electromagnetic flowmeter

Product coding field number	1 ... 5	6	7 ... 9	10	11	12	13	14, 15	16	17	18	19	20	21	22	23	24	25	26	27	Options					
Flowmeter system, optimized full bore, integral mount	FEV11																									
Flowmeter system, optimized full bore, remote mount	FEV12	X	XXX	X	X	X	X	XX	X	X	X	X	X	X	X	X	X	X	X	X						
Optimized full bore sensor only, for use with WaterMaster transmitter / remote	FEV18																									
Temperature range installation / ambient temperature range	Standard design / -20 ... 60 °C (-4 ... 140 °F)											1														
Nameplate	Adhesive											A														
Signal cable length and type*												0														
Without signal cable												1														
5 m (15 ft.) cable												2														
10 m (30 ft.) cable												3														
20 m (60 ft.) cable												4														
30 m (100 ft.) cable												5														
50 m (165 ft.) cable												6														
80 m (260 ft.) cable												7														
100 m (325 ft.) cable												8														
150 m (490 ft.) cable												9														
Special length > 150 m (> 490 ft.)																										
Explosion protection certification	General purpose (non-Ex design)																									
	FM Class 1 Div. 2																									
	usFMc Class 1 Div. 2																									
	ATEX / IECEx Zone 2, 21 & 22																									
Protection class transmitter / protection class sensor	IP67 (NEMA 4X) / IP67 (NEMA 4X) – integral																									
	IP67 (NEMA 4X) / IP68 (NEMA 6P) – cable not fitted and not potted																									
	IP67 (NEMA 4X) / IP68 (NEMA 6P) – cable fitted and potted																									
Cable conduits *	M20 x 1.5 (plastic)																									
	NPT 1/2 in. (blanked when cable not fitted)																									
	M20 SWA (armored)																									
	M20 SWA sensor, M20 x 1.5 (plastic) power / output																									
	Without																									
Power supply	Without																									
	100... 230 V AC, 50 Hz																									
	24 V AC or 24 V DC, 50 Hz																									
	100... 230 V AC, 60 Hz																									
	24 V AC or 24 V DC, 60 Hz																									
	Others																									
Input and output signal type	HART + 20 mA + pulse + contact output																									
	PROFIBUS DP RS485 physical layer + pulse + contact output																									
	MODBUS RTU RS485 physical layer + pulse + contact output																									
	Without																									
Configuration type / diagnostics type	Without																									
	Factory defaults / standard diagnostics																									

Continued on next page...

* The type of signal cable supplied (standard or armored) depends on the type of cable conduit (variant digit number 24) ordered. For FM or FMC Approved versions, NPT only permitted.

Product coding field number		1	...	5	6	7 ... 9	10	11	12	13	14, 15	16	17	18	19	20	21	22	23	24	25	26	27	Options	
Flowmeter system, optimized full bore, integral mount		FEV11																							
Flowmeter system, optimized full bore, remote mount		FEV12																							
Optimized full bore sensor only, for use with WaterMaster transmitter / remote		FEV18																							

Options**		Code
Accessories		
Configuration lead		AC
Documentation language		
German	M1	Chinese M6
Italian	M2	Swedish M7
Spanish	M3	Finnish M8
French	M4	Portuguese MA
English	M5 (default)	Danish MF
		Norwegian MN
Other usage certifications		
Measuring Instruments Directive (MID)		CM1
OIML R49 Calibration		CM2
Verification type		
Without fingerprint		V0
VeriMaster		V3
Potable water approval		
WRAS cold water approval		CWA
NSF 61 meter approval		CWC
DVGW		CWD
ACS		CWF
Without		CWY
Power supply frequency (sensor FEV18 only)		
50 Hz		F5
60 Hz		F6
Number of testpoints		
1 Point		T1
3 Points		T3

**Add codes for options.

Electromagnetic flowmeter WaterMaster FEF12 and FEF18

Product coding field number					6	7 ... 9	10	11	12	13	14, 15	16	17	18	19	20	21	22	23	24	25	26	27	Options
Flowmeter system, full bore, remote mount					FEF12	X	XXX	X	X	X	X	XX	X	X	X	X	X	X	X	X	X	X	X	
Full bore sensor only, for use with WaterMaster transmitter / remote					FEF18																			
Design																								
Non-hazardous areas					1																			
Hazardous areas (DN≥700 [27 in. NB])					5																			
Bore diameter																								
DN250 (10 in.)					250																			
DN300 (12 in.)					300																			
DN350 (14 in.)					350																			
DN375 (15 in.)					375																			
DN400 (16 in.)					400																			
DN450 (18 in.)					450																			
DN500 (20 in.)					500																			
DN600 (24 in.)					600																			
Others					999																			
Liner material																								
Elastomer – DN250 to 600 (10 to 24 in. NB)						K																		
Hard rubber – DN250 to 600 (10 to 24 in. NB)						H																		
Other						Z																		
Electrode design																								
Standard						1																		
Others						9																		
Measuring electrodes material																								
Stainless steel 316						S																		
Hastelloy® C-22						C																		
Super-austenitic steel (DN250 to 600 [10 to 24 in. NB])						U																		
Others						Z																		
Grounding accessories																								
Standard						1																		
One potential equalizing ring (stainless steel)						3																		
Two potential equalizing rings (stainless steel)						4																		
Others						9																		
Process connection type (refer to pages 35 to 33)																								
Flanges ASME B16.5 class 150						A1																		
Flanges ASME B16.5 class 300						A3																		
Flanges AWWA C207 class B						C1																		
Flanges AWWA C207 class D						C2																		
Flanges AS 4087 PN21						E0																		
Flanges AS 4087 PN16						E1																		
Flanges AS 4087 PN14						E2																		
Flanges AS 2129 Table F						E3																		
Flanges AS 2129 Table E						E4																		
Flanges AS 2129 Table D						E5																		
Flanges AS 2129 Table C						E6																		
Flanges AS 2129 Table H						E7																		
Flanges AS 4087 PN35						E8																		
Flanges JIS G5527 7.5K						J0																		
Flanges JIS B2220 10K						J1																		
Flanges JIS B2220 5K						J2																		
Flanges ISO / EN PN6						S0																		
Flanges ISO / EN PN10						S1																		
Flanges ISO / EN PN16						S2																		
Flanges ISO / EN PN25						S3																		
Flanges ISO / EN PN40						S4																		
Others						Z9																		
Note. DN80 to 200 (3 to 10 in. NB) available only with PN16																								
Process connection material																								
Carbon steel flanges						B																		
Others						Z																		
Usage certifications																								
Standard						1																		
Calibration type																								
Class 2 calibration – standard accuracy 0.4 %						A																		
Class 1 calibration – high accuracy 0.2 %						B																		
Extended range, class 1 calibration – high accuracy 0.2 %						N																		
Extended range, class 2 calibration – standard accuracy 0.4 %						P																		

Continued on next page ...

Product coding field number		1 ... 5	6	7 ... 9	10	11	12	13	14, 15	16	17	18	19	20	21	22	23	24	25	26	27	Options
Flowmeter system, full bore, remote mount		FEF12	X	XXX	X	X	X	X	XX	X	X	X	X	X	X	X	X	X	X	X	X	
Full bore sensor only, for use with WaterMaster transmitter / remote		FEF18																				
Temperature range installation / ambient temperature range		Standard design / -20 ... 60 °C (-4 ... 140 °F)											1									
Nameplate		Adhesive												A								
Signal cable length and type*		Without signal cable													0							
		5 m (15 ft.) cable													1							
		10 m (30 ft.) cable													2							
		20 m (60 ft.) cable													3							
		30 m (100 ft.) cable													4							
		50 m (165 ft.) cable													5							
		80 m (260 ft.) cable													6							
		100 m (325 ft.) cable													7							
		150 m (490 ft.) cable													8							
		Special Length > 150 m (> 490 ft.) (and / or armored cable)													9							
Explosion protection certification		General purpose (non-Ex design)															A					
Protection class transmitter / protection class sensor		IP67 (NEMA 4X) / IP68 (NEMA 6P) – cable not fitted and not potted																				2
		IP67 (NEMA 4X) / IP68 (NEMA 6P) – cable fitted and potted																				3
Cable conduits**		M20 x 1.5 (plastic)																				A
		NPT 1/2 in. (blanked when cable not fitted)																				B
		M20 SWA (armored)																				D
		M20 SWA sensor, M20 x 1.5 (plastic) power / output																				F
		Without																				Y
Power supply		Without																				0
		100... 230 V AC (50 Hz)																				1
		24 V AC or 24 V DC (50 Hz)																				2
		100... 230 V AC (60 Hz)																				3
		24 V AC or 24 V DC (60 Hz)																				4
Input and output signal type		HART + 20 mA + pulse + contact output																				A
		PROFIBUS DP RS485 physical layer + pulse + contact output																				G
		MODBUS RTU RS485 physical layer + pulse + contact output																				M
		Without																				Y
Configuration type / diagnostics type		Without																				0
		Factory defaults / standard diagnostics																				1
Options***																						
Accessories		Configuration lead																				AC
Documentation language		German	M1		Chinese	M6																
		Italian	M2		Swedish	M7																
		Spanish	M3		Finnish	M8																
		French	M4		Portuguese	MA																
		English	M5 (default)		Danish	MF																
					Norwegian	MN																
Verification type		Without fingerprint																				V0
		VeriMaster																				V3
Portable water approvals		WRAS cold water approval																				CWA
		NSF 61 meter approval																				CWC
		DVGW																				CWD
		ACS																				CFW
		WRAS 60 °C (140 °F) water approval																				CWK
		Without																				CWY
Power supply frequency (sensor FEF 18 only)		50 Hz																				F5
		60 Hz																				F6
Number of testpoints		1 Point																				T1
		3 Points																				T3

*Size is dependent on flange specification

**The type of signal cable supplied (standard or armored) depends on the type of cable conduit (variant digit number 24) ordered – for FM or FMC Approved versions, NPT only permitted.

***Add codes for options.

Electromagnetic flowmeter WaterMaster – FEW31, FEW32 and FEW38

Product coding field number					6	7 ... 9	10	11	12	13	14, 15	16	17	18	19	20	21	22	23	24	25	26	27	Options	
Flowmeter system – full bore, integral mount					FEW31																				
Flowmeter system – full bore, remote mount					FEW32	X	XXX	X	X	X	X	XX	X	X	X	X	X	X	X	X	X	X	X	X	
Full bore sensor only – for use with WaterMaster transmitter / remote					FEW38																				
Design																									
Non-hazardous areas					1																				
Hazardous areas					5																				
Bore diameter																									
DN10 (3/8 in.)						010																			
DN15 (1/2 in.)						015																			
DN20 (3/4 in.)						020																			
DN25 (1 in.)						025																			
DN32 (1 1/4 in.)						032																			
DN40 (1 1/2 in.)						040																			
DN50 (2 in.)						050																			
DN65 (2 1/2 in.)						065																			
DN80 (3 in.)						080																			
DN100 (4 in.)						100																			
DN125 (5 in.)						125																			
DN150 (6 in.)						150																			
DN200 (8 in.)						200																			
DN250 (10 in.)						250																			
DN300 (12 in.)						300																			
DN350 (14 in.)						350																			
DN400 (16 in.)						400																			
DN450 (18 in.)						450																			
DN500 (20 in.)						500																			
DN600 (24 in.)						600																			
DN700 (28 in.)						700																			
DN750 (30 in.)						750																			
DN800 (32 in.)						800																			
DN900 (36 in.)						900																			
DN1000 (40 in.)						001																			
DN1050 (42 in.)						051																			
DN1100 (44 in.)						101																			
DN1200 (48 in.)						201																			
DN1350 (54 in.)						351																			
DN1400 (56 in.)						401																			
DN1500 (60 in.)						501																			
DN1600 (64 in.)						601																			
DN1650 (66 in.)						651																			
DN1800 (72 in.)						801																			
DN1950 (78 in.)						951																			
DN2000 (80 in.)						002																			
DN2100 (84 in.)						102																			
DN2200 (88 in.)						202																			
DN2400 (96 in.)						402																			
Others						999																			
Liner material																									
PTFE – DN10 to 600 (3/8 to 24 in. NB)										A															
Hard rubber – DN40 to 2400 (1 1/2 to 96 in. NB)										H															
Elastomer – DN40 to 2400 (1 1/2 to 96 in. NB)										K															
Electrode design																									
Standard																							1		
Other																							9		
Measuring electrodes material																									
Hastelloy® C-4 (2.4610)																								D	
Stainless steel 316Ti/316L																								S	
Hastelloy C-22																								C	
Grounding accessories																									
Not required																								0	
Standard																								1	
One potential equalizing ring (stainless steel)																									3
Two potential equalizing rings (stainless steel)																									4

Continued on next page...

Product coding field number	1 ... 5	6	7 ... 9	10	11	12	13	14, 15	16	17	18	19	20	21	22	23	24	25	26	27	Options	
Flowmeter system – full bore, integral mount	FEW31																					
Flowmeter system – full bore, remote mount	FEW32	X	XXX	X	X	X	X	XX	X	X	X	X	X	X	X	X	X	X	X	X		
Full bore sensor only – for use with WaterMaster transmitter / remote	FEW38																					
Process connection type (refer to pages 21 to 26)																						
Flanges ASME B16.47 series B / B16.5 Class 150								A1														
Flanges ASME B16.47 series B / B16.5 Class 300								A3														
Flanges ASME B16.47 series A Class 150								B1														
Flanges ASME B16.47 series A Class 300								B3														
Flanges AWWA C207 Class B								C1														
Flanges AWWA C207 Class D								C2														
Flanges AWWA C207 Class E								C3														
Flanges AWWA C207 Class F								C4														
Flanges JIS 10K								J1														
Flanges JIS 5K								J2														
Flanges AS 4087 PN 16								E1														
Flanges AS 2129 Table E								E4														
Flanges AS 2129 Table D								E5														
Flanges AS 4087 PN 35								E8														
ISO 7005, DIN, EN 1092-1 PN6								S0														
ISO 7005, DIN, EN 1092-1 PN10								S1														
ISO 7005, DIN, EN 1092-1 PN16								S2														
ISO 7005, DIN, EN 1092-1 PN25								S3														
ISO 7005, DIN, EN 1092-1 PN40								S4														
Process connection material																						
Carbon steel flanges								B														
Stainless steel flange								D														
Usage certifications																						
Standard (without PED)								1														
Calibration type																						
Class 2 calibration – standard accuracy 0.4 %								A														
Class 1 calibration – high accuracy 0.2 %								B														
Temperature range installation / ambient temperature range																						
Standard design/ –20 ... 60 °C (–4 ... 140 °F)								1														
Nameplate																						
Adhesive								A														
Signal cable length and type																						
Without signal cable								0														
5 m (15 ft.) cable								1														
10 m (30 ft.) cable								2														
20 m (60 ft.) cable								3														
30 m (100 ft.) cable								4														
50 m (165 ft.) cable								5														
80 m (260 ft.) cable								6														
100 m (325 ft.) cable								7														
150 m (490 ft.) cable								8														
Special length or cable type								9														
Explosion protection certification*																						
General purpose (non-Ex design)								A														
FM Class 1 Div. 2								G														
usFMc Class 1 Div. 2								P														
ATEX / IECEx Zone 2, 21 & 22								M														

Continued on next page...

WaterMaster
Electromagnetic flowmeter

Product coding field number 1 ... 5					6	7 ... 9	10	11	12	13	14, 15	16	17	18	19	20	21	22	23	24	25	26	27	Options			
Flowmeter system – full bore, integral mount					FEW31																						
Flowmeter system – full bore, remote mount					FEW32					X	XXX	X	X	X	X	XX	X	X	X	X	X	X	X	X	X		
Full bore sensor only – for use with WaterMaster transmitter / remote					FEW38																						
Protection class transmitter / protection class sensor																											
IP67 (NEMA 4X) / IP67 (NEMA 4X) – cable not fitted and not potted to sensor																											
IP 67 (NEMA 4x) / IP68 (NEMA 6P) – cable not fitted and not potted to sensor																											
IP 67 (NEMA 4x) / IP68 (NEMA 6P) – cable fitted and potted to sensor																											
Cable conduits **																											
M20 x 1.5 (plastic)																											
NPT 1/2 in. (blanked when cable not fitted)																											
M20 SWA (armored)																											
M20 SWA sensor, M20 x 1.5 (plastic) power / output																											
Without																											
Power supply																											
Without																											
108.. 230 V AC, 50 Hz																											
24 V AC or 24 V DC, 50 Hz																											
100 ... 230 V AC, 60 Hz																											
24 V AC or 24 V DC, 60 Hz																											
Input and output signal type																											
HART + 20 mA + pulse + contact output																											
PROFIBUS DP RS485 physical layer + pulse + contact output																											
MODBUS RTU RS485 physical layer + pulse + contact output																											
Without																											
Configuration type / diagnostics type																											
Not required																											
Factory default / Standard																											
Options***																											
Accessories																											
Configuration lead																											
Documentation language																											
German M1					Chinese M6																						
Italian M2					Swedish M7																						
Spanish M3					Finnish M8																						
French M4					Portuguese MA																						
English M5 (default)					Danish MF																						
					Norwegian MN																						
Lay length																											
ISO length – DN10 to 600 (3/8 to 24 in.) and 1.25D DN1800 to 2400 (72 to 96 in.)																											
1.3D DN700 to 2400 (28 to 96 in.) – see dimensional pages 25, 26, 27																											
1.0D DN700 to 1600 (28 to 64 in.) – see dimensional pages 25, 26, 27																											
Verification type																											
Without fingerprint																											
VeriMaster																											
Potable water approval																											
WRAS cold water approval																											
DVGW																											
WRAS 60 °C (140 °F) water approval																											
NSF material approval																											
Without																											
Power supply frequency (sensor FEW38 only)																											
50 Hz																											
60 Hz																											
Number of testpoints																											
1 Point																											
3 Points																											
5 Points																											

* FM approval in process. FEF product still available with full FM approval

** The type of signal cable supplied (standard or armored) depends on the type of cable conduit (variant digit number 24) ordered. For FM or FMC Approved versions, NPT only permitted.

