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Standard Specification for Corrugated High Density Polyethylene (HDPE) Water Quality Units[1]

This standard is issued under the fixed designation F2737; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers materials, structural design, physical dimensions and manufacturing requirements for monolithic or sectional corrugated high density polyethylene (HDPE) water quality units with volumes greater than or equal to 86 ft^3 or 640 gal (2,400 L).

1.2 The corrugated HDPE water quality units are placed as offline or inline treatment devices along storm drain pipe lines to remove total suspended solids (TSS), heavy metals and phosphorous. Typical sources of pollutants include construction activity, automotive transportation related wear and debris items, refuse, landscaping debris, agricultural activities, and other similar by-products.

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 This specification covers horizontally laid corrugated HDPE water quality units as illustrated in Fig. 1.

1.5 The following safety hazard caveat pertains only to the test methods portion, Section 9, of this specification. *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D1600 Terminology for Abbreviated Terms Relating to Plastics

D3212 Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals

D3350 Specification for Polyethylene Plastics Pipe and Fittings Materials

F412 Terminology Relating to Plastic Piping Systems

F477 Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

F714 Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter

F2306/F2306M Specification for 12 to 60 in. [300 to 1500 mm] Annular Corrugated Profile-Wall Polyethylene (PE) Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications

2.2 *Plastic Pipe Institute:*[3]

PPI TR-4 PPI Listing of Hydrostatic Design Basis (HDB), Pressure Design Basis (PDB), and Minimum Required Strength (MRS) Ratings for Thermoplastic Plastic Pipes

2.3 *AASHTO Standard*[4]

LDFD Bridge Design Specifications

3. Terminology

3.1 For definitions of terms relating to plastics, see Terminology F412 and abbreviations are in accordance with Terminology D1600, unless otherwise specified.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *access opening, n*—a hole in the top or crown of the water quality unit for access to the interior for inspection, cleaning and removing of sediment, hydrocarbons, floating debris, and pollutants without personnel entry.

3.2.2 *bypass, n*—an optional external piping intended to convey storm flow in excess of the treatment flow rate beyond the water quality unit.

3.2.3 *Compartment, n*—a separate and distinct section of the water quality unit designated for specific contaminant removal.

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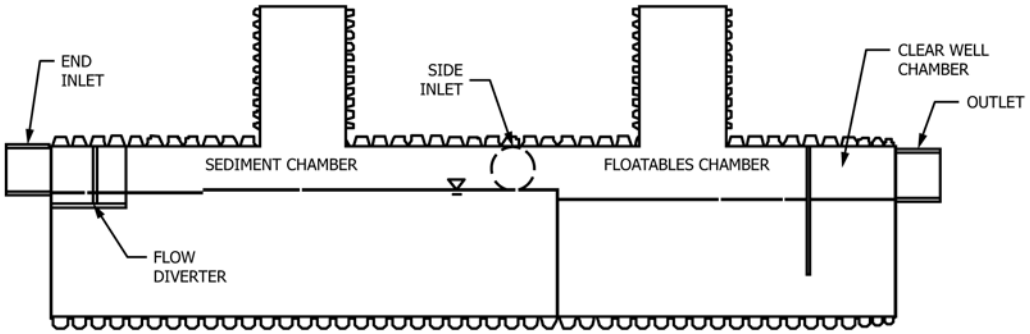
[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from Plastics Pipe Institute (PPI), 105 Decker Court, Suite 825, Irving, TX 75062, http://www.plasticpipe.org.

[4] Available from American Association of State Highway and Transportation Officials (AASHTO), 444 N. Capitol St., NW, Suite 249, Washington, DC 20001, http://www.transportation.org.



HDPE water quality units contain three (3) chambers. A side inlet may be used in lieu of the end inlet and flow diverter when a full height longitudinal partition is constructed in the sediment chamber compartment to extend the particle travel length and isolate incoming flow from sediment build-up.

FIG. 1 Horizontally Laid Corrugated HDPE Water Quality Units

3.2.4 *first flush, n*—the first half inch to one inch of rainfall which results in overland flow during a storm event or as required by the regional water quality regulatory agency.

3.2.5 *flow diverter (partitions), n*—a device at the inlet of the water quality unit that extends partially between the top and invert intended to deflect influent downward and increase the length of the flow path of the liquid as it travels through the water quality unit.

3.2.6 *joint, n*—a physical separation where two sections of the water quality unit are in contact.

3.2.7 *monolithic corrugated HDPE water quality unit, n*—a single extruded piece of pipe with no internal joints and welded end caps that serves as the water quality unit.

