

SECTION 02830
SEGMENTAL RETAINING WALL SYSTEMS
[Rio Retaining Wall Series](#)

PART 1 – GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Segmental retaining wall (SRW) units, soil reinforcement, and appurtenant.
- B. Related Sections
 - 1. Section 02300 - Earthwork
 - 2. Section 02630 – Storm Drainage

1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM) Standards
 - 1. ASTM C 140 – Methods of Sampling and Testing Concrete Masonry Units
 - 2. ASTM C 1262 – Freeze – Thaw Test for Masonry
 - 3. ASTM C 1372 – Standard Specification for Segmental Retaining Wall Units
 - 4. ASTM D 2166 – Triaxial Shear Test
 - 5. ASTM D 3080 – Direct Shear Test
 - 6. ASTM G 51 – Alkalinity
 - 7. ASTM G 57 – Resistivity
- B. National Concrete Masonry Association (NCMA)
 - 1. NCMA – Design Manual for Segmental Retaining Walls
 - 2. NCMA SRWU-2 – Shear Strength between Segmental Concrete Units

1.3 DEFINITIONS

- A. Soil Reinforcement: Structural geogrid formed by a regular network of integrally connected tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock, or earth and function primarily as structural reinforcement.
Geosynthetic (extensible) Soil Reinforcement: Polymer product specifically manufactured as soil reinforcement element that meets requirements of this specification.
- B. Segmental Concrete Facing Unit: A modular concrete facing unit machine-made from Portland cement, water, and mineral aggregates. All Rio Retaining Walls have an antique textured face
- C. Cap Unit: A modular concrete cap unit machine-made.

- D. Unit Drainage Fill: Free draining “open” aggregate fill which is within and between the segmental concrete facing units, and extends a minimum of 12” behind the units.
- E. Reinforced Backfill: Compacted soil which is within the reinforced soil volume as outlined on Construction Drawings.
- F. Foundation Soil: Compacted import or in-situ soil beneath entire wall.
- G. Retained Soil: Compacted import or in-situ soil behind reinforced zone of retaining wall.
- H. Leveling Pad: Level compacted gravel or unreinforced concrete footing upon which first course of segmental concrete facing units are placed.

1.4 SUBMITTALS

- A. Certificates of Compliance: Submit manufacturer’s certification to the Civil Engineering Consultant of Record and the Owner prior to start of work stating that the following meet requirements of this specification.
 - 1. Soil reinforcement
 - 2. Reinforced backfill materials
 - 3. Drainage materials
- B. Samples: Submit samples of [Rio 90](#) units showing double-sided textured finish and color to the Owner for selection prior to delivery of materials as required on Construction Drawings.

1.5 QUALITY ASSURANCE

- A. Qualifications: SRW system installer shall have a minimum of 50,000 square feet of documentable experience installing SRW systems over eight feet in height on minimum of five projects over the previous two years. Provide the Owner a project list with current references and telephone numbers for the proposed SRW Installer substantiating the required experience.
- B. Pre-Construction Meeting: A pre-construction meeting shall be conducted by the General Contractor prior to beginning construction on segmental retaining walls. Owner’s Construction Manager shall be notified of the date, time and location of the meeting. Mandatory attendees include the General Contractor, the project geotechnical engineer, the Contractor’s testing agency, and representatives of all sub-contractors involved with the foundation preparation, erection, and backfilling of the SRW. Meeting topics shall include, but are not limited to, schedule and phasing of wall construction, coordination with other on-site construction activities, responsibilities of parties, sources, quality, and acceptance of materials.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Segmental Concrete Facing Units:
 1. Check the materials upon delivery to assure the specified type, grade, color and texture of units have been received.
 2. Prevent excessive mud, wet concrete, epoxies, and like materials which may affix themselves from coming in contact with materials.
 3. Protect the materials form damage.

- B. Soil Reinforcement:
 1. Check the soil reinforcement upon delivery to assure the proper grade and type of material been received.
Provide a product certification with each shipment.
 2. Store soil reinforcement material in accordance with manufacturer's recommendations.

