ADMINISTRATIVE INFORMATION:
! This Engineering Instruction (EI) is effective beginning with projects submitted for the letting of May 6, 2010.
! Superseded issuance(s): This EI does not supersede any previous issuances.
! The information transmitted by this issuance will be incorporated into a future revision to the Standard Specifications.

PURPOSE: The purpose of this EI is to issue a new Standard Specification Section 212 Rock Slope Reinforcement and Catchment Systems.

TECHNICAL INFORMATION:
! Standard Specification Section 212 Rock Slope Reinforcement and Catchment Systems was created to include the following rock catchment fence items: Wire Rope Rock Catchment Fence, Chain Link Rock Catchment Fence, Wire Mesh Slope Protection, Wire Mesh Drape, and Temporary Rock Catchment Barrier.

! Additions to Standard Specification Section 733 Earthwork Materials were recently issued via EI 09-027.

! Standard Sheets M212-1 and M212-10 are being issued concurrently via EB 10-004.

! An addition to the Construction Inspection Manual (CIM) Section 212 Rock Slope Reinforcement and Catchment Systems will be issued separately at a later date.

IMPLEMENTATION:
! The Main Office Design Quality Assurance Bureau will insert these standard specification shelf notes beginning with projects submitted for the letting of May 6, 2010.

! Both metric and U.S. Customary shelf notes are attached.

! The following special specifications are disapproved:
  Item 203.7006 17: Wire Rope Rock Catchment Fence (Medium Impact) 1.83 Meters in Height
  Item 203.7008 17: Wire Rope Rock Catchment Fence (Medium Impact) 2.44 Meters in Height
  Item 203.7010 17: Wire Rope Rock Catchment Fence (Medium Impact) 3.05 Meters in Height
  Item 203.7012 17: Wire Rope Rock Catchment Fence (Medium Impact) 3.66 Meters in Height
  Item 203.17111017: Chain Link Rock Catchment Fence
Item 203.1711117: Chain Link Rock Catchment Fence with Vinyl Coated Chain Link on Front Face
Item 203.74 17: Temporary Rock Catchment Barrier (3 m High)
Item 203.75 17: Wire Mesh Drape
Item 203.76 17: Bolted Wire Rope Net
Item 203.77 17: Wire Mesh Slope Protection

The following Standard Specifications are approved:
Item 212.0106: Wire Rope Rock Catchment Fence (Medium Impact - 1.8 m)
Item 212.0108: Wire Rope Rock Catchment Fence (Medium Impact - 2.4 m)
Item 212.0110: Wire Rope Rock Catchment Fence (Medium Impact - 3.0 m)
Item 212.0112: Wire Rope Rock Catchment Fence (Medium Impact - 3.7 m)
Item 212.0201: Chain Link Rock Catchment Fence
Item 212.0202: Vinyl Coated Chain Link Rock Catchment Fence
Item 212.03: Wire Mesh Slope Protection
Item 212.04: Wire Mesh Drape
Item 212.0501: Temporary Rock Catchment Barrier (3.0 m)
Item 212.0502: Move Temporary Rock Catchment Barrier (3.0 m)

TRANSMITTED MATERIALS:
Standard Specification shelf notes of Section 212 Rock Slope Reinforcement and Catchment Systems. Both metric and U.S. Customary shelf notes are attached.

BACKGROUND: The NYS Department of Transportation is implementing Trns-Port SiteManager, including both Construction and Materials functionality. Implementation of standard AASHTO software enables SiteManager to allow revising this agency’s practices to be more consistent with industry-accepted best practices. The revisions to the Standard Specifications are to minimize the overall quantity of special specifications.

CONTACT: Questions or comments regarding this issuance should be directed to Randall J. Romer, P.E., of the Geotechnical Engineering Bureau at (518) 457-4714, rromer@dot.state.ny.us. Questions or comments regarding the technical aspects of the Standard Specifications should be directed to Yves Nazon, of the Geotechnical Engineering Bureau at (518) 457-4729, ynazon@dot.state.ny.us.
Make the following changes to the Standard Specifications dated May 4, 2006 as modified by EI 08-046:

Page 199, add the following after Section 211:

SECTION 212 – ROCK SLOPE REINFORCEMENT AND CATCHMENT SYSTEMS

212-1 DESCRIPTION. This work shall consist of furnishing and installing rock slope stabilization techniques or roadside protective measures in conformance with payment lines, type, size, and at the locations specified in the contract documents.

212-1.01 Definitions.
   A. General. As outlined in Section 203 Excavation and Embankment, all rock slopes shall be thoroughly scaled and cleaned of unsound material and loose masses of rock. This section provides requirements for specific techniques developed to address situations where a hazardous rock slope situation still exists after stripping and scaling in order to control a rockfall within a designated rockfall catchment area.
   B. Rock Fall. A rockfall is the movement of rock from a slope that is so steep the rock continues to move down slope. The movement may be by free falling, bouncing, rolling or sliding.
   C. Rock Catchment Area. The rockfall catchment area is defined as the area between the edge of roadway pavement and the base of an adjacent rockslope that is used to restrict rockfall from reaching the roadway. The term catchment area is synonymous with ditch, rockfall ditch, rockfall catch ditch and rock fallout area. The catchment area width is the horizontal distance between the roadway edge of pavement and the base (toe) of a rockslope.
   D. Rock Catchment Fences. Rock catchment fences are techniques to control rockfalls within the R.O.W. Rock catchment fences are wire or cable mesh draped from support columns situated to define the catchment area. The catchment fence, or impact section, attenuates the rockfall energy to capture the falling rock and maintain it within the catchment area.
   E. Rock Mesh Slope Protection. Rock mesh slope protection is a technique to control rockfalls within the R.O.W. Rock mesh slope protection is the placement of wire or cable mesh on a slope face. The mesh controls the descent of falling rock, which accumulates near the base of the slope within the catchment area.

212-2 MATERIALS

212-2.01 Wire Rope Rock Catchment Fence. The rock catchment fence system, as obtained from the manufacturer, shall have a tested capability of retaining a rock impact of 201 kJ of kinetic energy. The result of demonstration tests shall be furnished as required by the Engineer.

   A. Net Assembly. Provide a fence consisting of a net conforming to §710-06 Rock Slope Net and Wire Mesh Assemblies, Net Assembly.
      Cover all nets with chain link mesh fencing material of a minimum 11 gauge, 50 mm zinc coated mesh, conforming to the requirements of §710-02 Galvanized Steel Fence Fabric.

   B. Wire Ropes. Provide the following wire ropes:
4. **Anchor Cables.** Provide anchor cables conforming to §710-27 Rock Slope Wire Ropes, Anchor Cable.

Braking elements in the tieback restraining cable shall incorporate a protective, crushable sleeve as recommended by the manufacturer.

**C. Support Columns.** Fabricate the net support columns from W200 x 71 wide flange members conforming to the requirements of §715-18 Soldier Piles.

**D. Miscellaneous Appurtenances.** All steel bolts, nuts and washers shall conform to the requirements of §723-60 Anchor Bolts. All miscellaneous appurtenances such as wire rope clips, thimbles, bolts, etc., shall be galvanized as supplied by the manufacturer.