*** Add codes for options.

WaterMaster FER reduced-bore sensor flowmeter series

Product coding field number		1 ... 6	7 ... 9	10	11	12	13	14,15	16	17	18	19	20	21	22	23	24	25	26	27	Options
WaterMaster system. Reduced-bore sensor with remote mounted transmitter		FER121																			
WaterMaster system. Reduced-bore sensor with integral transmitter		FER111	XXX	X	X	X	X	XX	X	X	X	X	X	X	X	X	X	X	X	X	
WaterMaster reduced-bore sensor only, remote mount, without transmitter		FER181																			
Bore diameter																					
DN 40 (1½ in.)			040																		
DN 50 (2 in.)			050																		
DN 65 (2½ in.)			065																		
DN 80 (3 in.)			080																		
DN 100 (4 in.)			100																		
DN 125 (5 in.)			125																		
DN 150 (6 in.)			150																		
DN 200 (8 in.)			200																		
DN 250 (10 in.)			250																		
DN 300 (12 in.)			300																		
DN 350 (14 in.)			350																		
DN 375 (15 in.)			375																		
DN 400 (16 in.)			400																		
DN 450 (18 in.)			450																		
DN 500 (20 in.)			500																		
DN 600 (24 in.)			600																		
Liner material																					
Elastomer – DN40 to 600 (1½ to 24 in. NB)																					K
Electrode design																					
Standard																					1
Measuring electrodes material																					
Stainless steel 316																					S
Super austenitic steel (1.4529)																					U
Grounding accessories																					
1 x Stainless steel equalizing ring																					3
2 x Stainless steel equalizing rings																					4
Process connection type (refer to pages 30 and 30)																					
Flanges ANSI / ASME B16.5 / 16.47 series B Class 150			(40 / 50 / 80 / 100 / 150 ... 300)																		A1
Flanges AWWA C207 Class E			(40 / 50 / 80)																		C3
Flanges JIS 7.5K			(100 / 150 ... 300)																		J0
Flanges JIS 10K			(40 / 50 / 80 / 100 / 150 ... 300)																		J1
Flanges AS 4087 PN 21			(50 / 80 / 100 / 150 ... 600)																		E0
Flanges AS 4087 PN 16			(50 / 80 / 100 / 150 ... 350 / 450 ... 600)																		E1
Flanges AS 4087 PN 14			(40 / 50 / 80 / 100 / 150 ... 600)																		E2
Flanges AS 2129 Table F			(40 / 50 / 80 / 100 / 150 ... 600)																		E3
Flanges AS 2129 Table E			(40 / 50 / 80 / 100 / 125 / 150 ... 600)																		E4
Flanges AS 2129 Table D			(40 / 50 / 80 / 100 / 150 ... 300)																		E5
Flanges AS 2129 Table C			(40 / 50 / 80 / 100 / 150 ... 300)																		E6
ISO 7005 PN 10 EN 1092-1			(40 ... 600)																		S1
ISO 7005 PN 16 EN 1092-1			(40 ... 600)																		S2
ISO 7005 PN 40 EN 1092-1			(40)																		S4
Process connection material																					
Carbon steel																					B
Usage certifications																					
Standard																					1

Continued on next page...

WaterMaster
Electromagnetic flowmeter

Product coding field number		1 ... 6	7 ... 9	10	11	12	13	14,15	16	17	18	19	20	21	22	23	24	25	26	27	Options
WaterMaster system. Reduced-bore sensor with remote mounted transmitter		FER121																			
WaterMaster system. Reduced-bore sensor with integral transmitter		FER111	XXX	X	X	X	X	XX	X	X	X	X	X	X	X	X	X	X	X	X	X
WaterMaster reduced-bore sensor only, remote mount, without transmitter		FER181																			
See previous page																					
Calibration type																					
Class 2 calibration – standard accuracy 0.4 %																					A
Class 1 calibration – high accuracy 0.2																					B
Extended range, class 1 calibration – high accuracy 0.2 %																					N
Extended range, class 2 calibration – standard accuracy 0.4 %																					P
Installation temperature range / ambient temperature range																					
Standard design –20 ... 60 °C (–4 ... 140 °F)																					1
Name plate																					
Adhesive label																					A
Signal cable length and type																					
Without signal cable																					0
5 m (16.4 ft)																					1
10 m (32.8 ft)																					2
20 m (65.6 ft)																					3
30 m (98.4 ft)																					4
50 m (164.0 ft)																					5
80 m (262.5 ft)																					6
100 m (325 ft)																					7
150 m (490 ft)																					8
Others																					9
Explosion protection certification																					
General purpose (non-Ex design)																					A
Protection class transmitter / protection class sensor																					
IP67 (NEMA 4X) / IP68 (NEMA 6P) – cable not fitted and not potted																					2
IP67 (NEMA 4X) / IP68 (NEMA 6P) – cable fitted and potted																					3
Cable conduits*																					
M20 x 1.5																					A
NPT 1/2 in (blanked when cable not fitted)																					B
M20 SWA armored (FEV121 and FEV181 only)																					D
M20 SWA sensor, output and power connector (FEV121 and FEV181 only)																					F
Power supply																					
Without (FEV18 only)																					0
100... 230 V AC, 50 Hz																					1
24 V AC or 24 V DC, 50 Hz																					2
100... 230 V AC, 60 Hz																					3
24 V AC or 24 V DC, 60 Hz																					4
Input and output signal type																					
HART + 20 mA + pulse + contact output																					A
PROFIBUS DP RS485 physical layer + pulse + contact output (FEV111 and FEV121 only)																					G
MODBUS RTU RS485 physical layer + pulse + contact output (FEV111 and FEV121 only)																					M
Without (FEV181 only)																					Y
Configuration type / diagnostics type																					
Without (FEV18 only)																					0
Factory defaults / standard diagnostics (FEV11 and FEV12 only)																					1
Options**																					
Documentation language																					
German	M1	Chinese	M6																		
Italian	M2	Portuguese	MA																		
Spanish	M3	Russian	MB																		
French	M4	Danish	MF																		
English	M5 (default)																				
Verification type																					
Without fingerprint																					V0
VeriMaster																					V3
Potable water approval																					
WRAS cold water approval																					CWA
DVGW																					CWD
ACS																					CWF
Power supply frequency (sensor FER18 only)																					
50 Hz																					F5
60 Hz																					F6

* The type of signal cable supplied (standard or armored) depends on the type of cable conduit (variant digit number 24) ordered.
For FM or FMC Approved versions, NPT only permitted.

**Add codes for options.

Electromagnetic flowmeter transmitter for WaterMaster FET10 and FET12

		Product coding field number															Options
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Transmitter module		FET10															
Remote transmitter		FET12															
Design																	
Non-hazardous area		1															
Hazardous area		5															
Temperature range installation / ambient temperature range																	
Standard design / -20 ... 60 °C (-4 ... 140 °F)		1															
Nameplate																	
Adhesive		A															
Signal cable length																	
Without signal cable		0															
Explosion protection																	
Without (transmitter only)		Y															
FM Class 1 Div. 2		G															
usFMc Class 1 Div. 2		P															
ATEX / IECEx Zone 2, 21 & 22		M															
Protection class transmitter / protection class sensor																	
IP67 (NEMA 4X) / IP67 (NEMA 4X)		1															
Cable conduits																	
M20 x 1.5 (plastic)		A															
NPT 1/2 in. (blanked when cable not fitted)		B															
M20 SWA (armored)		D															
M20 SWA sensor, M20 x 1.5 (plastic) power / output		F															
Without		Y															
Power supply																	
100... 230 V AC		1															
24 V AC or 24 V DC		2															
Input and output																	
HART + 20 mA + pulse + contact output		A															
PROFIBUS DP RS485 physical layer + pulse + contact output		G															
MODBUS RTU RS485 physical layer + pulse + contact output		M															
Configuration type / diagnostics type																	
Factory defaults / standard diagnostics		1															
Options**																	
Accessories																	
Configuration lead		AC															
Documentation																	
German	M1	Chinese	M6														
Italian	M2	Swedish	M7														
Spanish	M3	Finnish	M8														
French	M4	Portuguese	MA														
English	M5 (default)	Danish	MF														
		Norwegian	MN														
Other usage																	
Measuring Instruments Directive (MID)		CM1															

*The transmitter converter module Input and Output Signal Type must match the transmitter backplane output configuration (HART or PROFIBUS) – see OI/FET100-EN.

**Add codes for options.

Common accessories

Accessory	Item Number
WaterMaster AC Fuse F1 Type T 250 mA A/S TR5	B20411
WaterMaster DC Fuse F2 Type T 2 A A/S TR5	B20412
WaterMaster Infra Red Comms Pack	MJBX9932
WaterMaster Backplane PCB Board (STD)	WATX2505
WaterMaster Sensor PCB Board	WATX2506
WaterMaster Comms Cable	WEBC2500
Signal cable for remote WaterMaster transmitter 5 m (15 ft.) 10 m (30 ft.) 20 m (60 ft.) 30 m (100 ft.) 50 m (165 ft.) 80 m (260 ft.) 100 m (325 ft.) 150 m (490 ft.) 500 m (1650 ft.)	STT4500/05 STT4500/10 STT4500/20 STT4500/30 STT4500/50 STT4500/80 STT4500/100 STT4500/150 STT4500/500
Armored signal cable for remote WaterMaster transmitter 5 m (15 ft.) 10 m (30 ft.) 20 m (60 ft.) 30 m (100 ft.) 50 m (165 ft.) 80 m (260 ft.) 100 m (325 ft.) 150 m (490 ft.) 500 m (1650 ft.)	STT4501/05 STT4501/10 STT4501/20 STT4501/30 STT4501/50 STT4501/80 STT4501/100 STT4501/150 STT4501/500

Acknowledgements

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Contact us

ABB Limited

Process Automation

Oldends Lane
Stonehouse
Gloucestershire GL10 3TA
UK

Tel: +44 1453 826 661

Fax: +44 1453 829 671

ABB Inc.

Process Automation

125 E. County Line Road
Warminster
PA 18974
USA

Tel: +1 215 674 6000

Fax: +1 215 674 7183

ABB Engineering (Shanghai) Ltd.

Process Automation

No. 5, Lane 369, Chuangye Road
201319, Shanghai,
P.R. China

Phone: +86 (0) 21 6105 6666

Fax: +86 (0) 21 6105 6992

Mail: china.instrumentation@cn.abb.com

www.abb.com

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3KXF211101R1001



Sales



Service



Software

FIBERGLASS UNDERGROUND TANK

SHORT FORM SPECIFICATION

The contractor shall provide the appropriate underground fiberglass storage tank and accessories as indicated on tank drawings. Capacity, dimensions, and fitting locations and sizes will also be indicated on tank drawings. Tanks shall be single-wall fiberglass as manufactured by Containment Solutions, Inc. The tank must be installed according to manufacturer's current installation instructions.

LONG FORM SPECIFICATION

1. GENERAL

1.1. Quality Assurance

1.1.1. Acceptable Manufacturers:
Containment Solutions, Inc., Conroe, Texas

1.1.2. Governing Standards, as applicable:

1.1.2.1. Tank manufacturer shall be in the business of manufacturing tanks to Underwriters Laboratories (UL) Standard 1316.

1.1.2.2. Tank manufacturer shall be in the business of manufacturing tanks with materials conforming to the requirements of ANSI/AWWA – D120 (Thermosetting Fiberglass-Reinforced Plastic Tanks).

1.2. Submittals

1.2.1. Contractor shall submit to engineer _____ copies of shop drawings for each tank and _____ copies of manufacturer's literature (including installation instructions).

2. PRODUCTS

2.1. Single-Wall Fiberglass Underground Tanks

2.1.1. Product-Storage Requirements:

2.1.1.1. All primary tanks must be vented. Tanks are designed for operation at atmospheric pressure only.

2.1.1.2. Tanks shall be capable of storing non-potable water not to exceed 150°F at the tank interior surface.

2.1.1.3. Tank shall be capable of storing products identified in the manufacturer's current limited warranty.

2.1.2. Loading Conditions - Tanks shall meet the following design criteria:

2.1.2.1. External hydrostatic pressure: Buried in ground with 7' of over burden over the top of the tank, the hole fully flooded and a safety factor of 5:1 against general buckling.

2.1.2.2. Surface Loads: When installed according to manufacturer's current installation instructions, tanks will withstand surface HS-20 axle loads (32,000 lbs/axle).

2.1.2.3. Internal Load: Tanks shall withstand 5 psig (3 psig for 12' tank) air pressure test with 5:1 safety factor.

2.1.2.4. Tanks shall be designed to support accessory equipment such as submersible pumps, ladders, drop/fill tubes, etc. when installed according to manufacturer's recommendations and limitations.

2.1.3. Materials:

2.1.3.1. The tank shall be manufactured as a matrix of premium resin, glass fibers and silane-treated silica that together result in a composite providing improved corrosion protection.

2.1.3.2. Tank inner wall shall be fabricated against a mold to produce a non-air inhibited and high gloss laminate to provide fully cured inner surface without the need of wax coats, a low coefficient of friction and a natural resistance to the build-up of algae or other contamination on the surface. Wax and wax resin coatings cannot be used to achieve full surface cure on tank shells and endcaps.

2.1.4. Tank Dimensions and Capacity: (refer to CSI sales literature and drawings)

2.1.4.1. Inside tank diameter shall be _____.

2.1.4.2. Tank length shall be _____.

2.1.4.3. Nominal tank capacity shall be _____.

2.2. Accessories

2.2.1. Optional Anchor Straps:

2.2.1.1. Straps shall be standard as supplied by tank manufacturer.

2.2.1.2. Provide glass fiber reinforced plastic anchor straps for each tank shown.

2.2.1.3. Number and location of straps shall be as specified by manufacturer.

2.2.2. Access Collar:

2.2.2.1. The standard access collar is 24", which is supplied by the manufacturer.
(30" and 36" collars are optional)

2.2.2.2. All access collars will be furnished complete with exterior adhesive channel.

2.2.2.3. Manufacturer supplied adhesive kit (Model Kit-AD) shall be used for watertight collar/riser connection.

2.2.2.4. Location(s) shall be indicated on tank drawings.

2.2.2.5. Optional fiberglass access riser shall be FRP with lockable composite lid.

2.2.3. Optional Flanged Manways:

2.2.3.1. The standard manway is 22", which is supplied by the manufacturer.
(30" and 36" manways are optional)

2.2.3.2. All manways will be furnished complete with gaskets, bolts and covers.

2.2.3.3. Location(s) shall be indicated on tank drawings.

2.2.3.4. Optional manway extensions shall be FRP

2.2.4. Fill Tubes: Fill tubes of appropriate design will be supplied by contractor.

2.2.5. Optional Ladders: Ladders shall be supplied by the tank manufacturer

2.2.6. Optional Pump Platform:

2.2.6.1. Pump platforms shall be FRP as supplied by the tank manufacturer.

2.2.6.2. Contact tank manufacturer with pump details, such as dimensions, mounting configuration and weight.

2.2.7. Optional Fittings:

2.2.7.1. All standard threaded fittings are carbon steel NPT half couplings. Reducers can be used for smaller sizes where specified and provided by the contractor.

2.2.7.2. All standard threaded fittings to the primary tank are 4" in diameter.

2.2.7.3. All optional FRP nozzles shall be flat-faced, flanged and conform to ANSI B16.5 150 pound bolting patterns.

2.2.7.4. All optional inlet/outlet stub outs shall be FRP or PVC.

2.2.7.5. Flexible connectors must be used on all piping connections. Piping must be free to move independent of the tank.

3. TESTING AND INSTALLATION

3.1. Testing and Installation

3.1.1. Testing - Tank shall be tested and installed according to the CSI Installation Instructions in effect at time of installation.

3.1.2. Installation - Tank shall be installed according to the CSI Installation Instructions in effect at time of installation. Contractor shall be trained by the tank manufacturer, state, or other approved agency. The installing contractor must complete the tank installation checklist (CSI Pub. No. INST 6001) provided with the tank and return the completed checklist to the tank owner upon completion of the installation. The signed checklist, and applicable written approvals from Containment Solutions, should be retained by the tank owner and must be provided later to CSI to validate any future warranty claim.