- C. Drainage Materials:
 1. Store plastic pipe in accordance with the manufacturer's recommendations to prevent deleterious materials from becoming affixed or deterioration from sun exposure.
 2. Store drainage aggregate to prevent contamination with other materials.

PART 2- PRODUCTS

2.1 SEGMENTAL CONCRETE FACING UNITS

- A. Manufacturers:
 - [Rinox Pavers LLC](http://www.rinoxpavers.com),
 - 23 Quarry Road
 - Douglassville, PA 19518
 - Phone: (610)323-6600 Fax: (610)323-6601
 - www.rinoxpavers.com

- B. Product: Rio 90 Retaining Wall System
 - [Rio 90 Retaining walls:](#)

<u>Shape</u>	<u>Block Thickness</u>	<u>Dimensions</u>
Stone - A	3 1/2" (90mm)	8-1/2" x 7"
Stone - B	3 1/2" (90mm)	8-1/2" x 8-7/8"
Stone - C	3 1/2" (90mm)	8-1/2" x 10-5/8"
Stone - D	3 1/2" (90mm)	8-1/2" x 10-5/8"
Stone - E	3 1/2" (90mm)	8-1/2" x 14"

 - * All Rio90 wall units and K-Blocks (connection clip)s are included in each pallet
 - * [Rio 90 Pillar kits](#) are also available but sold separately. Rio 90 can be combined with Rio 135 and Rio 180
 - * [10" double-sided coping and 13" double-sided step coping](#) are on separate pallets available

- C. Color and finish shall be as directed by the Owner from Rinox proprietary colors
 1. Morocco Beige

2. Milton Grey
3. Ash Charcoal
4. Burgundy Wine
5. Panama Beige

D. Facing units shall meet the following structural requirements:

1. SRW Shear Capacity: Concrete units shall have a demonstrated shear capacity to withstand laterally applied shear loads as defined in the design calculations. Shear capacity shall be demonstrated through full-scale testing of SRW facing system according to NCMA SRWU- 2 test method. Shear capacity shall be defined both with and without the soil reinforcement present at the interface.
2. Units shall be manufactured in accordance with ASTM C1372.
3. Concrete wall units including cap units shall have minimum 28-day compressive strength of 4,000 psi on the net area and have a maximum absorption rate of 6 percent.
4. Cementitious materials used in manufacture of units shall be Type I, Type II or Type III Portland cement in accordance with ASTM C150.
5. In areas where repeated freezing and thawing under saturated conditions occur, freeze thaw durability in water shall be demonstrated by testing per ASTM C1262. Testing shall be conducted for a minimum 100 cycles, and weight loss shall not exceed one percent.
6. Dimensional tolerances for exterior molded units shall be in accordance with ASTM C1372. SRW concrete facing unit molded dimensions shall be $\pm 1/8$ inch from the manufacturer's published dimensions, except for height which shall be $\pm 1/16$ inch. Maximum differential shall be no more than $1/8$ inch in height from front to back of unit.
7. SRW units shall provide minimum effective in place weight equivalent to 100 pcf. Fill placed within dimensions of units may be considered as integral to the effective unit weight. This in-place weight shall be determined by testing and used for all design calculations.
8. Units shall be sound and free of cracks or other defects that would interfere with the proper placing of the unit or significantly impair the strength or permanence of the construction. Chips and texture from tumbled blocks in the Rio Retaining Wall Series are not means for rejection unless it interferes with the structural integrity of the retaining wall system

2.2 BASE LEVELING PAD MATERIAL

- A. Base leveling pad material shall be crushed dense aggregate base material.

2.3 UNIT FILL

- A. Unit fill shall be free-draining crushed gravel (#57 Stone) conforming to SRW manufacturer's recommendations.