### 212-02 Chain Link Rock Catchment Fence.

**A. Fence Fabric.** Provide aluminum coated steel fence fabric a minimum of 6 gauge, chain link type with twist selvage edges, conforming to the requirements of §710-04 Aluminum Coated Steel Fence Fabric, except for gauge.

Vinyl coated steel fence fabric shall be 9 gauge, chain link type with twist selvage edges, conforming to the requirements of §710-03 Vinyl Coated Steel Fence Fabric, Class A Wire Diameter, except color. The color shall be black unless otherwise specified in the contract documents.

**B. Cables.** Provide galvanized guide rail cables a minimum 19 mm in diameter, consisting of 3 strands (7 wires per strand) conforming to the requirements of §710-22 Cable Guide Railing and having a minimum tensile strength of 110 kN.

**C. Posts.** Provide No. 36 steel rebar posts and No. 29 hook bar anchors conforming to the requirements of §709-01 Bar Reinforcement, Grade 420. The rebar posts and hook bar anchors shall be galvanized in accordance with the requirements of §719-01 Galvanized Coatings and Repair Methods, Type I. Exposed cut ends shall be field repaired in accordance with §719-01 Galvanized Coatings and Repair Methods. Hook bar anchors shall have a 180° hook with an outside diameter of 286 mm.

No. 36 steel rebar posts shall also conform to the requirements of §709-04 Epoxy-Coated bar Reinforcement, except color. The color shall be as specified on the plans or by the Engineer.

**D. Grout.** Provide grout to fill the annular space around the No. 36 steel rebar posts, No. 29 hook bar anchors and for backfilling below the anchor angle, conforming to the requirements of §701-05 Concrete Grouting Material.

**E. Anchor Angles.** Provide 610 mm long sections of anchor angles of 200 mm by 150 mm by 25 mm steel angle. The steel shall conform to the requirements of §715-01 Structural Steel and shall be galvanized in accordance with §719-01 Galvanized Coatings and Repair Methods, Type I. The anchor angle shall have two 50 mm diameter holes (for the bolts) bored through the 200 mm side. The holes shall be centered 105 mm in from each end along a line 75 mm in from the edge opposite the angle. The anchor angle shall also have three 21 mm diameter holes drilled on 100 mm centers along the centerline, with the middle hole located in the center of the 150 mm side for attachment of the steel turnbuckles.

**F. Rock Bolt Assembly.** Provide 32 mm nominal diameter, 1450 mm long, rock bolt assembly conforming to the requirements of §731-03 Rock Bolt Assembly.

Provide galvanized and Epoxy-coated 9.5 mm x 63.5 mm throat by 114 mm depth “U” bolts as shown in Detail’s C1 & C2 of the Standard Sheet M212-4 Chain Link Rock Catchment Fence with
ROCK SLOPE REINFORCEMENT AND CATCHMENT SYSTEMS

3.5 mm thread length to clamp 19 mm guide rail cables to No. 36 rebar posts.

G. Miscellaneous Appurtenances.

1. **Thimbles.** Provide galvanized thimbles for 19 mm guide rail cable conforming to the requirements of §710-22 Cable Guide Railing and as shown in Detail F of the Standard Sheet M212-5 Chain Link Rock Catchment Fence.

2. **Clips.** Provide galvanized cable clips for 19 mm guide rail cable conforming to the requirements of §710-22 Cable Guide Railing and as shown in Detail F of the Standard Sheet M212-5 Chain Link Rock Catchment Fence.

3. **Turnbuckles.** Provide galvanized steel turnbuckle cable end assemblies conforming to the requirements of §710-22 Cable Guide Railing and as shown in Detail G of the Standard Sheet M212-5 Chain Link Rock Catchment Fence.

4. **Cable Splices.** Provide galvanized cable splices conforming to the requirements of §710-22 Cable Guide Railing and as shown in Detail H of the Standard Sheet M212-5 Chain Link Rock Catchment Fence.

5. **Wedges.** Provide wedges for cable splices and cable ends conforming to the requirements of §710-22 Cable Guide Railing and as shown in Detail X of the Standard Sheet M212-5 Chain Link Rock Catchment Fence.

6. **Wire Ties.** Provide galvanized steel wire ties (12 gauge).

212-2.03 Wire Mesh Slope Protection.

A. **Wire Mesh.** Provide wire mesh conforming to §710-06 Rock Slope Net and Wire Mesh Assemblies, Wire Mesh.

B. **Cables.** Provide galvanized mesh support cables having a minimum diameter of 19 mm, 6 x 19 Independent Wire Rope Core (IWRC) construction (or equivalent), conforming to the requirements of §710-22 Cable Guide Railing.

C. **Anchors.** Provide galvanized 19 mm diameter wire rope anchors conforming to the requirements of §710-22 Cable Guide Railing.

   Furnish anchor centralizers consisting of plastic, steel or any material not detrimental to the anchor. Do not use wood.

D. **Grout.** Provide grout conforming to the requirements of §701-05 Concrete Grouting Material.

E. Miscellaneous Appurtenances.

1. **Seam Wire Rope.** Provide seam rope conforming to §710-27 Rock Slope Wire Ropes, Seam Rope for Wire Mesh Slope Protection.

2. **Steel Rings.** Provide 25 mm x 101 mm steel rings conforming to the requirements of Federal Specification RR-C71D Type VI.

3. **Clips.** Provide 19 mm wire rope clips conforming to the requirements of §710-22 Cable Guide Railing.

4. **Thimbles.** Provide 19 mm thimbles conforming to the requirements of §710-22 Cable Guide Railing.

212-2.04 Wire Mesh Drape.

A. **Wire Mesh Drape.** Provide wire mesh drape conforming to the requirements of §710-06 Rock Slope Net and Wire Mesh Assemblies, Rock Slope Wire Mesh Drape Assembly.
B. Cables. Provide galvanized mesh support cables a minimum 19 mm in diameter, consisting of 3 strands (7 wires per strand) conforming to the requirements of §710-22 Cable Guide Railing and having a minimum tensile strength of 110 kN.

C. Miscellaneous Appurtenances. Provide appurtenances, galvanized as supplied by manufacturer, as follows:

1. Tie Wire. Provide 2.2 mm minimum diameter steel tie wire.
2. Hog Rings. Provide 3 mm minimum diameter (11 gauge) hog rings or other steel fasteners.
3. Steel Rings. Provide welded forged steel rings with a stock diameter of 25 mm and a maximum inside diameter of 101 mm.

D. Rock Bolt Assembly. Provide 32 mm nominal diameter, 2 m long (min.), rock bolt assembly conforming to the requirements of §731-03 Rock Bolt Assembly except resin packages of one setting time only shall be utilized for installation of the mesh support and cable anchor rock bolts.

212-0.5 Temporary Rock Catchment Barrier.

A. Precast Concrete Barrier Units. Provide precast concrete barrier units consisting of three (3) components; precast concrete column supports, precast temporary concrete barriers, and precast concrete beams as detailed on the Standard Sheet M212-9 & 10 Temporary Rock Catchment Barrier.

1. Precast Concrete Column Supports. Provide precast concrete column supports conforming to the requirements of §704-05 Precast Concrete Barrier and to the dimensions and details “F”, “G”, “H”, “I”, and “N” on the Standard Sheet M212-10 Temporary Rock Catchment Barrier. Additional joint connection details shall be as shown on Standard Sheet M619-70 & 71 Temporary Concrete Barrier.