3.2.8 *non-sealed joint, n*—a joint where a machined fit will minimize the movement of liquid from one side of a wall to the opposite side.

3.2.9 *orifice equation, n*—prediction of flow rate through a round opening of liquid given the opening size and the head above the opening.

3.2.10 *owner, n*—is by definition end user, customer, or purchaser.

3.2.11 *sealed joint, n*—a joint that is sealed to prevent liquid passing from one side of a wall to the opposite wall.

3.2.12 *sectional corrugated HDPE water quality unit, n*—a group of two or more extruded pieces of pipe connected with sealed joints that when combined serve as the principal unit.

3.2.13 *Stokes Law, n*—prediction of settling time for particles of various sizes in a liquid.

3.2.14 *treatment flow rate, n*—the flow rate for which the water quality unit is intended to treat such to provide removal of Total Suspended Solids (TSS).

3.2.15 *water quality unit*—a single unit or series of units in which pollutants from storm runoff from land drainage is received, detained, and treated and from which the liquid effluent, which is comparatively free from settleable, suspended, and floating solids, is then discharged to a public storm sewer, water detention / retention structure, or publicly owned waterway.

3.2.16 *weir, n*—a partition across the width of the sediment chamber that partially extends between the invert and top and is intended to trap pollutants.

4. Ordering Information

4.1 The owner shall include the following information in bidding documents and on the purchase order, as applicable to the units being ordered:

4.1.1 Reference to this specification, and date of issue.

4.1.2 Quantity or number of water quality units.

4.1.3 Capacity of the tank in ft^3 or gal (L).

4.1.4 Project conditions such as peak storm flow rate, bypass diameter and associated piping elevations.

4.1.5 Acceptance will be based on a review of the calculations or testing submittals.

4.1.6 Design requirements such as depth of earth cover, live load applied at the surface, ground water level and joint requirements for bypass pipe.

4.1.7 Testing for water leakage shall not be required at the job site unless specifically required by the owner at the time of ordering.

5. Materials and Manufacture

5.1 *Water Quality Unit, Access Risers and Fittings*—Shall be fabricated from pipe and fittings meeting the requirements of Specification F2306/F2306M. It is permissible to utilize other pipe materials as long as they meet the performance criteria in this standard and are approved by the owner.

5.2 *Inlet and Outlet Tees*—Shall be fabricated from pipe and fittings meeting the requirements of Specification F2306/F2306M for dual wall pipe or Specification F714 for solid wall pipe. It is permissible to utilize other pipe materials as long as they meet the performance criteria in this standard and are approved by the owner.

5.3 *Internal Tank Piping*—Internal piping within the water quality unit shall be fabricated from pipe and fittings meeting the requirements of Specification F2306/F2306M for dual wall pipe or Specification F714 for solid wall pipe. It is permissible to utilize other pipe materials as long as they meet the performance criteria in this standard and are approved by the owner.

5.4 *Weirs, Flow Diverters, and End Caps*—Weirs, flow diverters (partitions), and end caps shall be fabricated from either flat plates meeting the requirements of PPI TR-4 PE 3408 material.

5.5 *Pipe Connections:*

5.5.1 Pipe to Water Quality Unit connections shall employ flexible watertight connectors conforming to the requirements of Specification F477.

6. Structural Design Requirements

6.1 Pipe sections used in the fabrication of the water quality unit shall be design by calculation using the AASHTO LRFD Bridge Specifications, Section 12, " Buried Structures and Tunnel Liners"

6.2 Structural analysis and design of the water quality units shall be performed using commercially practicable methods and may include computer aided analysis, field based analysis, or analytical calculations.

6.2.1 Structural analysis and design shall include provisions for external hydrostatic pressure.

6.2.2 Structural analysis and design shall incorporate a minimum live load at the surface, of an AASHTO H-25 load, unless greater loading is anticipated.

6.2.3 Structural analysis and design shall take into consideration the number, placement, and size of all openings.

6.3 Installation shall be in accordance with the manufacturer's instructions.

7. Physical Dimensions

7.1 *Water Quality Unit Sizes:*

7.1.1 The volume of water quality units is given in Table 1. These volumes do not reflect the treatment or removal efficiencies in 9.2.

7.2 *Compartments:*

7.2.1 Units shall utilize multiple compartments with dividing weirs and flow diverters (partitions) welded to the unit. Separate compartments shall exist for solids and floatable removal.