2.4 SOIL REINFORCEMENT

- A. Geosynthetic Soil Reinforcement:
 - 1. Properties: The geosynthetic soil reinforcement shall possess minimum strength and durability required by design as determined by product specific testing as defined in the NCMA Design Manual for Segmental Retaining Walls (Section 3,5), including provisions for minimum partial safety factors. Design submittal shall indicate the index tensile strength for each reinforcement type to be used in construction.
 - 2. Geogrid: Mirafi, Synteen, Strata, GTG, or approved equal

2.5 DRAINAGE MATERIALS

- A. Drainage collection pipe shall be perforated/slotted PVC or corrugated HDPE pipe as specified in Section 02630.
- B. Drainage aggregate shall be free- draining material, relative to the surrounding soil conforming to the SRW manufacturer's recommendations in order to prevent build- up of hydrostatic pressure.
- C. Drainage geotextile shall be Synthetic Industries 401 or approved equivalent.
- D. Drainage composite shall be J-Drain 400 Dimple Core Drainage by JDR Enterprises, Inc. Alpharetta, GA (800) 843-7569 or approved equivalent.

2.6 REINFORCED WALL BACKFILL

- A. Reinforced soil shall possess the following characteristics:
 - 1. Less than 35% passing the No. 200 sieve per ASTM D 422 with a maximum size of $\frac{3}{4}$ inches (4 inch maximum for steel reinforced systems)
 - 2. A liquid limit < 20 and a plasticity index < 5 per ASTM D 4318
 - 3. An effective angle of internal friction $> 30^\circ$ per ASTM D 2166 or D3080 at the compaction standard. Use of an effective friction angle greater than 30 degrees for design shall be verified by appropriate testing submitted to and approved by the owner's engineer prior to construction.
 - 4. Less than 5% organic material.
- B. Backfill reinforced with geosynthetic shall have a pH in the range of 3 to 9 per ASTM G 51.

- C. Backfill reinforced with steel reinforcement shall have a pH in the range of 5 to 10 per ASTM G 51, minimum resistivity of 3000 ohm-cm at 100% saturation per ASTM G 57 and free sulphates > 200 ppm or chlorides > 100 ppm. If the resistivity is \geq 5000 ohm-cm, the chloride and sulphate requirements are waived. Subject to approval, the owner's engineer may allow slightly wider ranges of pH for higher resistivities.

2.7 RETAINED BACKFILL OR COMMON BACKFILL

- A. Soil placed behind the reinforced backfill shall be satisfactory fill material as specified in Section 02300.

PART 3- EXECUTION

3.1 PREPARATION

- A. Comply with federal, state and local requirements for execution of the work, including local building codes and current OSHA excavation regulations. Provide excavation support as required to maintain stability of the area during excavation and wall construction. Ensure surrounding structures are protected from effects of wall excavation.
- B. Prior to grading or excavation of the site, confirm the location of the retaining walls and all underground features, including utility locations within the area of construction. Ensure surrounding structures are protected from effects of wall excavation.
- C. Coordinate installation of underground utilities with wall installation.
- D. Control surface water drainage and prevent inundation of the retaining wall area during construction.

3.2 EXCAVATION

- A. Excavate to lines and grades shown on the Construction Drawings. Take precautions to minimize over-excavation shall be backfilled with approved compacted material.
- B. Inspect excavation prior to placement of leveling pad material.
- C. In areas where soft, disturbed or otherwise unsuitable soils are encountered within the zone of the wall loading in the excavations, such unsuitable soils shall be over-excavated to the depths and extents required and replaced with select material and compacted per the contract documents.
- D. Fill over excavated area in front of wall face with approved compacted material before wall construction reaches 4 feet in height.

- E. In areas where a retaining wall or portion of a retaining wall is to be installed into cut, the required excavated shall extend horizontally to the extend of the reinforced zone and vertically to the elevation of the top of the leveling pad. The retained zone shall be bench cut in order to permit controlled placement of retained backfill.