   Each column support shall have cast-in-place a 152 mm x 152 mm x 6.4 mm structural steel tube to be used for support of the wire rope rock fence. The tube steel shall conform to the requirements of ASTM A500, Grade B or C, and shall conform to the dimensions and detail “N” on the Standard Sheet M212-10 Temporary Rock Catchment Barrier.

2. Precast Temporary Concrete Barriers. Provide precast temporary concrete barriers conforming to the requirements of §704-05 Precast Concrete Barrier and to the dimensions, joint connections, material details, and anchoring details shown on Standard Sheet M619-70 & 71 Temporary Concrete Barrier.

3. Precast Concrete Beams. Provide precast concrete beams conforming to the requirements of §704-05 Precast Concrete Barrier and to the dimensions and details “K”, and “M” shown on the Standard Sheet M212-10 Temporary Rock Catchment Barrier.

The Engineer will inspect all precast concrete barrier unit components upon delivery to the project site for conformance to specifications. Any barrier unit component having damage and/or defects in the concrete and/or joint connections will be rejected.

The precast concrete barrier units shall form a smooth and continuous barrier when joined together. Any sections damaged or misaligned while in service shall be corrected or replaced.

B. Net Support Columns. Fabricate the net support columns from W130 x 24 wide flange members conforming to the requirements of §715-18 Soldier Piles

Each support column shall have four (4) pairs (eight holes) of 25 mm diameter holes drilled on the side facing the rock slope. Two (2) holes shall be situated 75 mm from the top of the post and the remaining three (3) pairs spaced equally approximately 1015 mm apart.

After any required drilling, welding and/or cutting, all support columns and related hardware shall be hot dipped galvanized in accordance with the requirements of §719-01 Galvanized Coatings and Repair Methods, Type I.

D. Wire Rope Netting. Provide wire rope netting conforming to §710-06 Rock Slope Net and Wire Mesh Assemblies, Net Assembly.

Two (2) aluminum stop sleeves shall be used at all locations where two individual wire ropes are joined together.

The 200 mm x 200 mm mesh size shall be fabricated using high strength, hot dipped, galvanized steel clips, which are attached so that they are non-moveable. Nets damaged during clipping shall be rejected by the Engineer.

E. Chain Link Fence Fabric. Provide a minimum of 9 gauge chain link fence fabric conforming to the requirements of §710-02 Galvanized Steel Fence Fabric. The galvanized chain link fence fabric shall be 3658 mm high and have a 50 mm mesh size. The chain link fence fabric shall be continuous between wire rope net panels.

F. Synthetic Fabric Layer. Provide a synthetic fabric, 3200 mm in height conforming to the requirements of §737-01A Geotextile Bedding.

G. Cushion Sand. Provide sand conforming to the requirements of §703-06 Cushion Sand.

H. Miscellaneous Material. Provide miscellaneous hardware such as shackles, thimbles, wire clips, bolts, etc. which shall be hot dipped galvanized in accordance with §719-01 Galvanized Coatings and Repair Methods, Type I.

212-2.06 Move Temporary Rock Catchment Barrier. None Specified.

212-3 CONSTRUCTION DETAILS

212-3.01 Wire Rope Rock Catchment Fence. Assemble the wire rope rock catchment fence as detailed on the Standard Sheet M212-1, 2 & 3 Wire Rope Rock Catchment Fence.

Submit to the Engineer for approval not less than two weeks prior to the installation of the wire rope rock catchment fence. Do not begin work prior to approval. Provide the following:

a) Proposed start date, completion date and detailed construction sequence.

b) Proposed anchor drilling method and equipment including hole diameter, method of keeping holes open, and hole clean out procedures.

c) Proposed anchor installation procedure including grout placement procedures, grouting equipment, and the procedure for setting the wire rope anchor centralizers.

d) Method of verifying anchor capacity and equipment setup including details of the jacking frame and appurtenant bracing. Include the calibration data for the stressing device. The calibration shall be performed by an independent testing laboratory within 60 calendar days of the submittal date.

Install grouted wire rope anchors with accompanying centralizers at the top of the rock slope on 3.5 m centers or as indicated by Engineer. Mix grout per manufacturer’s instructions. Wait a minimum of 7 days after grouting before applying any load to the anchors. Proof test each anchor in accordance with §212-3.03 A. Anchor Testing.

Fasten all net braiding with high strength, corrosion resistant clips or other fasteners to produce a permanent, non-movable joint. Damage to the wire rope resulting from the installation of the clips, insofar as it affects the integrity of the system, in the opinion of the Engineer, shall be cause for rejection of the net panel.
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Cut the chain link material to fit each wire rope netting panel. Attach the chain link mesh fencing material to the inside face of the wire rope nets with clips to extend a minimum of 0.9 m beyond the bottom of the fence.

Provide and install one braking element per top and bottom net supporting rope per 6.1 m net section. Position the braking element not more than 0.9 m from the column.

Use seam ropes to fasten adjacent wire rope nets and the nets to the net support wire ropes, with at least 1 wrap per 0.4 m.

The column spacing shall be 6.1 m.

Install a tie-back restraining cable to extend from the top of each column in a direction perpendicular to the length of the fence and on the slope side of the fence. Install a braking element in each cable not more than 0.9 m from the column.

For a fence whose length is 36.6 m or less, both end columns shall have a lateral restraining cable without the braking element. This cable shall extend from the top of the column at an angle of 60° from the vertical to the ground. For a fence which is longer, install lateral restraining cables at every multiple of 36.6 m, or approximately midway for a fence less than 73.2 m.

Paint the fence installation where specified, with the appropriate material and color as directed by the Engineer.

212-3.02 Chain Link Rock Catchment Fence. Assemble the chain link rock catchment fence as detailed on the Standard Sheet M212-4 & 5 Chain Link Rock Catchment Fence.

Install galvanized No. 36 steel rebar posts in 50 mm diameter vertical holes drilled to a minimum depth of 610 mm into rock. Post spacing shall be 2440 mm. Pour a sufficient amount of concrete grouting material into the hole before inserting the post to allow overflow after insertion.

Install anchor angles for terminal sections. The location of the anchor angles shall be in line with the corresponding fence section and shall be determined by the angle (60° minimum) between the top longitudinal cable and the end post. The angle between any longitudinal cable and the end post shall not exceed 90°. Drill bolt holes for anchor angles into the rock spaced 400 mm on-center to a depth of 1220 mm. The bolt hole diameter shall be compatible with the bolt/drill hole/resin cartridge diameter, as recommended by the bolt manufacturer, but in no case shall the bolt hole diameter exceed the resin cartridge diameter by more than 10 mm. Install the anchor angle within 90° ± 15° to the axis of the rock bolt and in intimate contact with the rock surface for its entire contact area. Acceptable methods of leveling the rock surface include the following:

a) Chipping the rock surface.

b) Applying a special mix supplied by the bolt manufacturer for leveling purposes.

c) A combination of chipping and leveling.

Clean out the bolt hole to its full depth with air or water. Place the appropriate amount of resin in the hole. Insert the bolt into the hole and rotate at approximately 100 rpm while pushing the bolt down through the resin cartridges to the bottom of the hole by a means approved by the Engineer. Rotate the bolt in this position for 30 to 60 seconds to insure mixing of the resin in the hole. Do not rotate the bolt longer than the setting time of the resin. Leave the bolts undisturbed in the hole for the time required for the resin to harden. Place the anchor angle over the bolts on the prepared surface and add the appurtenances. Tension the bolts to 180 kN by means of hollow-ram hydraulic jack, or as ordered by the Engineer. Support the base of the jack at 90°± 2° to the axis of the bolt.