7.2.1.1 Welding of the weir and flow diverters (partitions) shall be done by continuous extrusion welding on both sides of the weir and flow diverters (partitions).

7.2.1.2 Welding rod shall be of medium or high density polyethylene corresponding to the properties for the end plate materials in 5.4 with the exception that the tensile strength at yield shall not be less than 5000 psi (3.5MKg/m^2).

7.2.2 Multiple units installed in series or parallel are acceptable.

7.2.3 Each compartment shall have an access riser for inspection and maintenance.

7.3 Inlet and Outlet Pipes:

7.3.1 The inlet pipe shall be no less than 10 in. (250 mm) in diameter.

7.3.2 The elevation difference between the invert of the inlet pipe and the invert of the outlet pipe shall be a minimum of 2 in. (50mm).

7.3.3 Connections to inlet and outlet pipes shall be made with a sealed flexible connector conforming to Specification F477.

7.4 *Bypass pipe:*

7.4.1 The bypass pipe shall be no less than 10 in. (250 mm) in diameter.

7.4.2 The bypass pipe shall be located between the connections of the inlet pipe and the outlet pipe of the water quality unit to the main storm drain line.

7.4.3 The bypass pipe shall be the same size as the main storm drain line.

7.4.3.1 Pipe size shall be determined by the design engineer and furnished to the manufacturer for fabrication.

7.5 *Outlet Devices:*

7.5.1 If tees or outlet filters are added, they shall be made of noncorrosive materials and be permanently connected with non-corrosive fasteners to either the inside of the water quality unit or the outlet pipe.

7.5.2 Outlet filter devices, if specified, shall be installed in accordance with manufacturer's recommendations or requirements of the regulating agencies, or both.

7.5.3 Specifications for tees and outlet filters shall be in accordance with treatment flow conditions.

7.6 *Access Openings:*

7.6.1 An access opening shall be provided for inspection and maintenance of all compartments.

7.6.2 Access openings shall be a minimum of 24 in. (600 mm) in diameter. The cover shall be provided with a locking mechanism to prevent unauthorized entrance unless otherwise specified by the owner.

7.6.3 An access opening shall be provide for each compartment.

7.7 *End Plates:*

7.7.1 Plates shall be welded to the ends of the pipe sections to form the completed water quality unit.

7.7.1.1 Welding of the end plates shall be done by continuous extrusion welding on both sides of the wall.

7.7.1.2 Welding rod shall be of medium or high density polyethylene meeting the properties for the unit as required

TABLE 1 Water Quality Unit Sizes

Unit Inside Diameter in. (mm)	Inside Length ft (m)	Total Volume gal (m^3)	Minimum Inlet/Outlet Diameter in. (mm)
36 (900)	12 (3.7)	640 (2.4)	10 (250)
36 (900)	20 (6)	1058 (4.0)	10 (250)
36 (900)	40 (12)	2116 (8.0)	10 (250)
42 (1050)	20 (6)	1439 (5.4)	12 (300)
42 (1050)	40 (12)	2879 (10.9)	12 (300)
48 (1200)	20 (6)	1879 (7.1)	12 (300)
48 (1200)	40 (12)	3758 (14.2)	12 (300)
60 (1500)	20 (6)	2937 (11.1)	15 (375)
60 (1500)	40 (12)	5874 (22.2)	15 (375)

under Specification F2306/F2306M with the exception that the tensile strength at yield shall not be less than 5000 psi (3.5M Kg /m^2).

7.7.2 End plates shall be made of virgin PE plastic compound meeting the requirements of cell classification 445434C as defined in Specification D3350, except that carbon black content shall not exceed 4%. Compounds that have a higher cell classification in one or more properties shall be permitted provided all other product requirements are met.

8. Quality Control and Sampling

8.1 The manufacturer shall measure and document the physical dimensions of each water quality unit as required under Section 7.

9. Performance Test Methods

9.1 *Watertight Integrity*—Laboratory leakage testing (if required) of the unit shall be performed using either the vacuum or hydrostatic test methods listed in 9.1.1 and 9.1.2. This testing is only to confirm the integrity of the welds and homogeneous quality of the wall. Pressure testing of the joints and any similar connections shall be in accordance with 9.2.

9.1.1 *Vacuum Testing*—Seal the empty unit and apply vacuum to 4 in. (100mm) of Mercury. Hold the vacuum for a period of 5 min to allow for pressure equalization, and stabilization of product creep. If the vacuum drops it shall be increased to 4 in. (100 mm) of Mercury and held for a period of 2 min. The unit is approved if 90% of vacuum is held for the 2 min period. If the unit fails, it shall be repaired and retested.