4. LIMITED WARRANTY

4.1. Limited Warranty

4.1.1. Warranty shall be Containment Solutions limited warranty in effect at time of delivery.

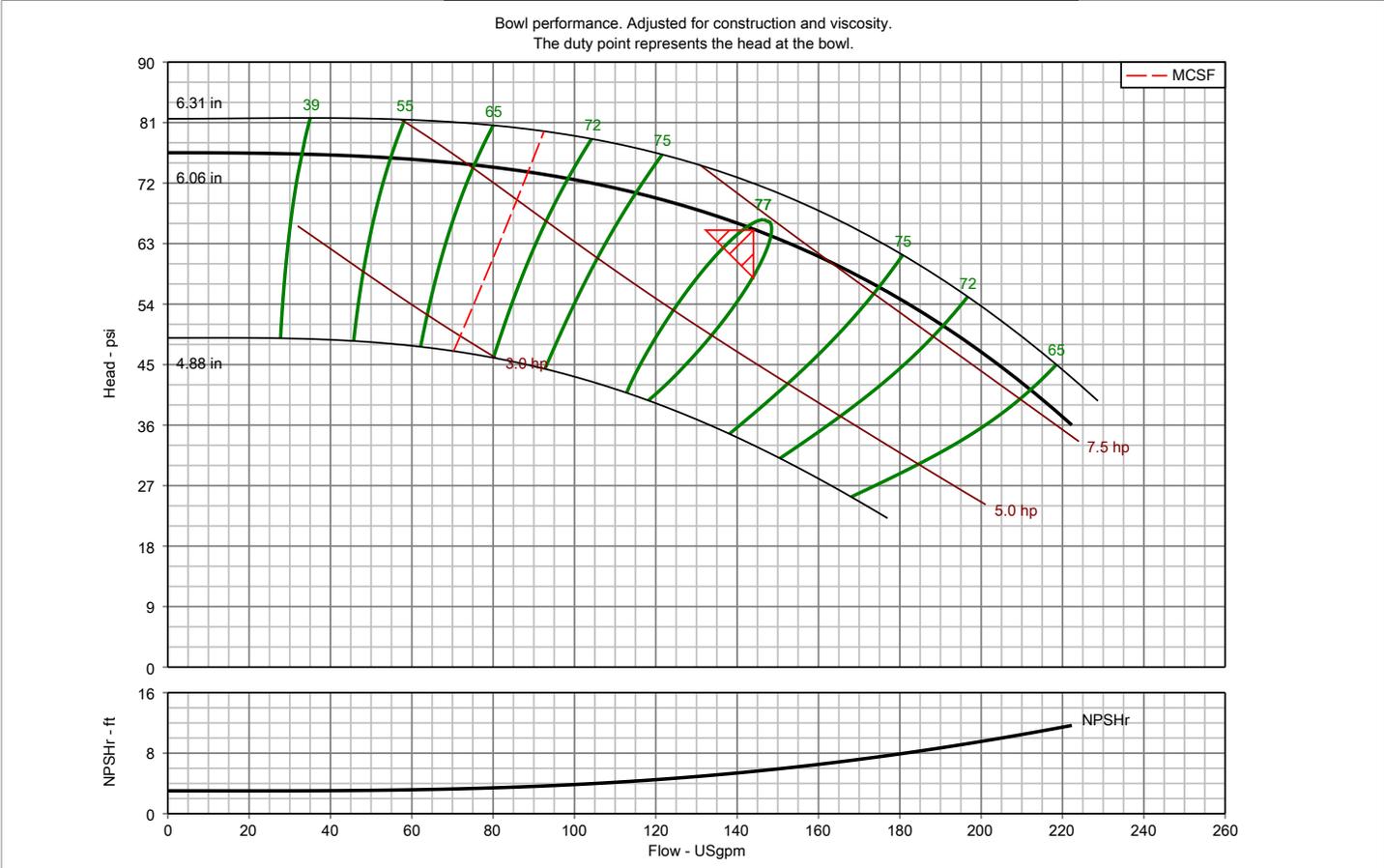
AMERICAN – MARSH PUMPS

Pump Performance Datasheet

Customer : SPECIFIED SALES ASSOCIATES, L.L.C.	Quote number : 469210
Customer reference :	Size : 8LC
Item number : 001	Stages : 5
Service :	Based on curve number : 8LC
Quantity : 1	Date last saved : 06 Oct 2015 4:13 PM

Operating Conditions	Liquid
Flow, rated : 144.0 USgpm	Liquid type : Water
Differential head / pressure, rated (requested) : 65.00 psi	Additional liquid description :
Differential head / pressure, rated (actual) : 65.34 psi	Solids diameter, max : 0.00 in
Suction pressure, rated / max : 0.00 / 0.00 psi.g	Solids concentration, by volume : 0.00 %
NPSH available, rated : Ample	Temperature, max : 68.00 deg F
Frequency : 60 Hz	Fluid density, rated / max : 1.000 / 1.000 SG
	Viscosity, rated : 1.00 cP
	Vapor pressure, rated : 0.34 psi.a

Performance	Material
Speed, rated : 1750 rpm	Material selected : Cast iron - Standard
Impeller diameter, rated : 6.06 in	
Impeller diameter, maximum : 6.31 in	
Impeller diameter, minimum : 4.88 in	
Efficiency (bowl / pump) : 77.01 / 76.30 %	
NPSH required / margin required : 5.59 / 0.50 ft	
Ns (total flow) / Nss (imp. eye flow) : 1,588 / 5,610 US Units	
MCSF : 88.55 USgpm	
Head, maximum, rated diameter : 76.52 psi	
Head rise to shutoff : 17.43 %	
Flow, best eff. point (BEP) : 145.5 USgpm	
Flow ratio (rated / BEP) : 98.99 %	
Diameter ratio (rated / max) : 96.03 %	
Head ratio (rated dia / max dia) : 90.54 %	
Cq/Ch/Ce/Cn [ANSI/HI 9.6.7-2010] : 1.00 / 1.00 / 1.00 / 1.00	
Selection status : Acceptable	

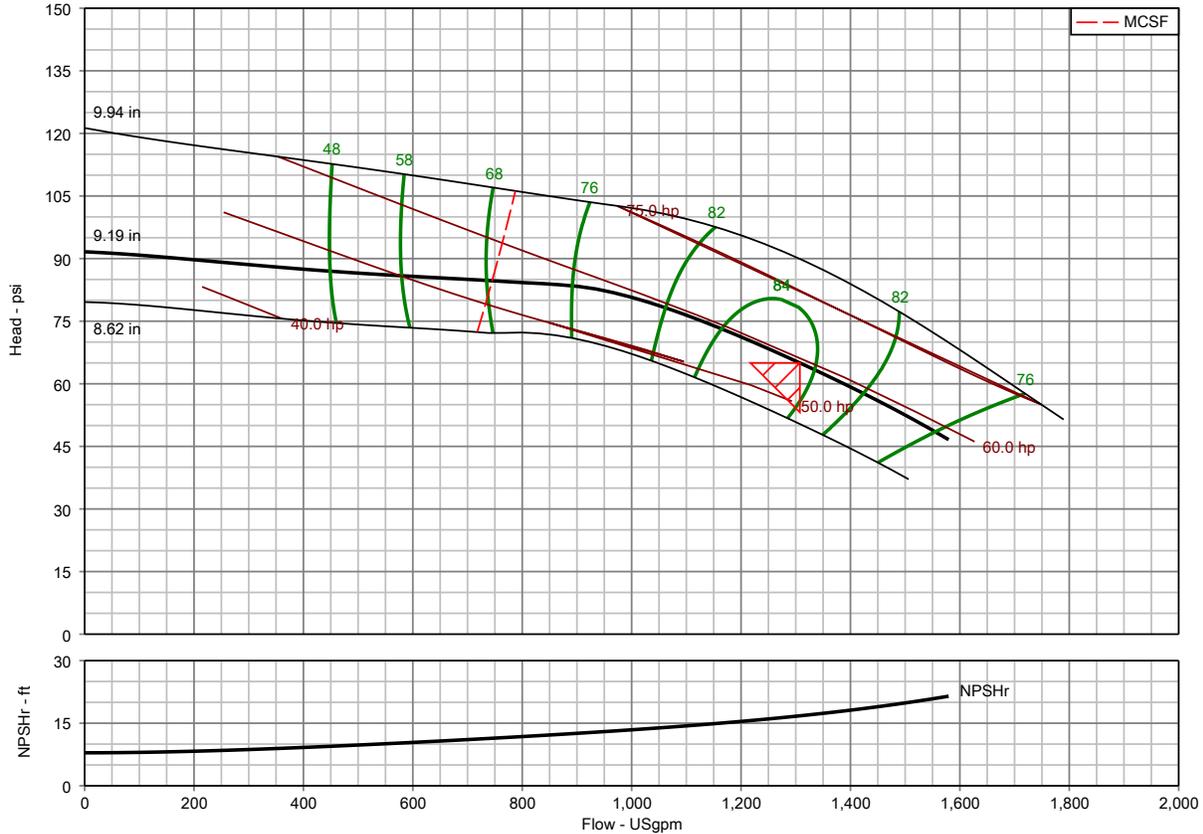


Pump Performance Datasheet

Customer : SPECIFIED SALES ASSOCIATES, L.L.C.	Quote number : 469210
Customer reference :	Size : 13MC
Item number : 002	Stages : 3
Service :	Based on curve number : 13MC
Quantity : 2	Date last saved : 06 Oct 2015 4:15 PM

Operating Conditions		Liquid	
Flow, rated	: 1,307.5 USgpm	Liquid type	: Water
Differential head / pressure, rated (requested)	: 65.00 psi	Additional liquid description	:
Differential head / pressure, rated (actual)	: 66.50 psi	Solids diameter, max	: 0.00 in
Suction pressure, rated / max	: 0.00 / 0.00 psi.g	Solids concentration, by volume	: 0.00 %
NPSH available, rated	: Ample	Temperature, max	: 68.00 deg F
Frequency	: 60 Hz	Fluid density, rated / max	: 1.000 / 1.000 SG
Performance		Material	
Speed, rated	: 1750 rpm	Material selected	: Cast iron - Standard
Impeller diameter, rated	: 9.19 in	Pressure Data	
Impeller diameter, maximum	: 9.94 in	Maximum working pressure	: See the Additional Data page
Impeller diameter, minimum	: 8.62 in	Maximum allowable working pressure	: See the Additional Data page
Efficiency (bowl / pump)	: 84.31 / 83.08 %	Maximum allowable suction pressure	: N/A
NPSH required / margin required	: 16.77 / 0.50 ft	Hydrostatic test pressure	: See the Additional Data page
Ns (total flow) / Nss (imp. eye flow)	: 2,665 / 7,615 US Units	Driver & Power Data	
MCSF	: 744.9 USgpm	Driver sizing specification	: Maximum power
Head, maximum, rated diameter	: 91.63 psi	Margin over specification	: 0.00 %
Head rise to shutoff	: 40.98 %	Service factor	: 1.15
Flow, best eff. point (BEP)	: 1,251.2 USgpm	Power, hydraulic	: 49.58 hp
Flow ratio (rated / BEP)	: 104.50 %	Power (bowl / pump)	: 58.80 / 59.04 hp
Diameter ratio (rated / max)	: 92.45 %	Power, maximum, rated diameter	: 59.44 hp
Head ratio (rated dia / max dia)	: 72.28 %	Minimum recommended motor rating	: 60.00 hp / 44.74 kW
Cq/Ch/Ce/Cn [ANSI/HI 9.6.7-2010]	: 1.00 / 1.00 / 1.00 / 1.00		
Selection status	: Acceptable		

Bowl performance. Adjusted for construction and viscosity.
The duty point represents the head at the bowl.



APPENDIX A

May 29, 2015

EAC Consulting, Inc.
815 N.W. 57th Avenue, Suite 402
Miami, Florida 33126

Attention: Ms. Sharmin Siddique, P.E.
Senior Project Manager, Civil Engineering

Re: Report of Geotechnical Engineering Services
Three Island Reuse Irrigation Project
Hallandale Beach, Broward County, Florida
PSI Project No. 0397-923
EAC Project No. 14045.SD01-01

Dear Ms. Siddique:

Professional Service Industries, Inc. (PSI) has completed the requested services at the subject site. Our services were provided in general accordance with PSI Proposal No. P0-0397-142882, dated, January 23, 2015. Our services were authorized by means of an EAC Subconsultant Agreement dated, May 5, 2015.

We trust this report is adequate for your current needs; however, should you have any questions or should additional information be required, please do not hesitate to contact our office at (305) 471-7725.

Respectfully Submitted,

Professional Service Industries, Inc.
Certificate of Authorization No: 3684



Jonathan Bassett, E.I.
Project Engineer



Dhuruva (Dru) Badri, P.E.
Department Manager
FL License No. 68718

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Sheet 3: Boring Location Plan
Boring Logs
Material Property Data Sheet - CONTECH C-60NW Nonwoven Geotextile

1.0 PROJECT INFORMATION

Based on the information supplied by Ms. Siddique, it is our understanding that the project will involve a $\pm 2,900$ linear foot extension of a gravity fed 8-inch polyvinyl chloride (PVC) reuse line. We have assumed the invert of the pipe to be in the upper 10 feet of the subsurface profile. The extension will begin at the intersection of Wiley Street and Diplomat Parkway, heading south along Diplomat Parkway and continue east along Atlantic Shores Boulevard where it will terminate at the intersection of Atlantic Shores Boulevard and Three Islands Boulevard in Hallandale Beach, Florida. A site vicinity map identifying the project location with respect to existing streets and features is presented on **Sheet 1** of the **Appendix**. Photographs from our site visit are presented in **Sheet 2** of the **Appendix**.

Additionally, a pump station will be installed on the east side of Diplomat Parkway, approximately ± 700 feet north of Atlantic Shores Boulevard. Though the final depth of the pump station has not yet been determined, based on our discussions with Ms. Shari Ramirez, P.E. with EAC Consulting, Inc., it is anticipated to be within the upper 15 feet of the subsurface profile

For the current study, our involvement relates to providing recommendations for pipe bedding, soil parameters for use in the pump station design, and pavement restorations. The design of the pump station will be by others.

If any of the noted information is incorrect or has changed, please notify PSI so that we may amend this report, if appropriate.

2.0 FIELD EXPLORATION AND SUBSURFACE CONDITIONS

2.1 STANDARD PENETRATION TEST (SPT) BORINGS

To evaluate subsurface conditions at the site, we drilled/sampled four SPT borings that were advanced to depths ranging from 15 to 40 feet below grade. The SPT borings were performed using a CME-75 truck mounted drill rig equipped with an automatic hammer. The approximate locations at which the borings were drilled are shown on **Sheet 3** of the **Appendix**.

After seating the sample spoon six inches, the number of successive blows required to drive the sampler twelve inches into the soil constitutes the test result commonly referred to as the "N" value. The "N" value has been empirically correlated with various soil properties and is considered to be indicative of the relative density of cohesionless soils and the consistency of cohesive materials. The recovered split spoon samples were visually classified in the field and transported to the laboratory for further review. Following completion of our field services, the boreholes were backfilled with excavated soil/rock, the asphaltic surface patched and the site generally cleaned, as required.

2.2 SUBSURFACE AND GROUNDWATER CONDITIONS

The soil types encountered at the boring locations are presented on individual logs included in the **Appendix**. The stratification presented is based on visual observation of the recovered soil samples and the interpretation of the field logs by a geotechnical engineer. Included with the profiles are the N-values and groundwater levels measured at the time the borings were drilled.

The results of our field exploration program disclosed a surficial cover of asphalt pavement (2 to 6 inches thick) underlain by granular material with varying amounts of sand and limerock that generally persisted to a depth of approximately 3 to 8 feet below grade.

Below the granular stratum the borings encountered an approximate 3.5 to 5.0 foot thick stratum of sandy silt which was encountered in the 3.0 to 11.5 foot depth interval. The sandy silt stratum will be hereafter referred to as "compressible stratum". The compressible stratum had a moisture contents and percentage of fines passing the number 200 sieve ranging from 67 to 105 percent and 34 to 86 percent, respectively. This layer is compressible/soft and unsuitable for structural support. In addition, materials containing percentage fines of this amount are moisture sensitive and difficult to compact/densify. The compressible stratum should be handled in accordance with **Section 3.1** of this report.

The granular/compressible stratum were underlain by moderately cemented limestone and/or fine sand (with occasional limestone stringers) to the maximum termination depth of the explorations at 40 feet below grade.

The groundwater table was observed in the borings at depths ranging from 1.8 to 4.3 feet below existing grade at the time of drilling (May 2015). The difference in the water level is primarily a result of changes in the ground surface elevation between the borehole locations.