If a failure of the bolt or anchorage occurs, a determination of the cause of failure will be made by a Departmental Engineering Geologist. Correct, as ordered by the Engineer, at no cost to the State, failures attributable to causes other than failure of the rock in the anchorage zone.

The State reserves the right to sample and test delivered materials.

Install No. 29 hook bar anchors on the uphill side of the fence, one hook bar anchor at each post located in a direction normal to the fence alignment. The location of the hook anchor on the ground surface shall be determined by the angle (60°± 5°) between the tie-back cable and the post at the top longitudinal cable. Construct hook bar anchorage according to depth of overburden.
Install No. 29 hook bar anchors at intermediate fence sections. The location of the hook bar anchors shall be in line with the corresponding fence section and shall be determined by the angle between the longitudinal cables and the intermediate anchorage post. This angle shall be between a minimum of 60°±5° and a maximum of 90°. Construct hook bar anchorages according to depth of overburden.

Secure longitudinal cables to anchor angles at terminal sections with steel turnbuckle cable end assemblies. Secure longitudinal cables at intermediate fence sections to hook bar anchors with one (1) thimble, and four (4) cable clips per cable loop. The maximum distance between terminal sections, and/or intermediate anchorage sections, shall be 60 m.

Secure 19 mm longitudinal guide rail cables to rebar posts with “U” bolts so as to have minimum sag without bending posts. Cable splices shall be staggered a minimum of 6 m on adjacent cables. Splices shall be spaced a minimum of 30 m on the same cable.

Recommended installation sequence:
   a) Start with lowest longitudinal cable working from one terminal anchorage toward another or toward an intermediate anchorage, if used.
   b) Draw cable taut and secure with “U” bolt to posts.
   c) Complete tightening entire length of lower cable between anchorages before starting next higher cable.

Install aluminum fence fabric on uphill side of posts. Attach fence fabric to longitudinal cables with 12 gauge galvanized steel wire ties at 305 mm intervals. Fence fabric splices shall be overlapped a minimum of four chain link rows. Attach fabric sections by tying both ends of the overlap at 305 mm intervals, or by a method approved by the Engineer.

Install vinyl coated fence fabric on roadway side of posts. Attach fence fabric to longitudinal cables with 9 gauge vinyl coated steel wire ties at 305 mm intervals. Fence fabric splices shall be overlapped a minimum of four chain link rows. Attach fabric sections by tying both ends of the overlap at 305 mm intervals, or by a method approved by the Engineer.

Bottom of fence fabric shall be in contact with the ground surface. Add fence fabric material as necessary. Added material shall be overlapped a minimum of four chain link rows. Tie both ends of the overlap at 305 mm intervals, or as approved by the Engineer.

Attach tie-back cables on uphill side of rebar posts after longitudinal cables have been tightened and chain link fence fabric has been installed. Tie-back cables shall have a maximum sag of 19 mm measured at the center.

212-3.03 Wire Mesh Slope Protection. Assemble the wire mesh slope protection as detailed on the Standard Sheet M212-6 & 7 Wire Mesh Slope Protection.

Design the grouted wire rope anchors so that the design load (P) is at least equal to 134 kN.

Submit shop drawings to the Engineer for approval not less than two weeks prior to the installation of the wire mesh slope protection. Do not begin work prior to approval. Provide drawings including the following:
   a) Proposed start date, completion date and detailed construction sequence.
   b) Details of the wire mesh and anchor layout on the existing slope.
   c) Proposed anchor drilling method and equipment including hole diameter, method of keeping holes open, and hole clean out procedures.
   d) Proposed anchor installation procedure including grout placement procedures, grouting equipment, and the procedure for setting the wire rope anchor centralizers.
   e) Method of verifying anchor capacity and equipment setup including details of the jacking frame and appurtenant bracing. Include the calibration data for the stressing device. The calibration shall be performed by an independent testing laboratory within 60 calendar days of the submittal date.

Install grouted wire rope anchors with accompanying centralizers at the top of the rock slope on 3.5 m centers or as indicated by Engineer. Mix grout per manufacturer’s instructions. Wait a minimum of 7 days after grouting before applying any load to the anchors. Proof test each anchor in accordance with §212-
3.03 A. Anchor Testing.

Connect vertical wire rope tag lines to the anchors. Connect the horizontal support cable(s) to the vertical tag lines with steel rings as shown on the attached drawing for this specification. Do not draw cable taut. Maintain a minimum cable sag of 19 mm on the horizontal support cable between vertical tag lines.

Attach the mesh to the horizontal support cable by a continuous weave through each of the mesh openings with galvanized 8 mm seam wire rope, as shown on the attached drawing for this specification.

Install the wire mesh in vertical strips. Overlay horizontal and vertical laps a minimum of 0.3 m and connect with a continuous weave through each of the mesh openings with galvanized 8 mm seam wire rope along the edge of the upper mesh strip. The mesh shall be installed in such a manner that the end of a roll curls into the rock face.

Install the wire mesh to cover the specified area of rock face.

A. Anchor Testing. Proof test each anchor. Perform the proof test by incrementally loading and unloading the anchors to 1.5 times the design load (P) in accordance with Table 212-1 Wire Mesh Slope Protection Proof Test Load Schedule. Record the anchor movements to the nearest 0.025 mm at each load increment.

<table>
<thead>
<tr>
<th>Load¹</th>
<th>Observation Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>AL</td>
<td>Minimum of 1 minute²</td>
</tr>
<tr>
<td>0.25 P</td>
<td>Minimum of 1 minute²</td>
</tr>
<tr>
<td>0.50 P</td>
<td>Minimum of 1 minute²</td>
</tr>
<tr>
<td>0.75 P</td>
<td>Minimum of 1 minute²</td>
</tr>
<tr>
<td>1.00 P</td>
<td>Minimum of 1 minute²</td>
</tr>
<tr>
<td>1.25 P</td>
<td>Minimum of 1 minute²</td>
</tr>
<tr>
<td>1.50 P (Load Hold)²</td>
<td>10 minutes (or 60 minutes depending on total movement³)</td>
</tr>
</tbody>
</table>

¹P = Design Load
AL = Alignment Load. The AL necessary to maintain position of the stressing and testing equipment shall not exceed 0.05 P. Set dial gauges to “zero” after the alignment load has been applied.

²Hold each load increment, except for the 1.5 P load, until the deflection stabilizes.

³The load hold portion of the proof test is a maximum test load of 1.50 P, which shall be held constant for 10 minutes. The load hold time shall start when the pump begins to load the anchor from the 1.25 P load to the test load. A load cell shall be used to monitor the constant load. Total movements with respect to an independent fixed reference point shall be recorded at 1 minute, 2, 3, 4, 5, 6, and 10 minutes. If the total movement between 1 minute and 10 minutes exceeds 1 mm, the test load shall be held for an additional 50 minutes. Total movements shall be recorded at 15, 20, 25, 30, 45 and 60 minutes.

No part of the temporary yoke or load frame shall bear within 0.9 m of the anchor. Plot the movement versus load for each increment.