3.3 LEVELING PAD CONSTRUCTION

- A. Place leveling pad as shown on the Construction Drawings with 6 inches of crushed dense aggregate base. The leveling pad shall extend laterally a minimum distance of 6 inches from the toe and heel of the lower- most SRW Unit in accordance with manufacturer's recommendations.
- B. Foundation soil shall be proofrolled and the top 12 inches compacted to minimum 95% Standard Proctor Maximum Dry Density (ASTMD 698) and tested prior to placement of leveling pad materials.
- C. Compact granular leveling pad material to provide a level hard surface on which to place the first course of units. Compact with mechanical plate compactors to minimum 95% of Standard Proctor Maximum Dry Density (ASTMD 698).

3.4 SRW UNIT INSTALLATION

- A. Place first course of SRW units on the leveling pad. Level units side- to- side, front- to- rear and aligned with adjacent units.
- B. Ensure units are in full contact with base.
- C. Place the front of the unit's side-by- side without gaps between the fronts of adjacent units. Layout of curves and corners shall be in accordance with SRW manufacturer's installation guidelines.
- D. Place and compact unit drainage fill within, between, and behind units. Place and compact infill soil behind drainage fill. Mechanical vibrating plate compactors shall not be used on top of the units. Compact fill between units and the three- feet zone behind the units by running hand- operated compaction equipment just behind units. Compact to minimum 90% Standard Proctor Maximum Dry Density (ASTM D698) within the 3 feet zone and 95% beyond the 3 feet zone.
- E. Place core drainage fill in the previous course of units prior to stacking of subsequent segmental retaining wall units.
- F. Clean excess debris from top of units.
- G. Repeat procedure to the extent of wall height.

3.5 SOIL REINFORCEMENT INSTALLATION

- A. Soil reinforcement shall be oriented with the highest strength axis perpendicular to the wall alignment.
- B. Install soil reinforcement to wall height, horizontal location, and extent as shown on the Drawings.
- C. Lay the soil reinforcement horizontally on compacted backfill/ Pull taut and connect to concrete SRW units according to connection detail shown on the Drawings or as recommended by Rinox prior to backfill placement on geosynthetic reinforcement.
- D. Soil reinforcements shall be continuous throughout their embedment lengths. Spliced connections between shorter pieces will not be allowed.
- E. Do not operate tracked construction equipment directly upon soil reinforcement. Provide a minimum fill thickness of 6 inches prior to operation of tracked equipment over soil reinforcement. Keep tracked vehicle turning to minimum to prevent tracks from displacing the fill and damaging soil reinforcement.
- F. Rubber-tired equipment may pass over soil reinforcement at low speeds, less than 10 mph, if permitted by the manufacturer. Avoid sudden braking and sharp turning.
- G. Changes to soil reinforcement layout, including, but not limited to, length, soil reinforcement type (strength), or elevation, may be made sudden braking and sharp turning.
- H. Verify orientation (Roll direction) of geosynthetic reinforcement.

3.6 REINFORCED BACKFILL PLACEMENT

- A. Place reinforced backfill, spread and compact in such a manner that will not develop slack in the soil reinforcement in accordance with Manufacturers recommendations.
- B. Place and compact reinforced backfill in lifts not to exceed 8 inches in compacted thickness.
- C. Compact reinforced backfill to a minimum of 95% Standard Proctor Maximum Dry Density (ASTMD 698) at moisture content from within +/- 3% of optimum.
- D. Compact reinforced backfill in all areas to the lines and grades shown on the Construction Drawings including all sloped areas above walls.
- E. At the end of each day's operation, slope the last lift of reinforced backfill away from the wall facing to rapidly direct runoff away from the wall face. Do not allow surface runoff from adjacent areas to enter the wall construction site.

3.7 RETAINED BACKFILL PLACEMENT

- A. Retained backfill shall be placed in a maximum 8 inch thick compacted to minimum 95% Standard Proctor Maximum Dry Density (ASTMD 698).