It should be noted that groundwater levels at this site fluctuate seasonally in response to rainfall and the infiltration rate of the soil. Therefore, at a time of the year different from the time of drilling, there is a possibility of a change in the recorded levels. We estimate that during the peak of the wet hydroperiod, with rainfall and recharge at a maximum, groundwater levels at the site could be one to two feet higher than those reported herein (i.e. seasonal high groundwater table level).

We recommend that the contractor determine the actual groundwater levels at the time of construction to assess the potential groundwater impact on the construction procedure.

Please refer to the individual boring logs presented in the **Appendix** for details on the subsurface conditions at specific exploration locations.

3.0 RECOMMENDATIONS

3.1 PIPE BEDDING

Based on the results of our field exploration program we anticipate that the proposed pipe subgrade materials will consist of either the compressible stratum or granular material. The aforementioned materials are considered to be a suitable pipe bearing stratum if they are properly prepared, as discussed next.

As we understand, an 8-inch PVC pipe is planned to be constructed using conventional cut-and-cover methods. We recommend that the bottom of the trench excavation be over-excavated to provide a minimum depth of 6 inches of pipe bedding in order to provide a positive contact with the contour of the utility pipe to promote uniform bearing for the full length of the pipe. The bedding material should consist of crushed stone (pea gravel) or No. 7 aggregate with not less than 95 percent passing the ½ inch and not less than 95 percent retained on a U.S. Standard No. 4 sieve. Alternatively, the use of FDOT 57 stone is also considered acceptable. The bedding material should be stabilized so it is firm and unyielding prior to placement of the pipe.

In addition, the designer should utilize a geotextile wrap such as CONTECH C-60NW or its material equivalent such that it completely envelopes the pipe and the bedding material. The purpose of the geotextile wrap is to maintain the integrity of the pipe bedding material by preventing the surrounding soils from being mixed-in. A stable pipe bedding layer will in turn minimize maintenance while extending the longevity of the pipe. A Material Property Data Sheet associated with geotextile C-60NW is presented in the **Appendix**.

The contractor should be aware that the asphalt at the existing roadway was noted to be as much as six inches in thickness or potentially greater. He should take this into account for the purposes of saw-cutting the existing asphalt, if required.

3.2 RECOMMENDED SOIL PARAMETERS – PUMP STATION

Based on the results of our field exploration program, we recommend that the below listed geotechnical parameters be utilized in the design of the pump station.

Total Unit Weight, γ	=	100 lb/ft ³
Effective Unit Weight, γ	=	38 lb/ft ³
Angle of Internal Friction, ϕ	=	28°

The factor of safety against uplift should not be less than 1.5. A lower factor of safety (but greater than 1.2) can be used for the pump station if it is assumed that the water is at the ground surface for the purpose of computing hydrostatic uplift forces on this structure.

Site preparation in the pump station area will require excavation/replacement of the compressible stratum. The compressible stratum should be excavated to its full depth and to a horizontal distance of at least 5 feet beyond the outside edges of the pump station, where practical. Based on the results of our field explorations we anticipate the depth of excavation to correspond to the top of the limestone which was encountered at approximate depths of 12 feet below grade that existed at the time of our field exploration.

Groundwater is expected to impact the replacement filling procedures. Therefore, we recommend that the excavation/filling activities be done in the "wet".

Fill material for use on this project should be composed of either clean sands or limerock. The fill should consist of an inorganic, non-plastic material, free of any man-made debris and limerock with a three inch maximum particle size. Proper control of the placement and compaction of new fills for the project should be exercised by a representative of the geotechnical engineer. The fill materials should be placed in lifts not exceeding 12 inches in loose thickness. Each lift should be compacted to at least 95 percent of the Modified Proctor maximum dry density near the optimum moisture content as determined by ASTM D-1557. Fill to be compacted with a vibratory plate tamper or a small walk behind vibratory roller should be placed in lifts not exceeding six inches in loose thickness. The fill material used both below the water table and to a height of one foot above it be as follows:

- A) The structural fill to be used above the water table should have a Unified Soil Classification System designation of GP, GW, SP, SW, GP-GM, GW-GM, SW-SM, or SP-SM containing less than 12 percent material passing the No. 200 sieve.
- B) The structural fill or backfill to be placed below the water table and to a height of one foot above it should consist of a combination of FDOT 57 Stone and structural fill material mixed in an approximate 50% proportion by volume. Density testing will not be required within this layer, however the subgrade preparation work should be observed by a representative from our office to confirm that the material is in a stable and unyielding condition.

3.3 GROUNDWATER CONTROL

The extent of groundwater control will depend on the design invert elevation of the pipe and the water level at the time of construction. At a minimum, groundwater control may likely be required for construction excavations at this site for either excavation dewatering or removal of temporarily perched water from a rain event. Such water can be controlled by pumping from sumps located in ditches or pits. Groundwater should be maintained at the following levels:

- 1. At least one foot below the bottom of any excavation made during construction operations.
- 2. At least two feet below the surface of any compaction operations.

Dewatering to greater depths may require well points to facilitate construction. Dewatering systems should be designed and operated so as not to impact adjacent construction. Additionally, the discharge from dewatering systems should be handled in accordance with current regulatory criteria as related to the same.

The dewatering operations should be carried out with care especially if the compressible soils are present below adjacent facilities.

3.4 PAVEMENT RESTORATION

Depending on the pipe alignment and associated construction excavation, the existing roadway pavement may need to be restored. Traffic volume/loads for the various streets were not available. However, from our experience with past field work along similarly trafficked roads within Broward County, existing pavement thickness noted in our field explorations, we suggest for the restoration work, the pavement thicknesses be as noted in **Table A**.

Table A: Suggested Pavement Thickness – Restoration Areas

Layer	Material Description	Layer Thickness (inches)
(A)	Asphalt Pavement	4
(B)	Crushed limerock with a minimum LBR of 100, compacted to 98% of the Modified Proctor maximum dry density	8
(SB)	Stabilized sub-grade (sub-base) with a minimum LBR of 40 compacted to 95% of the Modified Proctor maximum dry density	12

The base course materials in the pavements should consist of crushed limerock having a minimum Limerock Bearing Ratio (LBR) of 100. Base materials should meet the requirements presented in the latest revisions of the Florida Department of Transportation "Specifications for Road and Bridge Construction", Section 911 (limestone). The base course should be compacted to at least 98 percent of the material's maximum dry density (ASTM D-1557). The subgrade should be stabilized to a depth of 12 inches to achieve a minimum LBR of 40. This can be obtained by blending base material (limerock) with the existing subgrade soils. The required mixing ratio should be determined by laboratory testing. The stabilized subgrade should be compacted to at least 95 percent of the AASHTO 180 maximum dry density.

3.5 EXCAVATIONS

It is mandated by federal regulations that all excavations, whether they be utility trenches, or footing excavations, be constructed in accordance with the OSHA guidelines. It is our understanding that these regulations are being strictly enforced and if they are not closely followed, the owner and the contractor could be liable for substantial penalties.

4.0 REPORT LIMITATIONS

Our professional services have been performed, findings obtained, and recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices at the time of this report. This company is not responsible for the conclusions, opinions or recommendations made by others based on this data. No other warranties are implied or expressed. After the plans and specifications are complete, it is recommended that PSI be provided the opportunity to review the final design and specifications, in order to verify that the earthwork and recommendations are properly interpreted and implemented. At that time, it may be necessary to submit supplemental recommendations.

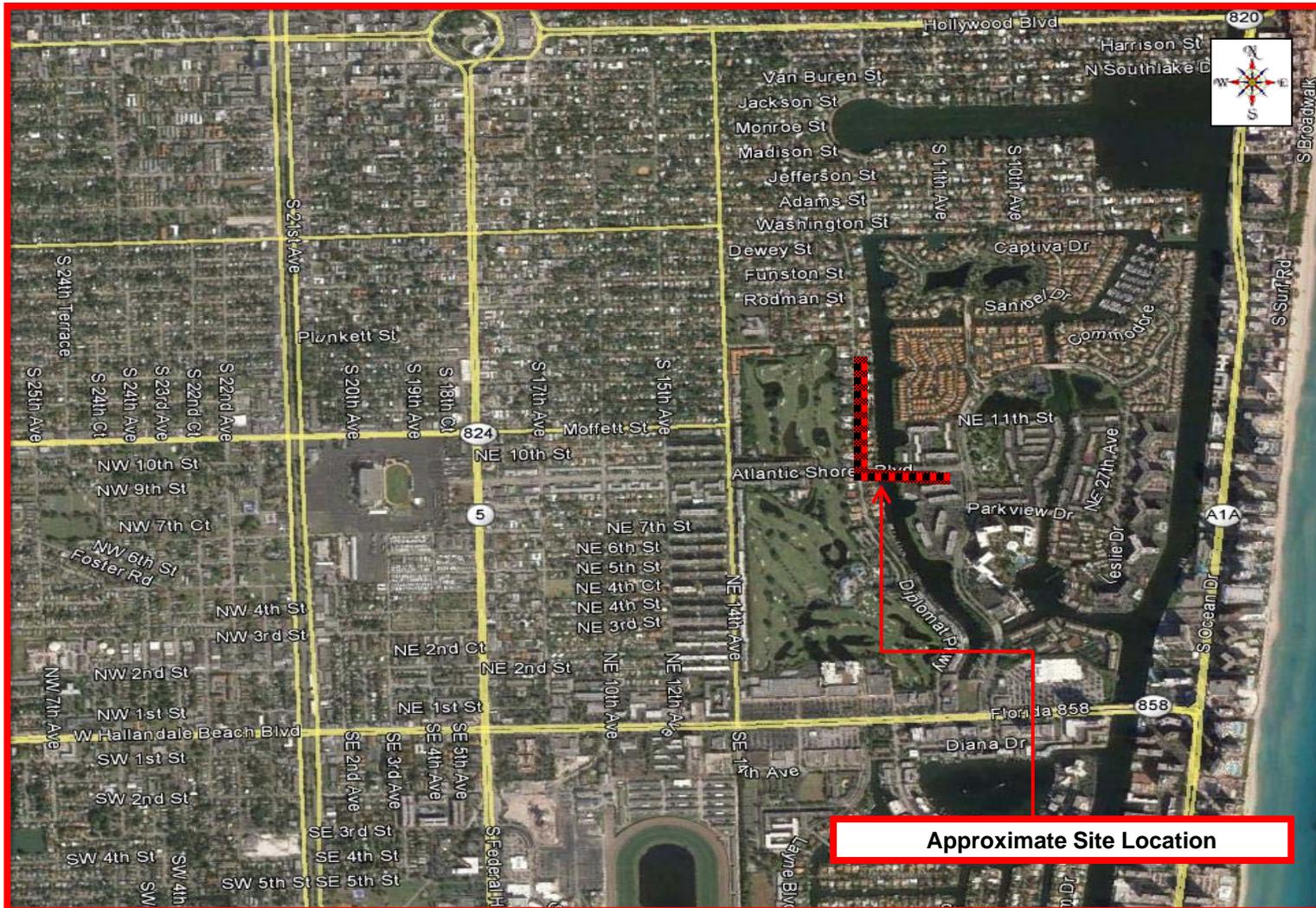
The analyses and recommendations submitted in this report are based upon the data obtained from the soil borings performed at the locations indicated. If any subsoil variations become evident during the course of this project, a re-evaluation of the recommendations contained in this report will be necessary after we have had an opportunity to observe the characteristics of the conditions encountered. The applicability of the report should also be reviewed in the event significant changes occur in the design, nature or location of the project.

The scope of our services did not include an environmental assessment for the presence or absence of hazardous or toxic materials in the soil and groundwater. Any statements in this report regarding odors, staining of soils, or other unusual conditions observed are strictly for the information of our client.

This report has been prepared for the exclusive use of EAC Consulting, Inc. and the City of Hallandale Beach, for the specific application to the design and construction of the proposed ±2,900 linear foot extension of a gravity fed 8-inch PVC reuse line in Hallandale Beach, Florida.

APPENDIX

SITE VICINITY MAP



GEOTECHNICAL ENGINEERING SERVICES
 Three Island Reuse Irrigation Project
 Hallandale Beach, Florida

DATE: 05/19/2014

DRAWN: JB

CHKD.: DB

psi Information
 To Build On
 Engineering • Consulting • Testing

SHEET No.: 1

PSI PROJECT No.:0397-923

SITE PHOTOGRAPHS



GEOTECHNICAL ENGINEERING SERVICES
Three Island Reuse Irrigation Project
Hallandale Beach, Florida

DATE: 05/19/2014

DRAWN: JB

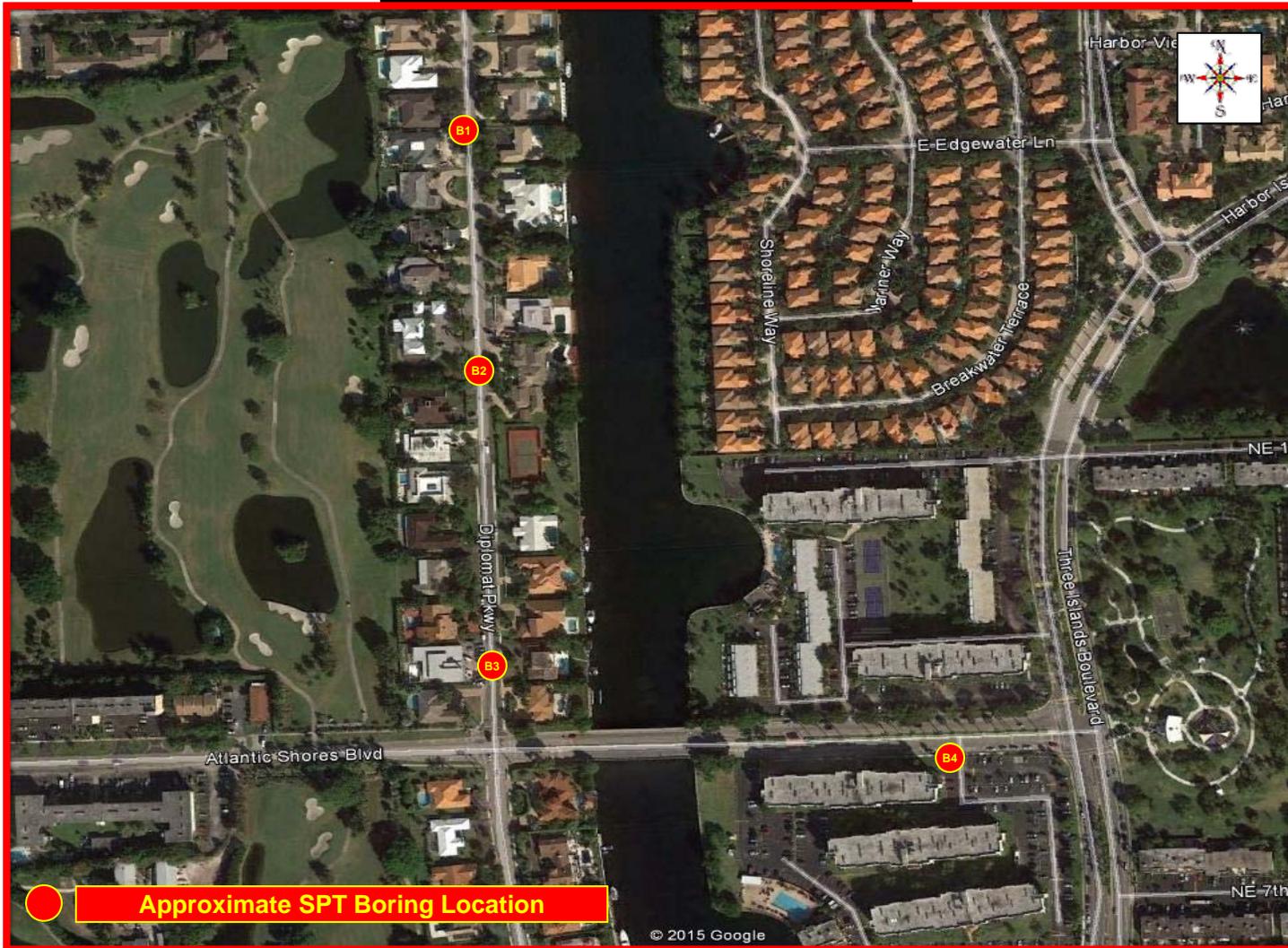
CHKD:: DB

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SHEET No.: 2

PSI PROJECT No.:0397-923

BORING LOCATION PLAN



GEOTECHNICAL ENGINEERING SERVICES
Three Island Reuse Irrigation Project
Hallandale Beach, Florida

DATE: 05/19/2014

DRAWN: JB

SHEET No.: 3

PSI PROJECT No.:0397-923

CHKD:: DB

psi Information
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Professional Service Industries, Inc.
 7950 N.W. 64th Street
 Miami, FL 33166
 Telephone: (305) 471-7725
 Fax: (305) 593-1915

LOG OF BORING B-1

Sheet 1 of 1

PSI Job No.: 0397-923
 Project: Three Island Reuse Irrigation Project
 Location: Hallandale Beach
 Florida

Drilling Method: SPT
 Sampling Method: SS
 Hammer Type: Automatic
 Boring Location: Refer to Sheet 3

WATER LEVELS	
▽ While Drilling	2.3 feet
▽ Upon Completion	2.3 feet
▽ Delay	N/A

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	Station: N/A Offset: N/A	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	STANDARD PENETRATION TEST DATA		Additional Remarks
										Moisture, %	Strength, tsf	
0				1			Asphalt	GP	14-8-7-7			
							Light Brown/Gray LIMEROCK with Fine Sand	SP	N=15			
				2			Light Brown/Gray Fine SAND with Limerock					
				3			Sandy SILT with Traces of Peat and Shells Natural Moisture Content: 106% Passing No. 200 Sieve: 81%	ML	3-3-1-1 N=4			
5				4					1-1-(W.O.H.) N=1			
				5			Light Brown/Gray Fine SAND	SP	(W.O.H.)-1-1 N=1			
10				6			Light Brown/Gray LIMESTONE with Fine Sand		4-7-8-10 N=15			
15									7-7-8 N=15			

Completion Depth: 15.0 ft
 Date Boring Started: 5/7/15
 Date Boring Completed: 5/7/15
 Logged By: I.L.
 Drilling Contractor: PSI, Inc.