An anchor will be accepted by the Engineer if the creep rate at 1.5P does not exceed 1 mm between the 1 and 10 minute readings or for a load hold time of 60 minutes, the creep rate does not exceed 2 mm per log cycle of time. If an anchor fails the proof test, install a new anchor at no cost to the State.
212-3.04 Wire Mesh Drape. Assemble the wire mesh drape as detailed on the Standard Sheet M212-8 Wire Mesh Drape.

Install untensioned resin rock bolts at the top of the rockslope on 15 m centers (maximum) or as shown in the contract documents. Proof test the first rock bolt per resin lot number to 90 kN in accordance with §212-3.03 A. Anchor Testing.

Place 19 mm diameter guide rail cable horizontally across the top of the rock slope, secured by 32 mm diameter resin rock bolts. Maintain a minimum cable sag of 0.6 to 0.8 m between rock bolts. Do not draw cable taut. Splices of the guide rail cable will not be allowed.

Fold the mesh over or under the guide rail cable a minimum of 0.3 m and connect the horizontal lap with galvanized tie wire with a continuous weave through each of the mesh openings.

Install the wire mesh in vertical strips, each lapped over the other by a minimum of 0.3 m. Connect the adjacent vertical strips by either a continuous weave of galvanized tie wire along the edge of the outer mesh strips only, or with hog rings or metal ties on a 150 mm staggered pattern along the edges of both panels. When used, overlay horizontal laps a minimum of 0.3 m and connect with a continuous weave of galvanized tie wire along the edge of the upper mesh strip.

Install the wire mesh to cover the area of rock face identified in the contract documents.

Repair all damaged galvanized surfaces in accordance with §719-01 Galvanized Coatings and Repair Methods.

212-3.05 Temporary Rock Catchment Barrier. Assemble and maintain the temporary rock catchment barrier as detailed on the Standard Sheet M212-9 & 10 Temporary Rock Catchment Barrier.

A. Precast Concrete Barrier Units. Each run, or bay, of precast concrete barrier units (precast concrete column support, precast temporary concrete barrier and precast concrete beam) shall be fastened together to form a continuous chain. After placement, each successive unit shall be moved longitudinally to remove any slack in the connecting joint. The units at each end of a run or bay shall be connected as shown on Standard Sheet M619-70 & 71 Temporary Concrete Barrier. To reduce movement of the barrier in areas where limited deflection is desired, one of the anchoring methods shown on Standard Sheet M619-70 & 71 Temporary Concrete Barrier shall be used. Where shown in the contract documents, the ends of the barrier run shall be fitted with an impact attenuation device or a tapered end section and flared back.

The empty space within each concrete barrier unit shall be filled with sand for the full height (813 mm) of the unit. The back of the concrete barrier units shall also be covered with sand to the full height of the unit. The sand shall then be laid back at the angle of repose of the material to a minimum sand thickness of 457 mm as shown in detail “E” on Standard Sheet M212-9 Temporary Rock Catchment Barrier. The cost of installing and removing the sand, including the final cleaning of the pavement and shoulder, shall be included in the bid price for this Item.

The Contractor shall provide and maintain delineation of temporary barriers. This delineation shall make the barrier visible to approaching traffic, as well as to traffic which is adjacent to the barrier. The Contractor shall have the choice of using one or more of the following: warning lights, delineators, pavement marking, reflective tape placed on the barrier, reflective paint, or any other device subject to the approval of the Engineer. The delineation devices shall be maintained dirt and snow free, and be visible throughout the term of the contract including shutdown periods.

B. Net Support Columns. The W 130 x 24 posts shall be installed in the 152 mm x 152 mm x 6.4 mm structural steel tubes cast in the precast concrete column support units. The columns shall be inserted flush with the bottom of the precast concrete column supports.

C. Net Support and Lateral Anchor Ropes. The 16 mm net support wire ropes shall be installed as shown in detail “B” on Standard Sheet M212-9 Temporary Rock Catchment Barrier. The net support wire
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rope shall have maximum sag of 50 mm. At both end sections and at every 38.1 m section of temporary catchment barrier (five precast concrete barrier units) install lateral anchors as shown in detail “C” on Standard Sheet M212-9 Temporary Rock Catchment Barrier. The wire rope loop at a 19 mm shackle connection shall be secured with three (3) wire rope clips as shown in detail “J” on Standard Sheet M212-10 Temporary Rock Catchment Barrier.

D. Rock Catchment Fence Fabric. The rock catchment fence fabric (wire rope net, chain link fence fabric and synthetic fabric) shall be attached to the support rope after the concrete barrier units have been installed.

The wire rope net panels shall be attached to the support ropes with 19 mm shackles spaced approximately 900 mm apart. The chain link fence fabric, 3658 mm in height, shall be attached to the wire rope net with hog rings or twist ties. The area between two adjacent wire rope net panels shall be covered with chain link fence fabric. The layer of synthetic fabric, with a minimum height of 3200 mm, shall be attached to the chain link fence.

212-3.06 Move Temporary Rock Catchment Barrier. Move and reset the temporary rock catchment barrier in accordance with the requirements of §212-3.05 Temporary Rock Catchment Barrier.

212-4 METHOD OF MEASUREMENT

212-4.01 Wire Rope Rock Catchment Fence. Wire rope rock catchment fence will be measured as the number of linear meters of fencing, measured from center-to-center of end posts.

212-4.02 Chain Link Rock Catchment Fence. Chain link rock catchment fence will be measured as the number of linear meters of fence, measured along the top of the fence between the terminal posts. An allowance of 3 linear meters will be added for each terminal section anchorage and for each intermediate section anchorage installed.

212-4.03 Wire Mesh Slope Protection. Wire mesh slope protection will be measured as the number of square meters of rock face satisfactorily covered. No measurement will be made of wire mesh used in any overlap.

212-4.04 Wire Mesh Drape. Wire mesh drape will be measured as the number of square meters of rock face satisfactorily covered. No measurement will be made of wire mesh used in any overlap.

212-4.05 Temporary Rock Catchment Barrier. Temporary rock catchment barrier will be measured as the number of linear meters of barrier, measured along the centerline of the uppermost concrete barrier surface, from one end anchor to the other.

212-4.06 Move Temporary Rock Catchment Barrier. Moving temporary rock catchment barrier will be measured as the number of linear meters of barrier moved, measured along the centerline of the uppermost concrete barrier surface, from one end anchor to the other.

212-5 BASIS OF PAYMENT

212-5.01 Wire Rope Rock Catchment Fence. The unit price bid per linear meter for wire rope rock catchment fence shall include the costs of furnishing all labor, material and equipment necessary to complete the work.

212-5.02 Chain Link Rock Catchment Fence. The unit price bid per linear meter for chain link rock catchment fence shall include the costs of furnishing all labor, material and equipment necessary to
complete the work.

212-5.03 Wire Mesh Slope Protection. The unit price bid per square meter for wire mesh slope protection shall include the costs of furnishing all labor, material and equipment necessary to complete the work, including anchor testing and disposal of any material removed from the slope.

212-5.04 Wire Mesh Drape. The unit price bid per square meter for wire mesh drape shall include the costs of furnishing all labor, material and equipment necessary to complete the work, including anchor testing and disposal of any material removed from the slope.