3.8 DRAINAGE SYSTEM

A. Drainage Collection Pipe:

1. Install the drainage collection pipe according to line, grades and sections shown on the Drawings.
2. Install drainage collection pipe to maintain gravity flow of water from reinforced soil zone. Daylight drainage collection pipe at storm sewer manhole or along slope at an elevation lower than lowest point of pipe within reinforced soil mass, every 40 feet minimum.
3. Main collection drain pipe just behind segmental units shall be minimum 4 inches in diameter. Secondary collection drain pipe shall gravity flow independently or tie into main collection drain pipe with laterals at maximum 40 foot spacing along wall face.

B. Drainage Aggregate:

1. Install drainage aggregate to line, grades, and sections shown on the Drawings.
2. When blanket drain is installed, a non-woven geotextile shall be installed on top of the aggregate placement in accordance with the Drawings.

C. Drainage Composite:

1. Install drainage composite as shown on the Drawings.
2. Wrap upper ends of drainage composite with approved geotextile fabric.
3. Drainage composite shall extend upwards minimum of $\frac{2}{3}$ of height of backcut and be spaced on horizontal centers to give a minimum of 30% horizontal coverage as required.
4. Drainage composite shall terminate in a French drain effectively connecting to a collector pipe wrapped in drainage aggregate and an approved fabric.

3.9 RIO CAP INSTALLATION

- A. Place and glue Rinox cap units per manufacturer's recommendations. Backfill and compact to finished grade.
- B. Incorporated surface water drainage control (swale) into finished grading at top of wall, as shown on the Drawings.
- C. Attach cap units to wall units with construction epoxy. Apply epoxy to bottom surface of cap unit and install on clean units below. Follow epoxy manufacturer's directions to ensure permanent bond.

3.10 CONSTRUCTION

- A. Mechanical vibrating plate compactors shall not be used on top of the units. Compact fill between units and the backfill zone behind the units by running hand-operated compaction equipment just behind units. Perform compaction to manufacturer's recommendations.

3.11 FIELD QUALITY CONTROL

- A. The Contractor shall engage inspection and testing service agencies, including independent laboratories, to provide quality control and testing services during construction. The Owner may engage a testing and inspection agency for quality assurance, but this does not relieve the General Contractor from providing the specified construction quality control and testing.
- B. Testing and inspection services shall be performed by trained and experienced technicians currently qualified for the work to be performed.
- C. The testing agency shall submit written reports of inspections to the Contractor on weekly basis. Such reports shall include description of work performed, deficiencies noted in construction, and corrective action taken to resolve such deficiencies. Owner shall be notified directly by the Contractor's testing agency of deficiencies noted by testing agency and provided with a summary and schedule for corrective action. Written reports will also include location, type, and results of all tests taken on the Project.
- D. The Contractor and testing agency shall provide a certification to the Owner that the completed SRW has been installed in accordance with the contract documents.
- E. Segmental Retaining Wall Units:
 - 1. Compressive strength test specimens shall conform to the saw-cut coupon provisions of Section 5.2.4 of ASTM C140 with the following exceptions:
 - a. Coupon shall have a minimum thickness of 1-1/2 inches.
 - b. Coupon shall not be oven dried before testing.
 - 2. The compressive strength shall be considered the average of three or more test coupons.
 - 3. Run compressive strength testing for every 20,000 square feet of installed wall facing material or fraction thereof. The testing shall be performed immediately upon receipt from laboratory.
- F. Soil and Backfill Testing: Unless otherwise directed by the Owner or required by this technical scope of work, type and minimum frequency of testing for soils-related portions of construction shall be as follows.