9.1.2 *Hydrostatic Testing*—Seal the empty unit and fill with water to its operational level, monitor the leakage, if any occurs, over a 1 h period. The maximum allowable leakage shall not exceed 0.1% of the manufactures stated total volume within the 1 h period. If the unit fails, it shall be repaired and retested.

9.2 *Joint Testing*—Testing of the bell and spigot joints shall be in accordance with Specification D3212.

9.3 *Removal Efficiency*—Removal efficiency testing shall be determined by the owner based on their required treatment flow rate. Testing to meet this criteria shall be mutually agreed upon by the owner and manufacturer prior to ordering. The certification test to meet these criteria are outside the scope of this standard, but if required by the owner, these criteria shall be included by the manufacturer as part of the Section 13 certification documentation.

10. Dimensions, Mass, and Permissible Variations

10.1 *Dimensional Tolerances*—The length, width, height, or diameter measurements of the water quality unit when measured on the inside surface shall not be less that 99% of the design dimensions.

11. Repairs

11.1 Repairs of corrugated HDPE water quality units, when required, shall be performed in accordance with the manufacturer's recommendations in a manner ensuring that the repaired water quality unit shall conform to the requirements of this specification.

12. Rejection

12.1 Corrugated HDPE water quality units or sections of water quality units shall be subject to rejection because of failure to conform after repairs to any of the requirements contained in this specification.

13. Certification

13.1 At the time of ordering, quality unit the owner has the option to require a certification for the design and performance of the water

13.1.1 Upon request, the manufacture shall provide certification for the acceptable installed structural performance limitations such as burial depth, maximum live load rating, and maximum external hydrostatic pressure.

13.1.2 Upon request, the manufacturer shall provide certification the water quality unit passed the water integrity and joint performance tests as required under Section 9.

14. Product Marking

14.1 Each water quality unit shall be clearly marked within 2 ft. (0.6m) of the inlet to the tank by indentation or other approved means with:

(1) this ASTM standard designation,
(2) date manufactured,
(3) name or trademark of the manufacturer,
(4) unit capacity,
(5) minimum and maximum earth cover in feet (meters) and
(6) inlet and outlet clearly identified, unless required otherwise by local codes.

14.2 When all the requirements of this specification are met, the product shall be so stamped.

15. Quality Assurance

15.1 When the product is marked with this designation, ASTM F2737, the manufacturer affirms that the product was manufactured, inspected, and tested in accordance with this specification and has been found to meet the requirements of this specification. When specified in the purchase order or contract, a report of the test results shall be furnished.

16. Keywords

16.1 Corrugated HDPE pipe; water quality unit; total suspended solids; floatables; stormwater treatment; pretreatment; settling; Stoke's Law

APPENDIX

(Nonmandatory Information)

X1. HYDRAULIC DESIGN OF WATER QUALITY UNITS

X1.1 *Calculations for Sizing a Water Quality Unit Treatment Capacity*— One of the most common methods for evaluating the treatment capacity for the water quality unit is by the use of Stoke's Law, which determines the vertical settling time of pollutants of differing particle sizes in combination with the orifice equation and horizontal flow rate. The Water Quality Unit in this standard can be most effectively designed using the fundamental principles of Stoke's Law and a standard orifice equation. Stoke's Law is used to determine the settling velocity of a known particle size. The settling velocity can then be used to calculate the settling time, which is the time it takes a particle to fall a distance equal to the inlet pipe diameter plus two inches (50 mm). The velocity through the chamber is found by dividing the treated flow rate by the cross sectional area of the sediment chamber. The length of the sediment chamber is determined by taking the velocity through the chamber and multiplying by the settling time. After the length of the sediment chamber is established, the size of the orifice can be calculated. The orifice controls the amount of water entering the water quality unit. Once the treated flow rate is reached, excess water may be diverted to a bypass or another water quality unit. A standard orifice equation is used to find the diameter of the orifice. Flow rates in excess of the treatment flow, up to and including the design storm peak event, if diverted to a bypass pipe will not be treated by the unit.

X1.2 *Bypass Flow*—When the available head on the system is reached, the water quality unit is overloaded or goes into a bypass flow mode. The bypass flow can be as high as the peak flow rate by which the storm sewer system is designed. In bypass flow the entire peak storm must be conveyed by the bypass pipe. Bypass flow is determined by the engineer on the project, and the diameter of bypass flow is based on the storm sewer calculations for the run where the water quality unit is located.