212-5.05 Temporary Rock Catchment Barrier. The unit price bid per linear meter for temporary rock catchment barrier shall include the costs of furnishing all labor, material and equipment necessary to erect, maintain, and remove the required barrier, including any required connection devices, end treatments, delineation or guiding devices, and devices for pinning and connecting temporary precast concrete barrier units.

After placement, 90% of the item unit price will be paid. The remaining 10% will be paid when the rock catchment barrier has been removed.

212-5.06 Move Temporary Rock Catchment Barrier. The unit price bid per linear meter for moving temporary rock catchment barrier shall include the costs of furnishing all labor, material and equipment necessary to remove, transport, erect, and maintain the required barrier, including any required connection devices, end treatments, delineation or guiding devices, and devices for pinning and connecting temporary precast concrete barrier units.

Movements necessary to maintain, realign, or replace damaged units will not be considered as moving temporary rock catchment barrier and shall be done at no additional cost to the State.

Payment will be made under:

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<tr>
<th>Item No.</th>
<th>Item</th>
<th>Pay Unit</th>
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<tbody>
<tr>
<td>212.0106</td>
<td>Wire Rope Rock Catchment Fence (Medium Impact – 1.8 m)</td>
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<tr>
<td>212.0108</td>
<td>Wire Rope Rock Catchment Fence (Medium Impact – 2.4 m)</td>
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<td>212.0110</td>
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Make the following changes to the Standard Specifications dated May 1, 2008 as modified by EI 08-046:

Page 204, add the following after Section 211:

SECTION 212 – ROCK SLOPE REINFORCEMENT AND CATCHMENT SYSTEMS

212-1 DESCRIPTION. This work shall consist of furnishing and installing rock slope stabilization techniques or roadside protective measures in conformance with payment lines, type, size, and at the locations specified in the contract documents.

212-1.01 Definitions.
   A. General. As outlined in Section 203 Excavation and Embankment, all rock slopes shall be thoroughly scaled and cleaned of unsound material and loose masses of rock. This section provides requirements for specific techniques developed to address situations where a hazardous rock slope situation still exists after stripping and scaling in order to control a rockfall within a designated rockfall catchment area.
   B. Rock Fall. A rockfall is the movement of rock from a slope that is so steep the rock continues to move down slope. The movement may be by free falling, bouncing, rolling or sliding.
   C. Rock Catchment Area. The rockfall catchment area is defined as the area between the edge of roadway pavement and the base of an adjacent rockslope that is used to restrict rockfall from reaching the roadway. The term catchment area is synonymous with ditch, rockfall ditch, rockfall catch ditch and rock fallout area. The catchment area width is the horizontal distance between the roadway edge of pavement and the base (toe) of a rockslope.
   D. Rock Catchment Fences. Rock catchment fences are techniques to control rockfalls within the R.O.W. Rock catchment fences are wire or cable mesh draped from support columns situated to define the catchment area. The catchment fence, or impact section, attenuates the rockfall energy to capture the falling rock and maintain it within the catchment area.
   E. Rock Mesh Slope Protection. Rock mesh slope protection is a technique to control rockfalls within the R.O.W. Rock mesh slope protection is the placement of wire or cable mesh on a slope face. The mesh controls the descent of falling rock, which accumulates near the base of the slope within the catchment area.

212-2 MATERIALS

212-2.01 Wire Rope Rock Catchment Fence. The rock catchment fence system, as obtained from the manufacturer, shall have a tested capability of retaining a rock impact of 155 kip-ft of kinetic energy. The result of demonstration tests shall be furnished as required by the Engineer.

   A. Net Assembly. Provide a fence consisting of a net conforming to §710-06 Rock Slope Net and Wire Mesh Assemblies, Net Assembly.
      Cover all nets with chain link mesh fencing material of a minimum 11 gauge, 2 in. zinc coated mesh, conforming to the requirements of §710-02 Galvanized Steel Fence Fabric.

   B. Wire Ropes. Provide the following wire ropes:
ROCK SLOPE REINFORCEMENT AND CATCHMENT SYSTEMS

   Braking elements in the tieback restraining cable shall incorporate a protective, crushable sleeve as recommended by the manufacturer.

C. Support Columns. Fabricate the net support columns from W8 x 48 wide flange members conforming to the requirements of §715-18 Soldier Piles.

D. Miscellaneous Appurtenances. All steel bolts, nuts and washers shall conform to the requirements of §723-60 Anchor Bolts. All miscellaneous appurtenances such as wire rope clips, thimbles, bolts, etc., shall be galvanized as supplied by the manufacturer.

212-2.02 Chain Link Rock Catchment Fence.

A. Fence Fabric. Provide aluminum coated steel fence fabric a minimum of 6 gauge, chain link type with twist selvage edges, conforming to the requirements of §710-04 Aluminum Coated Steel Fence Fabric, except for gauge.
   Vinyl coated steel fence fabric shall be 9 gauge, chain link type with twist selvage edges, conforming to the requirements of §710-03 Vinyl Coated Steel Fence Fabric, Class A Wire Diameter, except color. The color shall be black unless otherwise specified in the contract documents.

B. Cables. Provide galvanized guide rail cables a minimum ¾ in. in diameter, consisting of 3 strands (7 wires per strand) conforming to the requirements of §710-22 Cable Guide Railing and having a minimum tensile strength of 25 kips.

C. Posts. Provide No. 11 steel rebar posts and No. 9 hook bar anchors conforming to the requirements of §709-01 Bar Reinforcement, Grade 420. The rebar posts and hook bar anchors shall be galvanized in accordance with the requirements of §719-01 Galvanized Coatings and Repair Methods, Type I. Exposed cut ends shall be field repaired in accordance with §719-01 Galvanized Coatings and Repair Methods. Hook bar anchors shall have a 180° hook with an outside diameter of 11 in.
   No. 11 steel rebar posts shall also conform to the requirements of §709-04 Epoxy-Coated bar Reinforcement, except color. The color shall be as specified on the plans or by the Engineer.

D. Grout. Provide grout to fill the annular space around the No. 11 steel rebar posts, No. 9 hook bar anchors and for backfilling below the anchor angle, conforming to the requirements of §701-05 Concrete Grouting Material.

E. Anchor Angles. Provide 2 ft. long sections of anchor angles of 8 in. by 6 in. by 1 in. steel angle. The steel shall conform to the requirements of §715-01 Structural Steel and shall be galvanized in accordance with §719-01 Galvanized Coatings and Repair Methods, Type I. The anchor angle shall have two 2 in. diameter holes (for the bolts) bored through the 8 in. side. The holes shall be centered 4 in. in from each end along a line 3 in. in from the edge opposite the angle. The anchor angle shall also have three 7/8 in. diameter holes drilled on 4 in. centers along the centerline, with the middle hole located in the center of the 6 in. side for attachment of the steel turnbuckles.

F. Rock Bolt Assembly. Provide 1 ¼ in. nominal diameter, 5 ft. long, rock bolt assembly conforming to the requirements of §731-03 Rock Bolt Assembly.
   Provide galvanized and Epoxy-coated 3/8 in. x 2 ½ in. throat by 4 ½ in. depth “U” bolts as shown in Detail’s C1 & C2 of the Standard Sheet 212-4 Chain Link Rock Catchment Fence with 1/8 in. thread length to clamp ¾ in. guide rail cables to No. 11 rebar posts.
G. Miscellaneous Appurtenances.