Sample Types:

- Shelby Tube
- Hand Auger
- Calif. Sampler
- Texas Cone
- Auger Cutting
- Split-Spoon
- Rock Core

Latitude:
 Longitude:
 Drill Rig: CME-75
 Remarks:

The stratification lines represent approximate boundaries. The transition may be gradual.



Professional Service Industries, Inc.
 7950 N.W. 64th Street
 Miami, FL 33166
 Telephone: (305) 471-7725
 Fax: (305) 593-1915

LOG OF BORING B-2

Sheet 1 of 1

PSI Job No.: 0397-923
 Project: Three Island Reuse Irrigation Project
 Location: Hallandale Beach
 Florida

Drilling Method: SPT
 Sampling Method: SS
 Hammer Type: Automatic
 Boring Location: Refer to Sheet 3

WATER LEVELS	
▽ While Drilling	1.8 feet
▽ Upon Completion	1.8 feet
▽ Delay	N/A

Elevation (feet)	Depth (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	Station: N/A Offset: N/A	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	STANDARD PENETRATION TEST DATA		Additional Remarks
										Moisture, %	Moisture, %	
0				1			Asphalt	GP	15-7-7-6 N=14	⊙		
				2			Light Brown/Gray LIMEROCK with Fine Sand Light Brown/Gray Fine SAND with Limerock	SP	3-3-4-3 N=7	⊙		
	5			3			Sandy SILT with Traces of Peat Natural Moisture Content: 75% Passing No. 200 Sieve: 47%	ML	1-1-1-1 N=2	⊙		
				4				ML	1-1-1-1 N=2	⊙		
	10			5			Light Brown/Gray Fine SAND	SP	1-1-3-4 N=4	⊙		
	15			6			Light Brown/Gray LIMESTONE with Fine Sand		6-7-8 N=15	⊙		
	20			7			Light Brown/Gray LIMESTONE with Silty Fine Sand		3-4-4 N=8	⊙		
	25			8					4-2-1 N=3	⊙		
	30			9			Light Brown/Gray Fine SAND	SP	W.O.H N=0	⊙		
				10				SP	W.O.H N=0	⊙		
				11					1-2-2 N=4	⊙		
	35			12			Light Brown/Gray Fine SAND with Limestone Lenses/Layers	SP	3-4-4 N=8	⊙		
	40			13			Light Brown/Gray LIMESTONE with Fine Sand		10-18-(50/2") N=50/2"	>>⊙		

Completion Depth: 40.0 ft
 Date Boring Started: 5/7/15
 Date Boring Completed: 5/7/15
 Logged By: I.L.
 Drilling Contractor: PSI, Inc.

Sample Types:

- Auger Cutting
- Split-Spoon
- Rock Core
- Shelby Tube
- Hand Auger
- Calif. Sampler
- Texas Cone

Latitude:
 Longitude:
 Drill Rig: CME-75
 Remarks:

The stratification lines represent approximate boundaries. The transition may be gradual.



Professional Service Industries, Inc.
 7950 N.W. 64th Street
 Miami, FL 33166
 Telephone: (305) 471-7725
 Fax: (305) 593-1915

LOG OF BORING B-3

Sheet 1 of 1

PSI Job No.: 0397-923
 Project: Three Island Reuse Irrigation Project
 Location: Hallandale Beach
 Florida

Drilling Method: SPT
 Sampling Method: SS
 Hammer Type: Automatic
 Boring Location: Refer to Sheet 3

WATER LEVELS	
▽ While Drilling	2.4 feet
▽ Upon Completion	2.4 feet
▽ Delay	N/A

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	Station: N/A Offset: N/A	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	STANDARD PENETRATION TEST DATA		Additional Remarks
										Moisture, %	Moisture, %	
0	0	Asphalt		1			Light Brown/Gray LIMEROCK with Fine Sand	GP	25-18-15-15 N=33	○		
	2			2					7-5-4-3 N=9	○		
	5			3			Sandy SILT with Traces of Peat Natural Moisture Content: 67% Passing No. 200 Sieve: 34%	ML	1-1-1-1 N=2	○		
				4					(W.O.H.) N=0	○		
	10			5			Light Brown/Gray Fine SAND	SP	1-1-5-6 N=6	○		
	15			6			Light Brown/Gray LIMESTONE with Fine Sand		7-8-8 N=16	○		

Completion Depth: 15.0 ft
 Date Boring Started: 5/7/15
 Date Boring Completed: 5/21/15
 Logged By: I.L.
 Drilling Contractor: PSI, Inc.

Sample Types:

- Shelby Tube
- Hand Auger
- Calif. Sampler
- Texas Cone
- Auger Cutting
- Split-Spoon
- Rock Core

Latitude:
 Longitude:
 Drill Rig: CME-75
 Remarks:

The stratification lines represent approximate boundaries. The transition may be gradual.



Professional Service Industries, Inc.
 7950 N.W. 64th Street
 Miami, FL 33166
 Telephone: (305) 471-7725
 Fax: (305) 593-1915

LOG OF BORING B-4

Sheet 1 of 1

PSI Job No.: 0397-923
 Project: Three Island Reuse Irrigation Project
 Location: Hallandale Beach
 Florida

Drilling Method: SPT
 Sampling Method: SS
 Hammer Type: Automatic
 Boring Location: Refer to Sheet 3

WATER LEVELS	
▽ While Drilling	4.3 feet
▽ Upon Completion	4.3 feet
▽ Delay	N/A

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	Station: N/A Offset: N/A	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	STANDARD PENETRATION TEST DATA		Additional Remarks
										Moisture, %	Strength, tsf	
0				1			Asphalt		15-10-7-8 N=17	⊙		
				2			Light Brown/Gray LIMEROCK with Fine Sand	GP	10-6-6-5 N=12	⊙		
				3	4.3				2-2-2-2 N=4	⊙		
				4					2-2-2-2 N=4	⊙		
				5			Sandy SILT with Traces of Peat Natural Moisture Content: 88% Passing No. 200 Sieve: 86%	ML	1-1-1-1 N=2	⊙		
				6			Light Brown/Gray Fine SAND	SP	1-1-2-4 N=3	⊙		
				7			Light Brown/Gray LIMESTONE with Fine Sand		6-6-8 N=14	⊙		

Completion Depth: 15.0 ft
 Date Boring Started: 5/7/15
 Date Boring Completed: 5/7/15
 Logged By: I.L.
 Drilling Contractor: PSI, Inc.

Sample Types:

- Auger Cutting
- Split-Spoon
- Rock Core
- Shelby Tube
- Hand Auger
- Calif. Sampler
- Texas Cone

Latitude:
 Longitude:
 Drill Rig: CME-75
 Remarks:

The stratification lines represent approximate boundaries. The transition may be gradual.

Material Property Data Sheet

CONTECH C-60NW Nonwoven Geotextile

CONTECH® C-60NW is a polypropylene, staple fiber, needle punched nonwoven geotextile. The fibers are needled to form a stable network that retains dimensional stability relative to each other. The geotextile is resistant to ultraviolet degradation and to biological and chemical environments normally found in soils. CONTECH C-60NW conforms to the property values listed below which have been derived from quality control testing.

PROPERTY	TEST METHOD	MINIMUM AVERAGE ROLL VALUES ²	
		<i>English</i>	<i>Metric</i>
<u>Mechanical</u>			
Grab Tensile Strength	ASTM D-4632	160 lbs	712 N
Grab Elongation	ASTM D-4632	50 %	50 %
Trapezoidal Tear	ASTM D-4533	60 lbs	267 N
CBR Puncture Resistance	ASTM D-6241	410 lbs	1824 N
<u>Hydraulic</u>			
Apparent Opening Size (AOS) ³	ASTM D-4751	70 US Std. Sieve	0.212 mm
Permittivity	ASTM D-4491	1.5 Sec ⁻¹	1.5 Sec ⁻¹
Water Flow Rate	ASTM D-4491	110 gpm/ft ²	4480 l/min/m ²
<u>Endurance</u>			
UV Resistance (% Retained at 500 hrs)	ASTM D-4355	70 %	70 %

NOTES:

1. The property values listed above are effective 7/7/10 and are subject to change without notice.
2. Values reported in weaker principal direction. All values listed are Minimum Average Roll Values (MARV) unless otherwise noted, calculated as the typical minus two standard deviations. Statistically, it yields a 97.7% degree of confidence that any samples taken from quality assurance testing will exceed the value reported.

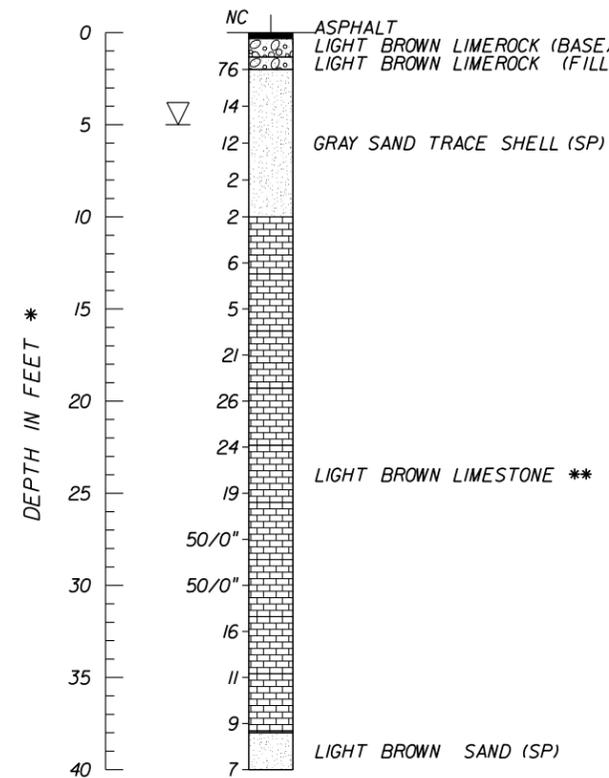
APPENDIX B



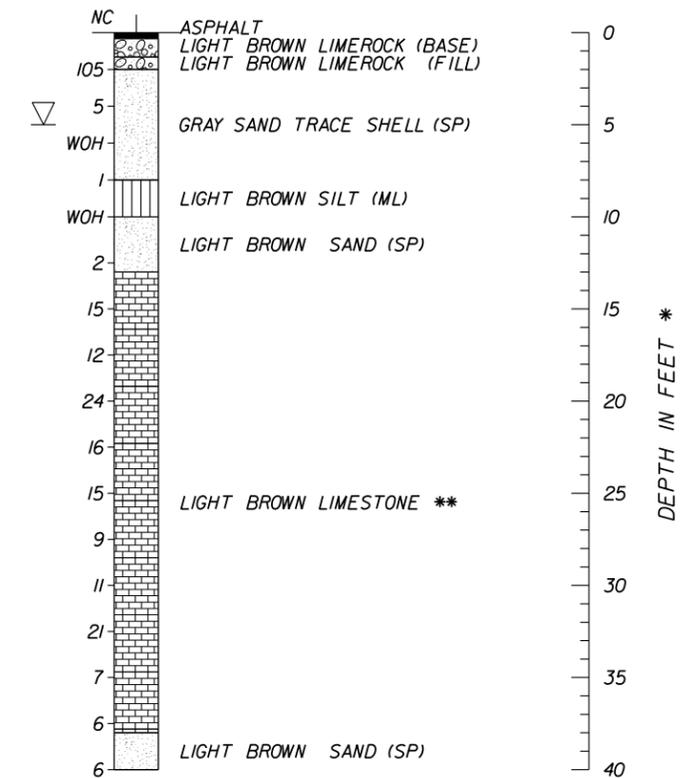
BORINGS LOCATION PLAN

BOR # B-1
 DATE 10/28/2015
 HAMMER Auto
 RIG CME-55

BOR # B-2
 DATE 10/28/2015
 HAMMER Auto
 RIG CME-55



Boring Terminated at Depth of 40ft



Boring Terminated at Depth of 40ft

LEGEND

- Approximate Location of SPT Borings**
- Asphalt
- Sandy Gravel
- Sand
- Limestone
- Silt

NOTES

- ▽ ENCOUNTERED GROUNDWATER TABLE
- NC NUMBERS TO THE LEFT OF BORINGS INDICATED CORRECTED SPT VALUE FOR 12" PENETRATION USING AN AUTOMATIC HAMMER CORRECTION FACTOR OF 1.24
- * DENOTES DEPTH IN FEET FROM EXISTING GROUND SURFACE
- ** DENOTES SANDY LIMESTONE LAYER, THIS MATERIAL TYPICALLY OFFER HIGH RESISTANCE TO DRILLING AND EXCAVATION.

WOH WEIGHT OF HAMMER

DRAWN BY:
NG
 CHECKED BY:
MP

APPROVED BY:
RK
 DATE:
10/16/2015

ENGINEER OF RECORD:
RAJ KRISHNASAMY, P.E.
 FLORIDA LICENSE NO.:
53567



RAJ KRISHNASAMY, P.E.
 P.E. LICENSE NUMBER 53567
 TIERRA SOUTH FLORIDA
 2765 VISTA PARKWAY, S-10
 WEST PALM BEACH, FL 33411
 CERTIFICATE OF AUTHORIZATION 28073

SCALE:
NTS

PROJECT NUMBER:
7111-15-350

GEOTECHNICAL ENGINEERING SERVICES

THREE ISLANDS IRRIGATION

HALLANDALE BEACH, FLORIDA

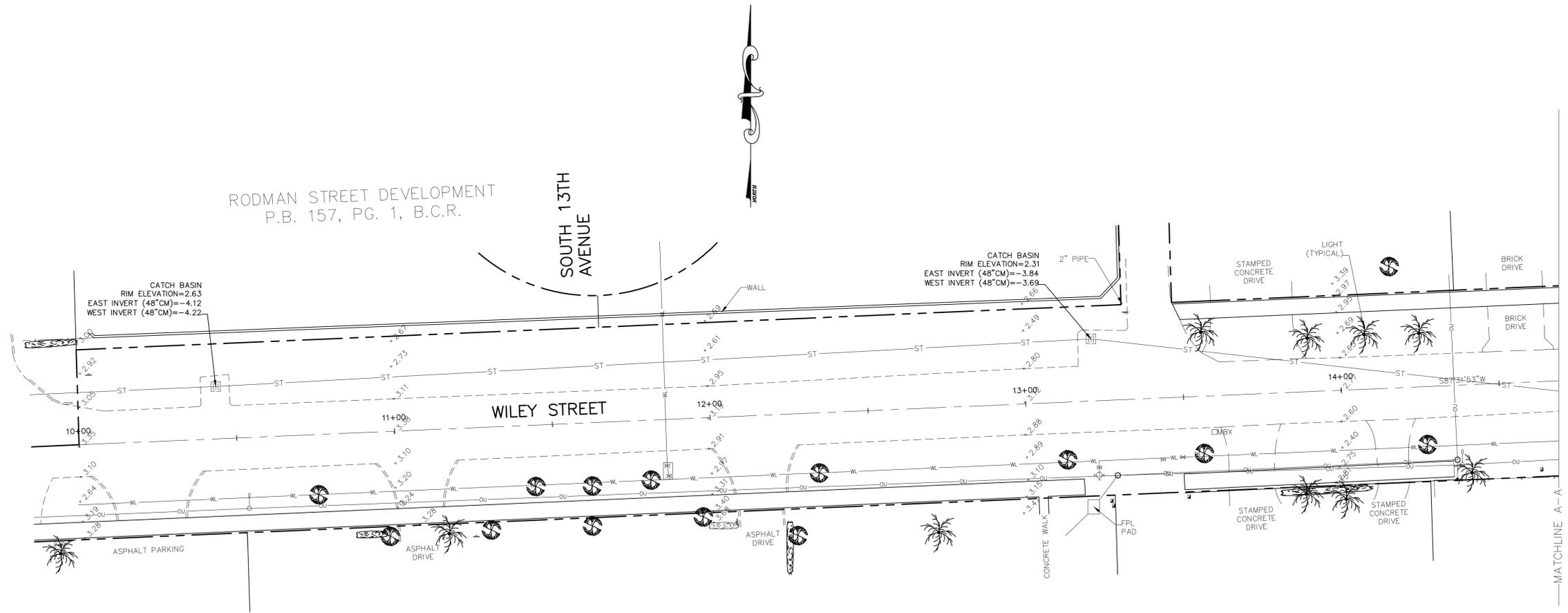
Sheet:

1

APPENDIX C
NOT SUBMITTED
FOR THIS
PROJECT

APPENDIX D

LEGEND		LEGEND	
	FLAG POLE		CONCRETE
	CABLE TV RISER		OFFICIAL RECORD BOOK
	TELEPHONE RISER		BROWARD COUNTY RECORDS
	SIAMESE CONNECTION		TREE (TYPE, SIZE, SPREAD)(EX: B.O.=BLACK OLIVE, UNK=UNKNOWN)
	BACKFLOW PREVENTOR		BUSH
	BOLLARD		HEDGE
	ELECTRIC BOX		PALM TREE (TRUNK SIZE VARIES 5"-24")
	METAL LIGHT POLE		LIGHT POLE
	GATE VALVE/TOP VALVE/TOP LID		ELECTRIC HANDHOLE
	WATER METER		INDICATES CORNERS FOUND (FOUND IRON PIPE, FOUND IRON ROD, FOUND IRON ROD & CAP, FOUND NAIL & DISC)
	FIRE HYDRANT ASSEMBLY		INDICATES BENCHMARK/ELEVATION (NAVD88) (SET NAIL & TAB)
	MANHOLE - SEE SURVEY		
	CB		
	WOOD POWER POLE		
	CONCRETE POWER POLE		
	ANCHOR/GUY WIRE		
	CONCRETE LIGHT POLE		
	TRAFFIC SIGN POST		
	CLEANOUT		
	MAIL BOX		
			CONCRETE POWER POLE
			METAL FENCE
			WOOD FENCE
			BURIED CABLE
			BURIED TELEPHONE
			BURIED FORCE MAIN
			BURIED WATER LINE
			BURIED ELECTRIC
			BURIED GAS LINE
			OVERHEAD UTILITY
			CENTERLINE
			RIGHT-OF-WAY LINE
			LIMITED ACCESS RIGHT-OF-WAY LINE
			CONCRETE WALL
			PVC FENCE
			OVERHEAD SIGNALS
			REUSED WATERLINE



UTILITY DISCLAIMER:

WITH REGARD TO OBSERVED EVIDENCE (SURVEYED LOCATIONS) OF ALL UTILITIES SHOWN ON THIS SURVEY:

INFORMATION FROM PLANS AND MARKINGS HAVE BEEN COMBINED WITH ABOVE-GROUND, VISIBLE EVIDENCE OF UTILITIES, TOGETHER WITH GEOPHYSICAL METHODS (MAGNETIC TRACING) TO DEVELOP A VIEW OF UNDERGROUND UTILITIES, (AS SHOWN HEREON BY THEIR RESPECTIVE LINE TYPES). HOWEVER, LACKING EXCAVATION, THE EXACT LOCATION OF UNDERGROUND FEATURES CANNOT BE ACCURATELY, COMPLETELY AND RELIABLY DEPICTED. WHERE ADDITIONAL OR MORE DETAILED INFORMATION IS REQUIRED, THE CLIENT IS HEREBY ADVISED THAT EXCAVATION MAY BE NECESSARY.

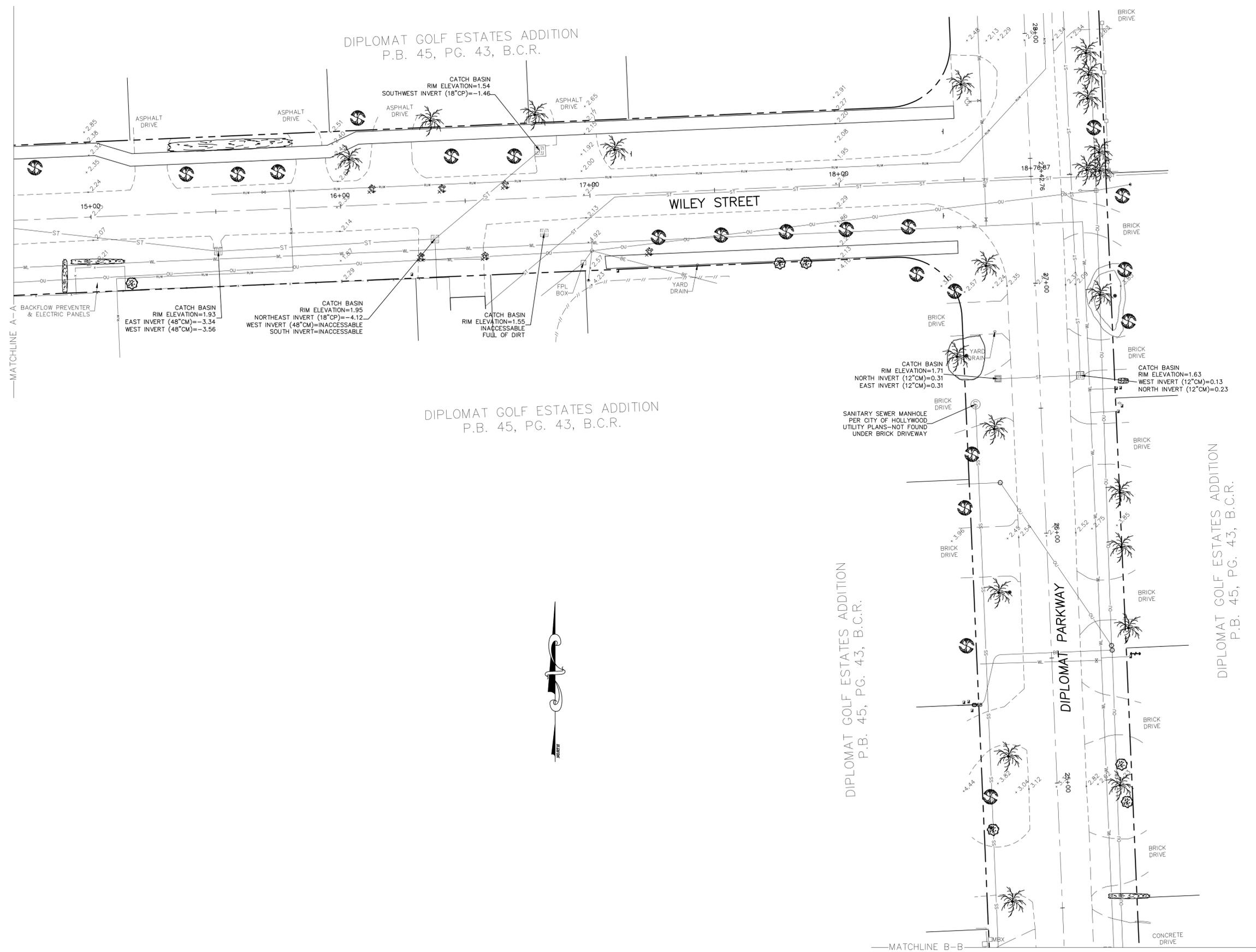
- NOTES
- 1) THE LAND DESCRIPTION SHOWN HEREON WAS PROVIDED BY THE CLIENT. EASEMENTS AND RIGHTS-OF-WAY PER RECORD PLAT HAVE BEEN SHOWN HEREON. NO FURTHER SEARCH FOR MATTERS OF RECORD HAS BEEN MADE BY THIS FIRM.
 - 2) THIS SURVEY IS PREPARED FOR THE SOLE AND EXCLUSIVE USE OF THE PARTIES AS SURVEYED FOR AND AS CERTIFIED TO AND SHALL NOT BE RELIED UPON BY ANY OTHER ENTITY OR INDIVIDUAL.
 - 3) ELEVATIONS SHOWN HEREON ARE BASED ON NORTH AMERICAN VERTICAL DATUM OF 1988.
 - 4) BENCHMARK NGS MONUMENT PID AD2430, ELEVATION=1.68, NAVD88 AT NORTHEAST CORNER OF HOLLYWOOD BOULEVARD AND N. 9TH AVENUE.
 - 5) NORTH ARROW RELATIVE TO ASSUMED S.87°31'53"W. ALONG THE CENTERLINE OF WILEY STREET.

FEMA FLOOD INSURANCE RATE MAP		COMMUNITY NO.		REVISION		DATE		BY	
CITY OF HOLLYWOOD		N/A							
BROWARD COUNTY, FLORIDA		N/A							
PANEL NO.	SUFFIX	ZONE	FIRM DATE	BASE ELEV. FLR. ELEV.	LOWEST	AVG. GRD.			
N/A	N/A	N/A	N/A	N/A	N/A	N/A			

SKETCH OF TOPOGRAPHIC SURVEY		
JOB #: RN8083	DATE: 10-18-12	DRAWN BY: SHG
SCALE: 1"=20'	SHEET 1 OF 5	CHECKED BY: SKS
NOT VALID WITHOUT THE SIGNATURE AND ORIGINAL RAISED SEAL OF THE FLORIDA LICENSED SURVEYOR AND MAPPER		

STEPHEN K. SEELEY, FOR THE FIRM
 PROFESSIONAL SURVEYOR & MAPPER
 FLORIDA REGISTRATION NO. 4574

GIBBS LAND SURVEYORS
 2131 HOLLYWOOD BOULEVARD, SUITE 204
 HOLLYWOOD, FL 33020 (954) 923-7666
 LICENSED BUSINESS NO. 7018



MATCHLINE A-A

MATCHLINE B-B

- NOTES
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FEMA FLOOD INSURANCE RATE MAP		COMMUNITY NO.	
CITY OF HOLLYWOOD		N/A	
BROWARD COUNTY, FLORIDA		N/A	
PANEL NO.	SUFFIX	ZONE	DATE
N/A	N/A	N/A	N/A

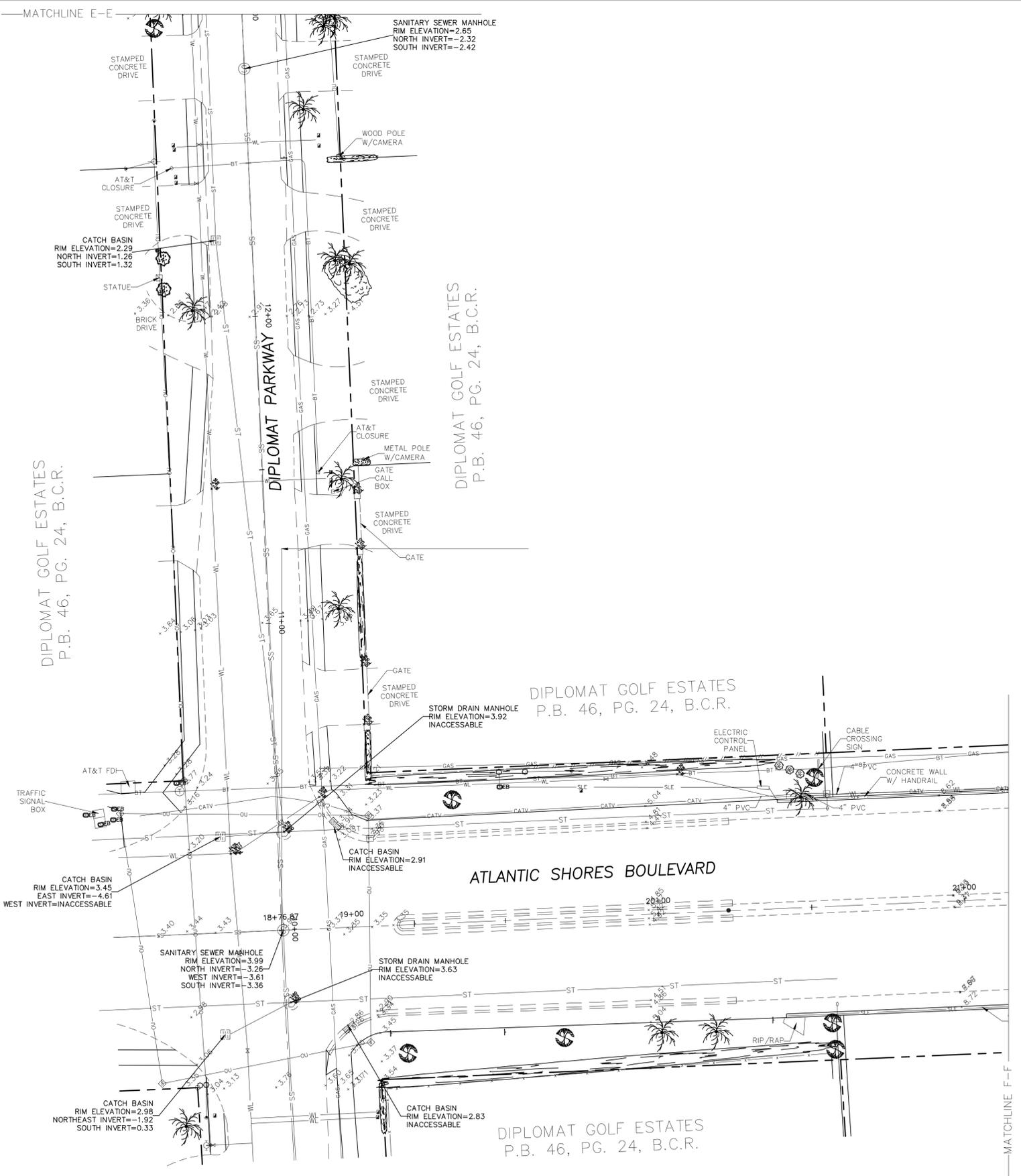
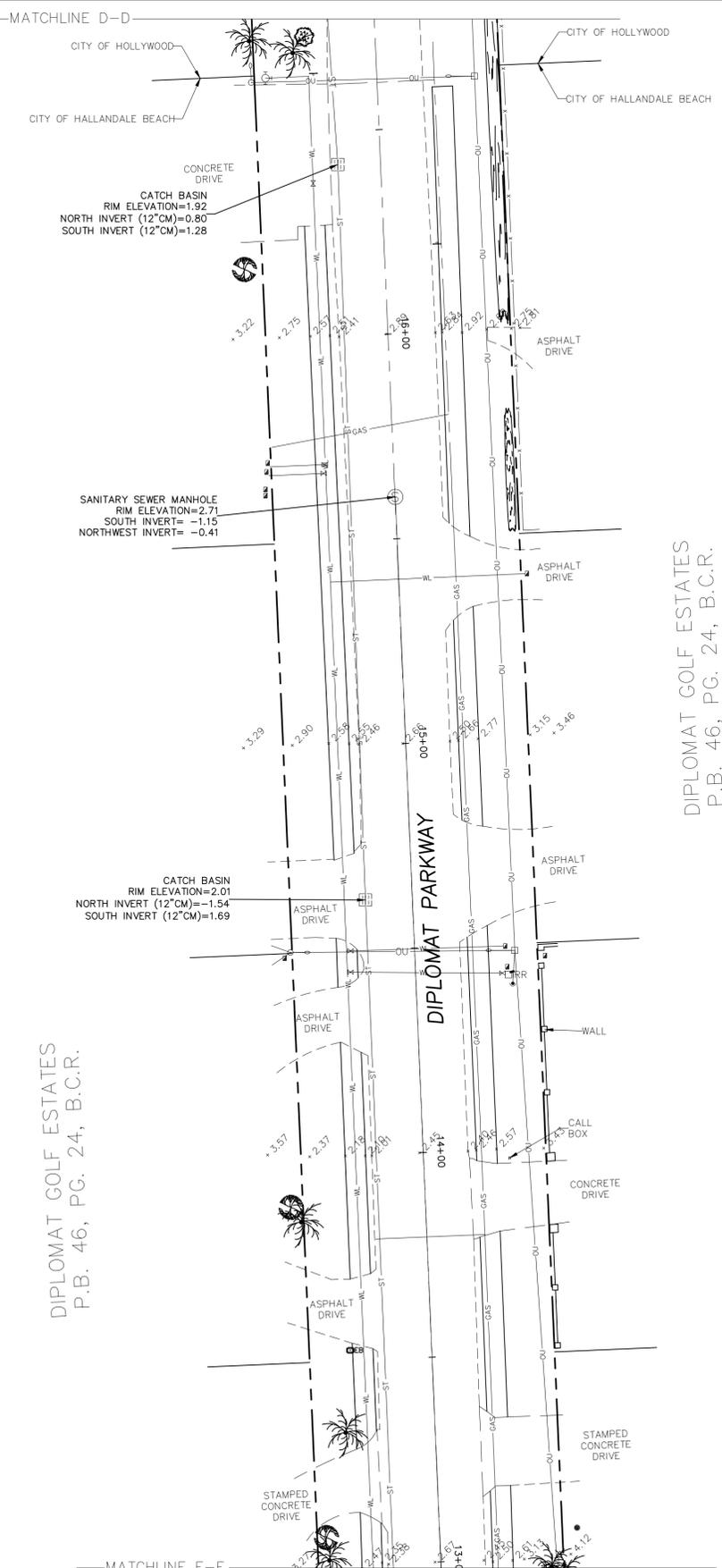
REVISION	DATE	BY

SKETCH OF TOPOGRAPHIC SURVEY		
JOB #: RN8083	DATE: 10-18-12	DRAWN BY: SHG
SCALE: 1"=20'	SHEET 2 OF 5	CHECKED BY: SKS

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 FLORIDA REGISTRATION NO. 4574

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 HOLLYWOOD, FL 33020 (954) 923-7666
 LICENSED BUSINESS NO. 7018

NOT VALID WITHOUT THE SIGNATURE AND ORIGINAL RAISED SEAL OF THE FLORIDA LICENSED SURVEYOR AND MAPPER



DIPLOMAT GOLF ESTATES
P.B. 46, PG. 24, B.C.R.