1. Field density tests in accordance with ASTM D 2922:
 - a. Subgrade Soils: One test for every 2,500 square feet per lift of material.
 - b. Base Leveling Pad: One test for every 100 lineal feet.
 - c. Reinforced Backfill: One test for every 2,500 square feet per lift. Every other lift shall be tested.
2. Laboratory moisture- density relationships, ASTM D 698: One test for every compacted material type
3. Gradation Analysis, ASTM D 422:
 - a. Unit Fill: One test for every 500 cubic yards of material
Reinforced Backfill: One test for every 500 cubic yards of material or when material type changes

I. DESIGN

- A. Designs for SRW's using extensible (geosynthetic) reinforcement shall be prepared according to design methodology presented in NCMA "Design Manual for Segmental Retaining Walls" and conform to the minimum safety factors as specified in this section. Design submittals not meeting this design criteria or technical/administrative criteria as specified will be rejected in their entirety until complete compliance is achieved. Owner reserves all rights in determining compliance for plan approval and may reject any submittals.
- B. The SRW system must have 12" of free draining stone (#57) placed behind the block facing.
- C. Designs submitted using inextensible reinforcements, including Panel Wall Systems, shall be performed per AASHTO Standard Specifications for Highway Bridges. Allowable tensile stress at the end of design service life shall not exceed 55 percent of yield strength of steel for metallic strap and wire reinforcements after accounting for appropriate amount of sacrificial steel for corrosion. Soil pH and electrical resistivity values as determined during the geotechnical investigation shall be considered in the determination of anticipated corrosion. Design submittals not meeting these design criteria or technical/ administrative criteria as specified will be rejected in their entirety until complete compliance is achieved. Owner reserves all rights in determining compliance for plan approval and may reject any submittals.
- D. Soil design parameters shall be as provided in the Construction Documents. Wall Design Engineer of Record shall be responsible for selecting and specifying reinforced fill material. Reinforced fill material shall have a minimum angle of internal friction of 30 degrees. General Contractor is responsible for ensuring and documenting the reinforced fill meets the specified parameters for both strength and compaction. Compacted retained soil shall meet the minimum requirements specified in 4.02.D

- E. Design Parameters: Design of the SRW system shall be based on the following soil parameters as determined during geotechnical investigation.

Wall Segment	Friction Angle	Cohesion	Unit Weight
Reinforced Backfill	30 degrees min	0psf	125pcf
Retained Backfill	30 degrees	0psf	125pcf
Foundation	30 degrees	0psf	125pcf

- F. Design Requirements:

1. Unless otherwise indicated below, SRW design shall be performed in strict accordance with the procedures presented in the NCMA Design Manual for Segmental Retaining Walls.
2. Internal Stability of Walls
 - a. Minimum Factor of Safety on Tensile Overstress 1.0
 - b. Minimum Factor of Safety on Geogrid Pullout (peak load criterion) 1.5
 - c. Minimum Factor of Safety on Geogrid Pullout (serviceability criterion) 0.75 inches 1.0
 - d. Minimum Factor of Safety on Facing Shear (peak load criterion) 1.5
 - e. Minimum Factor of Safety on Facing Shear (serviceability criterion) 2% of height of SRW units 1.0
 - f. Minimum Factor of Safety Connections (peak load criterion) 1.5
 - g. Minimum Factor of Safety Connections (serviceability criterion) 0.75 inches 1.0
 - h. Minimum Factor of Safety for Uncertainties 1.5
3. External Stability:
 - a. Minimum Factor of Safety Against Base Sliding (static condition) 1.5
 - b. Minimum Factor of Safety Against Overturning 2.0
 - c. Minimum Factor of Safety for Global Stability 1.5
 - d. Minimum Factor of Safety for Bearing Capacity 2.0
4. Design shall address hydrostatic loading, seismic loading, rapid drawdown, surcharge, and backslopes where appropriate. Minimum Design Live Load of 100 psf shall be used for all walls. Minimum Design Live Load of 250 psf shall be used for walls supporting entrance drives, services drives and other areas subject to traffic.

5. Minimum geogrid length shall be 70 percent of the wall height. Geogrid reinforcement coverage at each layer shall be 100 percent (no gaps).
6. The maximum vertical distance between layers of soil reinforcement shall be as recommended by the manufacturer, but shall not exceed 24 inches.

END OF SECTION