1. **Thimbles.** Provide galvanized thimbles for ¾ in. guide rail cable conforming to the requirements of §710-22 *Cable Guide Railing* and as shown in Detail F of the Standard Sheet 212-5 *Chain Link Rock Catchment Fence*.

2. **Clips.** Provide galvanized cable clips for ¾ in. guide rail cable conforming to the requirements of §710-22 *Cable Guide Railing* and as shown in Detail F of the Standard Sheet 212-5 *Chain Link Rock Catchment Fence*.

3. **Turnbuckles.** Provide galvanized steel turnbuckle cable end assemblies conforming to the requirements of §710-22 *Cable Guide Railing* and as shown in Detail G of the Standard Sheet 212-5 *Chain Link Rock Catchment Fence*.

4. **Cable Splices.** Provide galvanized cable splices conforming to the requirements of §710-22 *Cable Guide Railing* and as shown in Detail H of the Standard Sheet 212-5 *Chain Link Rock Catchment Fence*.

5. **Wedges.** Provide wedges for cable splices and cable ends conforming to the requirements of §710-22 *Cable Guide Railing* and as shown in Detail X of the Standard Sheet 212-5 *Chain Link Rock Catchment Fence*.

6. **Wire Ties.** Provide galvanized steel wire ties (12 gauge).

**212-2.03 Wire Mesh Slope Protection.**

A. **Wire Mesh.** Provide wire mesh conforming to §710-06 *Rock Slope Net and Wire Mesh Assemblies*, Wire Mesh.

B. **Cables.** Provide galvanized mesh support cables having a minimum diameter of ¾ in., 6 x 19 Independent Wire Rope Core (IWRC) construction (or equivalent), conforming to the requirements of §710-22 *Cable Guide Railing*.

C. **Anchors.** Provide galvanized ¾ in. diameter wire rope anchors conforming to the requirements of §710-22 *Cable Guide Railing*.

   Furnish anchor centralizers consisting of plastic, steel or any material not detrimental to the anchor. Do not use wood.

D. **Grout.** Provide grout conforming to the requirements of §701-05 *Concrete Grouting Material*.

E. **Miscellaneous Appurtenances.**

   1. **Seam Wire Rope.** Provide seam rope conforming to §710-27 *Rock Slope Wire Ropes*, Seam Rope for Wire Mesh Slope Protection.

   2. **Steel Rings.** Provide 1 in. x 4 in. steel rings conforming to the requirements of Federal Specification RR-C71D Type VI.

   3. **Clips.** Provide ¾ in. wire rope clips conforming to the requirements of §710-22 *Cable Guide Railing*.

   4. **Thimbles.** Provide ¾ in. thimbles conforming to the requirements of §710-22 *Cable Guide Railing*.

**212-2.04 Wire Mesh Drape.**

A. **Wire Mesh Drape.** Provide wire mesh drape conforming to the requirements of §710-06 *Rock Slope Net and Wire Mesh Assemblies*, Rock Slope Wire Mesh Drape Assembly.

B. **Cables.** Provide galvanized mesh support cables a minimum ¾ in. in diameter, consisting of 3
strands (7 wires per strand) conforming to the requirements of §710-22 Cable Guide Railing and having a minimum tensile strength of 25 kips.

C. Miscellaneous Appurtenances. Provide appurtenances, galvanized as supplied by manufacturer, as follows:

1. Tie Wire. Provide 1/12 in. minimum diameter steel tie wire.
2. Hog Rings. Provide 1/8 in. minimum diameter (11 gauge) hog rings or other steel fasteners.
3. Steel Rings. Provide welded forged steel rings with a stock diameter of 1 in. and a maximum inside diameter of 4 in.

D. Rock Bolt Assembly. Provide 1 ¼ in. nominal diameter, 6 ½ ft. long (min.), rock bolt assembly conforming to the requirements of §731-03 Rock Bolt Assembly except resin packages of one setting time only shall be utilized for installation of the mesh support and cable anchor rock bolts.

212-2.05 Temporary Rock Catchment Barrier.

A. Precast Concrete Barrier Units. Provide precast concrete barrier units consisting of three (3) components: precast concrete column supports, precast temporary concrete barriers, and precast concrete beams as detailed on the Standard Sheet 212-9 & 10 Temporary Rock Catchment Barrier.

1. Precast Concrete Column Supports. Provide precast concrete column supports conforming to the requirements of §704-05 Precast Concrete Barrier and to the dimensions and details “F”, “G”, “H”, “I”, and “N” on the Standard Sheet 212-10 Temporary Rock Catchment Barrier. Additional joint connection details shall be as shown on Standard Sheet 619-01 Temporary Concrete Barrier.

Each column support shall have cast-in-place a 6 in. x 6 in. x ½ in. structural steel tube to be used for support of the wire rope rock fence. The tube steel shall conform to the requirements of ASTM A500, Grade B or C, and shall conform to the dimensions and detail “N” on the Standard Sheet 212-10 Temporary Rock Catchment Barrier.

2. Precast Temporary Concrete Barriers. Provide precast temporary concrete barriers conforming to the requirements of §704-05 Precast Concrete Barrier and to the dimensions, joint connections, material details, and anchoring details shown on Standard Sheet 619-01 Temporary Concrete Barrier.

3. Precast Concrete Beams. Provide precast concrete beams conforming to the requirements of §704-05 Precast Concrete Barrier and to the dimensions and details “K”, and “M” shown on the Standard Sheet 212-10 Temporary Rock Catchment Barrier.

The Engineer will inspect all precast concrete barrier unit components upon delivery to the project site for conformance to specifications. Any barrier unit component having damage and/or defects in the concrete and/or joint connections will be rejected.

The precast concrete barrier units shall form a smooth and continuous barrier when joined together. Any sections damaged or misaligned while in service shall be corrected or replaced.

B. Net Support Columns. Fabricate the net support columns from W5 x 16 wide flange members conforming to the requirements of §715-18 Soldier Piles

Each support column shall have four (4) pairs (eight holes) of 1 in. diameter holes drilled on the side facing the rock slope. Two (2) holes shall be situated 3 in. from the top of the post and the remaining three (3) pairs spaced equally approximately 40 in. apart.

After any required drilling, welding and/or cutting, all support columns and related hardware shall be hot dipped galvanized in accordance with the requirements of §719-01 Galvanized Coatings and Repair Methods, Type I.

C. Net Support Ropes. Provide net support ropes conforming to §710-27 Rock Slope Wire Ropes, Net
Supporting Wire Rope.

**D. Wire Rope Netting.** Provide wire rope netting conforming to §710-06 *Rock Slope Net and Wire Mesh Assemblies*, Net Assembly.

Two (2) aluminum stop sleeves shall be used at all locations where two individual wire ropes are joined together.

The 8 in. x 8 in. mesh size shall be fabricated using high strength, hot dipped, galvanized steel clips, which are attached so that they are non-moveable. Nets damaged during clipping shall be rejected by the Engineer.

**E. Chain Link Fence Fabric.** Provide a minimum of 9 gauge chain link fence fabric conforming to the requirements of §710-02 *Galvanized Steel Fence Fabric*. The galvanized chain link fence fabric shall be 12 ft. high and have a 2 in. mesh size. The chain link fence fabric shall be continuous between wire rope net panels.