ATLANTIC SHORES BOULEVARD

DIPLOMAT GOLF ESTATES
P.B. 46, PG. 24, B.C.R.

- NOTES
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FEMA FLOOD INSURANCE RATE MAP				COMMUNITY NO.	
CITY OF HOLLYWOOD				N/A	
BROWARD COUNTY, FLORIDA				N/A	
PANEL NO.	SUFFIX	ZONE	FIRM DATE	BASE ELEV. FLR. ELEV.	AVG. GRD.
N/A	N/A	N/A	N/A	N/A	N/A

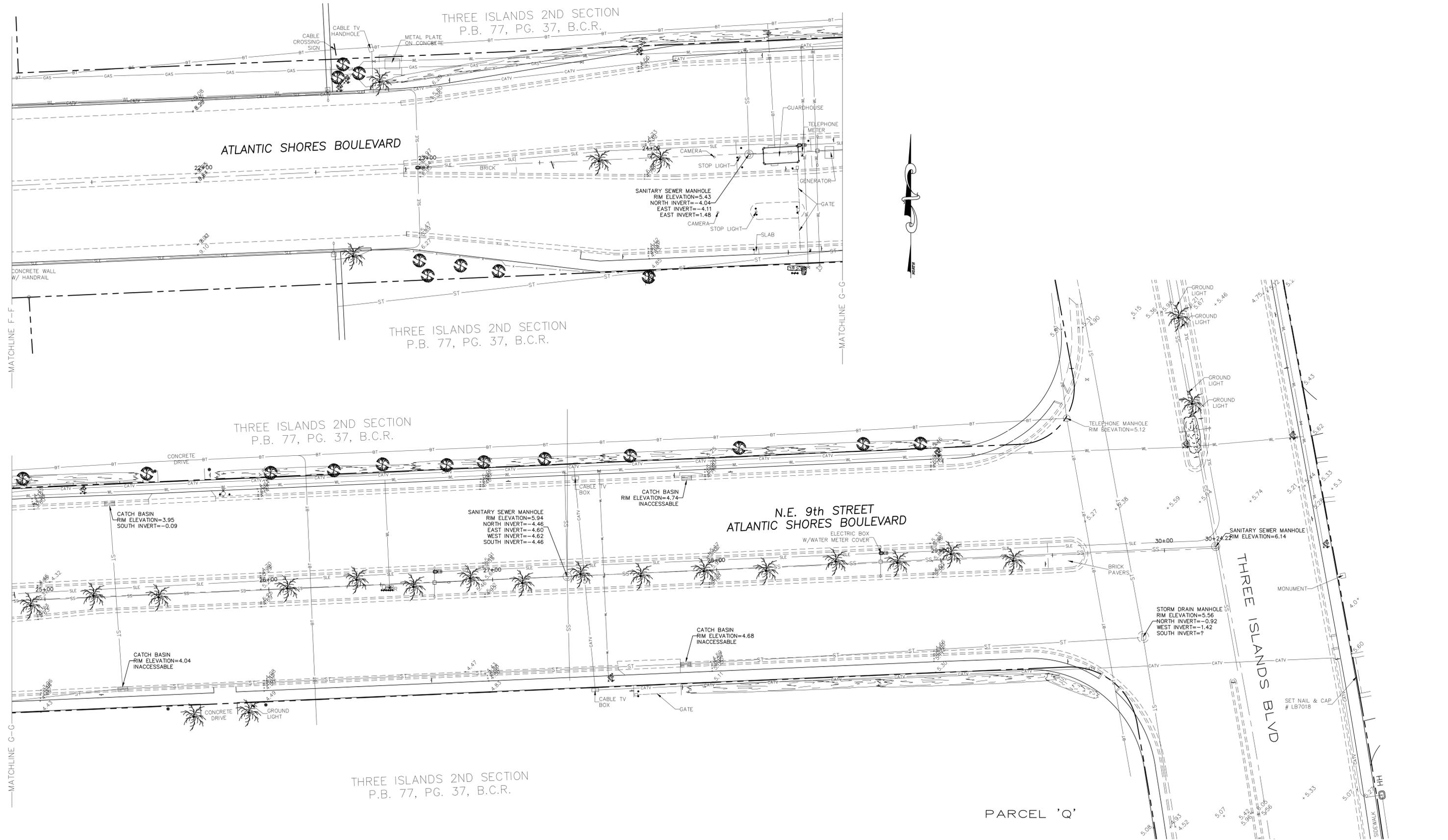
REVISION	DATE	BY

SKETCH OF TOPOGRAPHIC SURVEY		
JOB #: RN8083	DATE: 10-18-12	DRAWN BY: SHG
SCALE: 1"=20'	SHEET 4 OF 5	CHECKED BY: SKS

STEPHEN K. SEELEY, FOR THE FIRM
PROFESSIONAL SURVEYOR & MAPPER
FLORIDA REGISTRATION NO. 4574

GIBBS LAND SURVEYORS
2131 HOLLYWOOD BOULEVARD, SUITE 204
HOLLYWOOD, FL 33020 (954) 923-7666
LICENSED BUSINESS NO. 7018

NOT VALID WITHOUT THE SIGNATURE AND ORIGINAL RAISED SEAL OF THE FLORIDA LICENSED SURVEYOR AND MAPPER



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FEMA FLOOD INSURANCE RATE MAP				COMMUNITY NO.		REVISION		DATE		BY	
CITY OF HOLLYWOOD				N/A							
BROWARD COUNTY, FLORIDA				N/A							
PANEL NO.	SUFFIX	ZONE	FIRM DATE	BASE ELEV.	LOWEST FLR. ELEV.	AVG. GRD.					
N/A	N/A	N/A	N/A	N/A	N/A	N/A					

SKETCH OF TOPOGRAPHIC SURVEY		
JOB #: RN8083	DATE: 10-18-12	DRAWN BY: SHG
SCALE: 1"=20'	SHEET 5 OF 5	CHECKED BY: SKS

STEPHEN K. SEELEY, FOR THE FIRM
 PROFESSIONAL SURVEYOR & MAPPER
 FLORIDA REGISTRATION NO. 4574

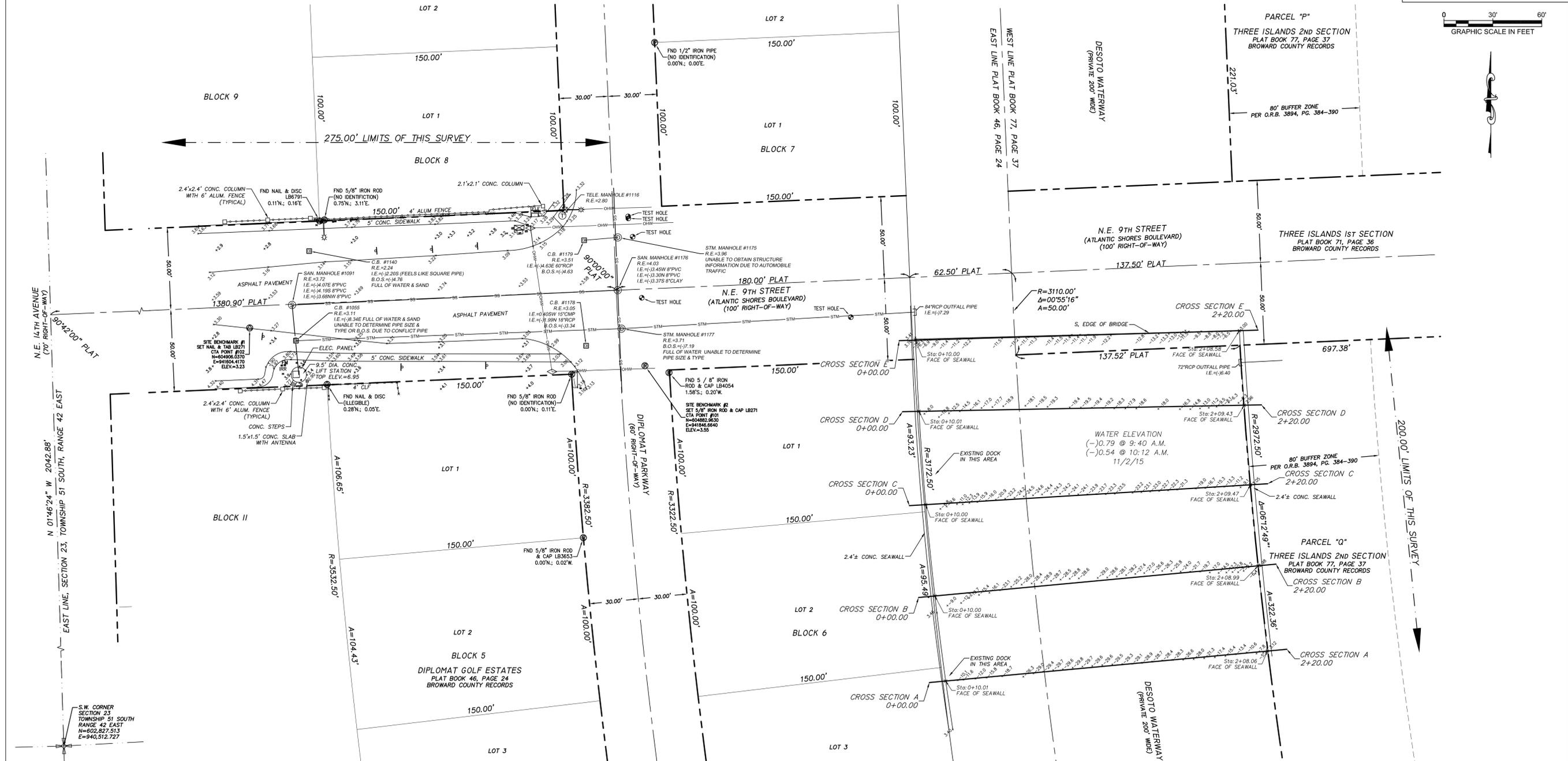
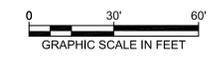
GIBBS LAND SURVEYORS
 2131 HOLLYWOOD BOULEVARD, SUITE 204
 HOLLYWOOD, FL 33020 (954) 923-7666
 LICENSED BUSINESS NO. 7018

NOT VALID WITHOUT THE SIGNATURE AND ORIGINAL RAISED SEAL OF THE FLORIDA LICENSED SURVEYOR AND MAPPER

APPENDIX E

SKETCH OF SURVEY TOPOGRAPHIC SURVEY

NOTE: The undersigned and CRAVEN THOMPSON & ASSOCIATES, INC. make no representations or guarantees as to the information reflected herein pertaining to easements, right-of-way, set back lines, reservations, agreements and other similar matters, and this instrument is not intended to reflect or set forth all such matters. Such information should be obtained and further confirmed by others through appropriate title verification.
NOTE: Lands shown hereon were not abstracted for right-of-way and/or easements of record.



SURVEYOR'S NOTES:

- THE BEARINGS AND COORDINATE VALUES SHOWN HEREON ARE BASED ON THE NORTH AMERICAN DATUM OF 1983/1990 (NAD 83/90), STATE PLANE COORDINATE SYSTEM (FLORIDA EAST ZONE) AND REFERENCED TO THE SOUTHWEST CORNER OF SECTION 23, TOWNSHIP 51 SOUTH RANGE 42 EAST AS DETERMINED BY EASTERN BROWARD HORIZONTAL GPS NETWORK CONTROL, ESTABLISHED BY BROWARD COUNTY ENGINEERING DEPARTMENT, SURVEY SECTION.
- THE LEGAL DESCRIPTION SHOWN HEREON WAS PREPARED BY THIS OFFICE.
- ALL EASEMENTS SHOWN HEREON ARE PER THE RECORD PLAT UNLESS OTHERWISE NOTED.
- THIS SURVEY WAS PREPARED UNDER THE BENEFIT OF A TITLE SEARCH, THEREFORE ONLY THOSE EASEMENTS ON THE RECORD PLAT ARE SHOWN UNLESS OTHERWISE NOTED. INFORMATION REGARDING EASEMENTS, RIGHTS-OF-WAY, AND/OR OWNERSHIP WAS NOT PROVIDED TO OR PURSUED BY THE UNDERSIGNED. ENCUMBRANCES OTHER THAN SHOWN HEREON MAY EXIST. THIS SURVEY IS SUBJECT TO PERTINENT EASEMENTS, RIGHTS-OF-WAY AND RESTRICTIONS OF RECORD, IF ANY.
- THIS SURVEY MEETS AND EXCEEDS THE LINEAR CLOSURE OF 1 IN 10,000 FEET FOR SURVEYS AND COMMERCIAL/HIGH RISK SURVEYS AS DEFINED IN THE FLORIDA STANDARDS OF PRACTICE (5J-17.051 AND 5J-17.052, F.A.C.). THE ACCURACY OBTAINED BY MEASUREMENT AND CALCULATION OF A CLOSED GEOMETRIC FIGURE WAS FOUND TO EXCEED THIS REQUIREMENT.
- THIS SURVEY IS LIMITED TO THE LOCATION OF ABOVE GROUND IMPROVEMENTS ONLY. UNDERGROUND UTILITIES, FOUNDATIONS OR OTHER BURIED ENCROACHMENTS WERE NOT LOCATED IN CONNECTION WITH THIS SURVEY UNLESS OTHERWISE NOTED.
- THE TOPOGRAPHICAL MEASUREMENTS SHOWN WERE OBTAINED USING A 'LEICA TC-700 SERIES' TOTAL STATION AND 'SPECTRA PRECISION' SURVEY PRO DATA COLLECTION SOFTWARE. THE ACCURACY OF CONTROL SURVEY DATA HAS BEEN VERIFIED BY REDUNDANT MEASUREMENTS OR TRAVERSE CLOSURES.
- THIS SURVEY DRAWING WAS PREPARED FOR THE EXCLUSIVE USE OF THE CITY OF HALLANDALE BEACH FOR THE EXPRESS PURPOSES STATED HEREON AND/OR CONTAINED IN THE CONTRACT WITH THE AFOREMENTIONED CLIENT FOR THIS PROJECT. REUSE OF THIS SURVEY FOR PURPOSES OTHER THAN WHICH IT WAS INTENDED, WITHOUT WRITTEN PERMISSION, WILL BE AT THE RE-USERS SOLE RISK AND WITHOUT LIABILITY TO THE SURVEYOR. NOTHING SHOWN HEREON SHALL BE CONSTRUED TO GIVE RIGHTS OR BENEFITS TO ANYONE OTHER THAN THOSE CERTIFIED TO.
- SHEET V-1 OF THIS MAP IS INTENDED TO BE DISPLAYED AT A SCALE OF 1"=30' OR SMALLER. THE HORIZONTAL FEATURES SHOWN HEREON ARE PLOTTED WITHIN 1/20 OF THE MAP SCALE. HORIZONTAL FEATURE LOCATIONS ARE TO THE CENTER OF THE SYMBOL AND MAY BE ENLARGED FOR CLARITY AND MAY NOT REPRESENT THE ACTUAL SIZE OR SHAPE OF THE FEATURE.
- ADDITIONS AND DELETIONS TO SURVEY MAPS AND REPORTS BY OTHER THAN THE SIGNING PARTY OR PARTIES IS PROHIBITED WITHOUT WRITTEN CONSENT OF THE UNDERSIGNED. THIS DOCUMENT CONSISTS OF 2 SHEETS AND EACH SHEET SHALL NOT BE CONSIDERED FULL, VALID AND COMPLETE UNLESS ATTACHED TO THE OTHERS.
- THE ELEVATIONS SHOWN HEREON ARE FOR THE PURPOSE OF INDICATING THE GROUND ELEVATION ONLY AT THE POSITION SHOWN AND IN NO WAY INDICATE ELEVATIONS AT ANY OTHER POINT THAN THAT SHOWN HEREON AND DO NOT DETERMINE SUBSURFACE CONDITIONS.
- THE ELEVATIONS SHOWN HEREON ARE BASED ON THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88) AND REFERENCED TO THE FOLLOWING BENCHMARK: STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION BENCHMARK HEMI SHOWN ON PROJECT NETWORK CONTROL PLAN, FINANCIAL PROJECT NO. 228034-52-14, DATED SEPTEMBER 26, 2002. AN FDOT DISK STAMPED B-01, 5-86-97, ELEVATION = 1.328 (METRIC) 4.357 (CONVERTED).

ABBREVIATION LEGEND:

- A ARC DISTANCE
- Δ DELTA ANGLE
- ALUM. ALUMINUM
- B.O.S. BOTTOM OF STRUCTURE
- C.B. CATCH BASIN
- CONC. CONCRETE
- CLP CHAIN LINK FENCE
- CMP CORRUGATED METAL PIPE
- CTA CRAVEN-THOMPSON & ASSOCIATES, INC.
- DIA. DIAMETER
- ELEC. ELECTRIC
- ELEV. ELEVATION
- FDOT FLORIDA DEPARTMENT OF TRANSPORTATION
- FND. FOUND
- INVERT INVERT ELEVATION
- LB LICENSED BUSINESS
- O.R.B. OFFICIAL RECORDS BOOK
- PG. PAGE
- PVC POLYVINYL CHLORIDE PIPE
- RCP RADIUS DISTANCE
- R.F. REINFORCED CONCRETE PIPE
- R.M. RIM ELEVATION
- SAN. SANITARY
- STM. STORM
- STA. STATION
- TELE. TELEPHONE

CONTROL LEGEND:

- ⊙ IRON PIPE
- ⊙ IRON ROD
- ⊙ NAIL & TAB

SYMBOL LEGEND:

- ⊙ ANCHOR
- ⊙ CATCH BASIN
- ⊙ CONCRETE LIGHT POLE
- ⊙ ELECTRICAL PULL BOX
- ⊙ FORCE MAIN VALVE
- ⊙ IRRIGATION CONTROL VALVE
- ⊙ OUTFALL
- ⊙ PLUG
- ⊙ SANITARY MANHOLE
- ⊙ SIGN
- ⊙ STORM MANHOLE
- ⊙ TELEPHONE MANHOLE
- ⊙ TEST HOLES
- ⊙ TRAFFIC SIGNAL CONTROL BOX OR CABINET
- ⊙ TRAFFIC SIGNAL POLE
- ⊙ TRAFFIC SIGNAL PULL BOX
- ⊙ WATER METER
- ⊙ WATER VALVE
- ⊙ WOOD LIGHT POLE
- ⊙ WOOD TELEPHONE POLE
- ⊙ ALUMINUM FENCE
- ⊙ OVER HEAD WIRES
- ⊙ STORM SEWER PIPE
- ⊙ SANITARY SEWER PIPE
- ⊙ CHAIN LINK FENCE

DESCRIPTION:

THAT PORTION OF THE 200.00 FOOT WIDE DESOTO WATERWAY, DIPLOMAT GOLF ESTATES, ACCORDING TO THE PLAT THEREOF, AS RECORDED IN PLAT BOOK 46, PAGE 24, AND THREE ISLANDS 2ND SECTION, ACCORDING TO THE PLAT THEREOF, AS RECORDED IN PLAT BOOK 77, PAGE 37, BOTH OF THE PUBLIC RECORDS OF BROWARD COUNTY, FLORIDA, LYING SOUTH OF, AND WITHIN 200.00 FEET OF THE SOUTH FACE OF THE EXISTING BRIDGE ON N.E. 9th STREET.

TOGETHER WITH:

THAT PORTION OF THE 200.00 FOOT WIDE DESOTO WATERWAY, DIPLOMAT GOLF ESTATES, ACCORDING TO THE PLAT THEREOF, AS RECORDED IN PLAT BOOK 46, PAGE 24, AND THREE ISLANDS 2ND SECTION, ACCORDING TO THE PLAT THEREOF, AS RECORDED IN PLAT BOOK 77, PAGE 37, BOTH OF THE PUBLIC RECORDS OF BROWARD COUNTY, FLORIDA, LYING SOUTH OF, AND WITHIN 200.00 FEET OF THE SOUTH FACE OF THE EXISTING BRIDGE ON N.E. 9th STREET.

SAID LANDS SITUATE, LYING AND BEING IN THE CITY OF HALLANDALE, BROWARD COUNTY, FLORIDA.

SEE SHEET V-2 FOR DESOTO WATERWAY PROFILE SECTION.

THE ELEVATIONS SHOWN HEREON ARE BASED ON THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88).

SURVEYOR'S CERTIFICATE:

I HEREBY CERTIFY THAT THIS SKETCH OF SURVEY AND OTHER PERTINENT DATA SHOWN HEREON, OF THE ABOVE DESCRIBED PROPERTY WAS MADE ON THE GROUND, CONFORMS TO THE STANDARDS OF PRACTICE FOR LAND SURVEYING IN THE STATE OF FLORIDA, AS OUTLINED IN RULES 5J-17.051 AND 5J-17.052, (FLORIDA ADMINISTRATIVE CODE) AS ADOPTED BY THE DEPARTMENT OF AGRICULTURE AND CONSUMER SERVICES, BOARD OF PROFESSIONAL SURVEYORS AND MAPPERS IN SEPTEMBER, 1981, AS AMENDED, PURSUANT TO CHAPTER 472.027, FLORIDA STATUTES AND THAT SAID SURVEY IS TRUE AND CORRECT TO THE BEST OF OUR KNOWLEDGE AND BELIEF AS SURVEYED UNDER OUR DIRECTION IN NOVEMBER 2015.

LAST DATE OF FIELD WORK: NOVEMBER 2, 2015

CRAVEN THOMPSON & ASSOCIATES, INC.
CERTIFICATE OF AUTHORIZATION NO. LB271

THOMAS C. SHAHAN-FOR THE FIRM
PROFESSIONAL SURVEYOR & MAPPER NO. 4387
STATE OF FLORIDA

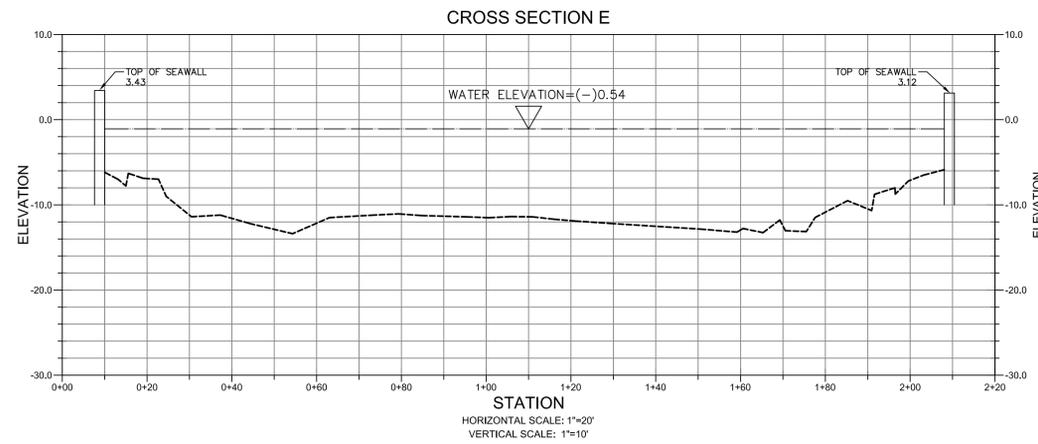
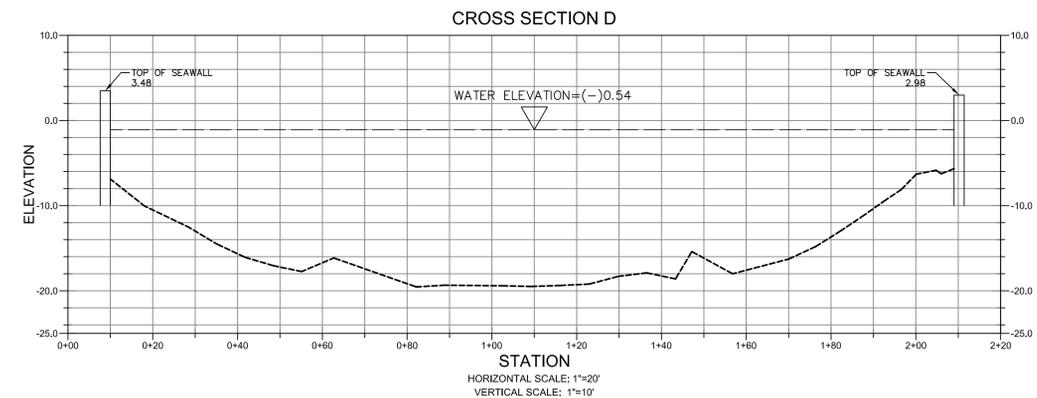
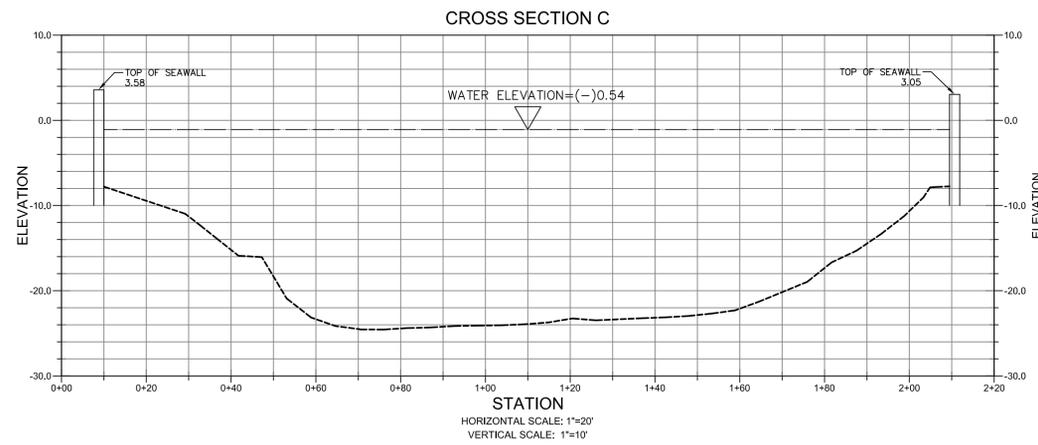
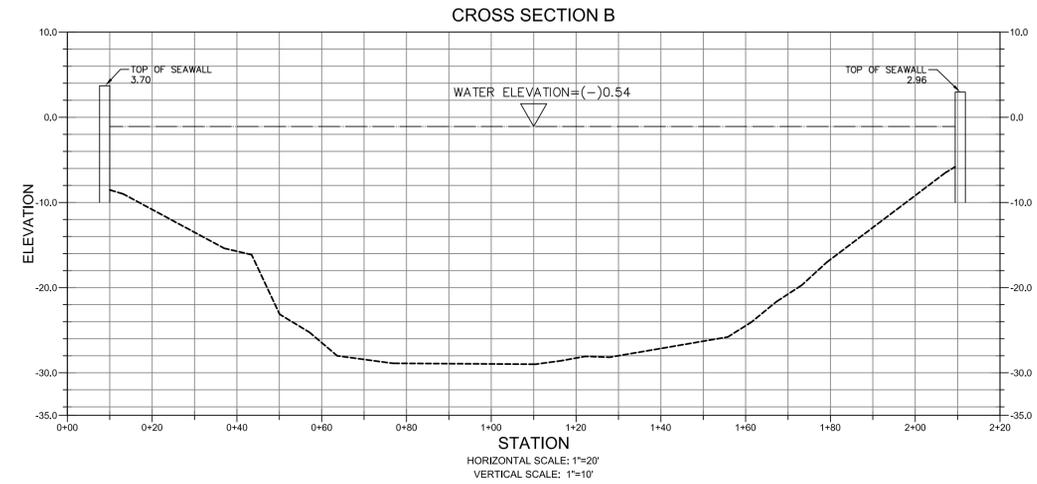
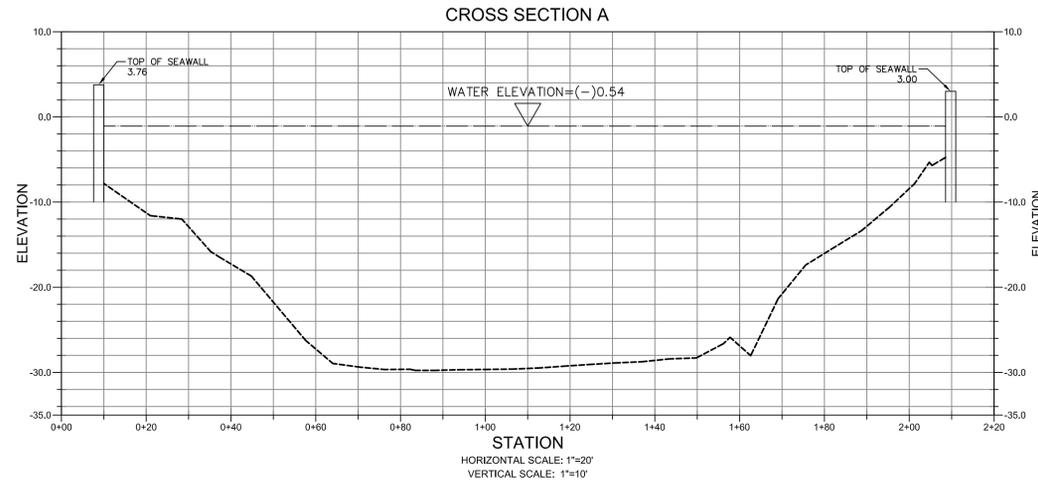
THIS SURVEY MAP AND REPORT OR COPIES THEREOF ARE NOT VALID WITHOUT THE SIGNATURE AND ORIGINAL RAISED SEAL OR A UNIQUE ELECTRONIC SIGNATURE OF A FLORIDA LICENSED PROFESSIONAL SURVEYOR AND MAPPER UNDER CHAPTER RULES 5J-17.061 & 5J-17.062 FLORIDA ADMINISTRATIVE CODE.

DATE: 11/02/15		SCALE: 1"=30'	DRAWN BY: T.S.	CHECKED BY: R.Y.	FIELDBOOK: 2718	PAGE(S): 32-39
<p>THREE ISLANDS REUSE IRRIGATION PROJECT HALLANDALE BEACH - BROWARD COUNTY - FLORIDA City of Hallandale Beach TOPOGRAPHIC SURVEY</p>						
<p>PREPARED FOR: City of Hallandale Beach</p>						
<p>SEAL PROJECT NO. 15-0080-001 V-1 SHEET 1 OF 2</p>						
<p>CRAVEN THOMPSON AND ASSOCIATES, INC. ENGINEERS - PLANNERS - SURVEYORS 3563 N.W. 53RD STREET, FORT LAUDERDALE, FLORIDA 33309 TEL: (954) 739-6400 FAX: (954) 739-6409 FLORIDA LICENSED BUSINESS NO. 271 FLORIDA LICENSED ARCHITECTURE BUSINESS NO. C00014 MATERIAL SHOWN HEREON IS THE PROPERTY OF CRAVEN THOMPSON & ASSOCIATES, INC. AND SHALL NOT BE REPRODUCED OR TRANSMITTED IN ANY FORM OR BY ANY MEANS, ELECTRONIC OR MECHANICAL, INCLUDING PHOTOCOPYING, RECORDING, OR BY ANY INFORMATION STORAGE AND RETRIEVAL SYSTEM.</p>						

SKETCH OF SURVEY TOPOGRAPHIC SURVEY

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DATE:	11/02/15
SCALE:	AS SHOWN
DRAWN BY:	T.S.
CHECKED BY:	R.Y.
FIELDBOOK:	2718
PAGE(S):	32-39



SEE SHEET V-1 FOR TOPOGRAPHIC SURVEY INFORMATION, SURVEYOR'S NOTES, DESCRIPTION, ABBREVIATION AND SYMBOL LEGENDS AND SURVEYOR'S CERTIFICATION.

THE ELEVATIONS SHOWN HEREON ARE BASED ON THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88).

CRAVEN • THOMPSON AND ASSOCIATES, INC.
ENGINEERS • PLANNERS • SURVEYORS
3563 N.W. 53RD STREET, FORT LAUDERDALE, FLORIDA 33309
FAX: (954) 739-6409 TEL: (954) 739-6400
FLORIDA LICENSE NUMBER: SURVEYING & MAPPING BUSINESS NO. 271
FLORIDA LICENSE NUMBER: ARCHITECTURE BUSINESS NO. C00014
MATERIAL SHOWN HEREON IS THE PROPERTY OF CRAVEN THOMPSON & ASSOCIATES, INC. AND SHALL NOT BE REPRODUCED OR TRANSMITTED IN ANY FORM OR BY ANY MEANS, ELECTRONIC OR MECHANICAL, INCLUDING PHOTOCOPYING, RECORDING, OR BY ANY INFORMATION STORAGE AND RETRIEVAL SYSTEM.

THREE ISLANDS REUSE IRRIGATION PROJECT
HALLANDALE BEACH - BROWARD COUNTY - FLORIDA
PREPARED FOR:
City of Hallandale Beach
CANAL CROSS-SECTION PROFILE SHEET

SEAL
PROJECT NO.
15-0080-001

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