**F. Synthetic Fabric Layer.** Provide a synthetic fabric, 10 ½ ft. in height conforming to the requirements of §737-01A *Geotextile Bedding*.

**G. Cushion Sand.** Provide sand conforming to the requirements of §703-06 *Cushion Sand*.

**H. Miscellaneous Material.** Provide miscellaneous hardware such as shackles, thimbles, wire clips, bolts, etc. which shall be hot dipped galvanized in accordance with §719-01 *Galvanized Coatings and Repair Methods*, Type I.

**212-2.06 Move Temporary Rock Catchment Barrier.** None Specified.

**212-3 CONSTRUCTION DETAILS**

**212-3.01 Wire Rope Rock Catchment Fence.** Assemble the wire rope rock catchment fence as detailed on the Standard Sheet 212-1, 2 & 3 *Wire Rope Rock Catchment Fence*.

Submit to the Engineer for approval not less than two weeks prior to the installation of the wire rope rock catchment fence. Do not begin work prior to approval. Provide the following:

   a) Proposed start date, completion date and detailed construction sequence.
   b) Proposed anchor drilling method and equipment including hole diameter, method of keeping holes open, and hole clean out procedures.
   c) Proposed anchor installation procedure including grout placement procedures, grouting equipment, and the procedure for setting the wire rope anchor centralizers.
   d) Method of verifying anchor capacity and equipment setup including details of the jacking frame and appurtenant bracing. Include the calibration data for the stressing device. The calibration shall be performed by an independent testing laboratory within 60 calendar days of the submittal date.

Install grouted wire rope anchors with accompanying centralizers at the top of the rock slope on 12 ft. centers or as indicated by Engineer. Mix grout per manufacturer’s instructions. Wait a minimum of 7 days after grouting before applying any load to the anchors. Proof test each anchor in accordance with §212-3.03 A. Anchor Testing.

Fasten all net braiding with high strength, corrosion resistant clips or other fasteners to produce a permanent, non-movable joint. Damage to the wire rope resulting from the installation of the clips, insofar as it affects the integrity of the system, in the opinion of the Engineer, shall be cause for rejection of the net panel.

Cut the chain link material to fit each wire rope netting panel. Attach the chain link mesh fencing material to the inside face of the wire rope nets with clips to extend a minimum of 3 ft. beyond the bottom
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of the fence.

Provide and install one braking element per top and bottom net supporting rope per 20 ft. net section. Position the braking element not more than 3 ft. from the column.

Use seam ropes to fasten adjacent wire rope nets and the nets to the net support wire ropes, with at least 1 wrap per 16 in.

The column spacing shall be 20 ft.

Install a tie-back restraining cable to extend from the top of each column in a direction perpendicular to the length of the fence and on the slope side of the fence. Install a braking element in each cable not more than 3 ft. from the column.

For a fence whose length is 120 ft. or less, both end columns shall have a lateral restraining cable without the braking element. This cable shall extend from the top of the column at an angle of 60° from the vertical to the ground. For a fence which is longer, install lateral restraining cables at every multiple of 120 ft., or approximately midway for a fence less than 240 ft.

Paint the fence installation where specified, with the appropriate material and color as directed by the Engineer.

212-3.02 Chain Link Rock Catchment Fence. Assemble the chain link rock catchment fence as detailed on the Standard Sheet 212-4 & 5 Chain Link Rock Catchment Fence.

Install galvanized No. 11 steel rebar posts in 2 in. diameter vertical holes drilled to a minimum depth of 2 ft. into rock. Post spacing shall be 8 ft. Pour a sufficient amount of concrete grouting material into the hole before inserting the post to allow overflow after insertion.

Install anchor angles for terminal sections. The location of the anchor angles shall be in line with the corresponding fence section and shall be determined by the angle (60° minimum) between the top longitudinal cable and the end post. The angle between any longitudinal cable and the end post shall not exceed 90°. Drill bolt holes for anchor angles into the rock spaced 16 in. on-center to a depth of 4 ft. The bolt hole diameter shall be compatible with the bolt/drill hole/resin cartridge diameter, as recommended by the bolt manufacturer, but in no case shall the bolt hole diameter exceed the resin cartridge diameter by more than 3/8 in. Install the anchor angle within 90° ± 15° to the axis of the rock bolt and in intimate contact with the rock surface for its entire contact area. Acceptable methods of leveling the rock surface include the following:

a) Chipping the rock surface.

b) Applying a special mix supplied by the bolt manufacturer for leveling purposes.

c) A combination of chipping and leveling.

Clean out the bolt hole to its full depth with air or water. Place the appropriate amount of resin in the hole. Insert the bolt into the hole and rotate at approximately 100 rpm while pushing the bolt down through the resin cartridges to the bottom of the hole by a means approved by the Engineer. Rotate the bolt in this position for 30 to 60 seconds to insure mixing of the resin in the hole. Do not rotate the bolt longer than the setting time of the resin. Leave the bolts undisturbed in the hole for the time required for the resin to harden. Place the anchor angle over the bolts on the prepared surface and add the appurtenances. Tension the bolts to 40 kips by means of hollow-ram hydraulic jack, or as ordered by the Engineer. Support the base of the jack at 90°± 2° to the axis of the bolt.

If a failure of the bolt or anchorage occurs, a determination of the cause of failure will be made by a Departmental Engineering Geologist. Correct, as ordered by the Engineer, at no cost to the State, failures attributable to causes other than failure of the rock in the anchorage zone.

The State reserves the right to sample and test delivered materials.

Install No. 9 hook bar anchors on the uphill side of the fence, one hook bar anchor at each post located in a direction normal to the fence alignment. The location of the hook anchor on the ground surface shall be determined by the angle (60°± 5°) between the tie-back cable and the post at the top longitudinal cable. Construct hook bar anchorage according to depth of overburden.

Install No. 9 hook bar anchors at intermediate fence sections. The location of the hook bar anchors shall be in line with the corresponding fence section and shall be determined by the angle between the
longitudinal cables and the intermediate anchorage post. This angle shall be between a minimum of 60°± 5° and a maximum of 90°. Construct hook bar anchorages according to depth of overburden.

Secure longitudinal cables to anchor angles at terminal sections with steel turnbuckle cable end assemblies. Secure longitudinal cables at intermediate fence sections to hook bar anchors with one (1) thimble, and four (4) cable clips per cable loop. The maximum distance between terminal sections, and/or intermediate anchorage sections, shall be 200 ft.

Secure ¾ in. longitudinal guide rail cables to rebar posts with “U” bolts so as to have minimum sag without bending posts. Cable splices shall be staggered a minimum of 20 ft. on adjacent cables. Splices shall be spaced a minimum of 100 ft. on the same cable.

Recommended installation sequence:

a) Start with lowest longitudinal cable working from one terminal anchorage toward another or toward an intermediate anchorage, if used.

b) Draw cable taut and secure with “U” bolt to posts.

c) Complete tightening entire length of lower cable between anchorages before starting next higher cable.

Install aluminum fence fabric on uphill side of posts. Attach fence fabric to longitudinal cables with 12 gauge galvanized steel wire ties at 1 ft. intervals. Fence fabric splices shall be overlapped a minimum of four chain link rows. Attach fabric sections by tying both ends of the overlap at 1 ft. intervals, or by a method approved by the Engineer.

Install vinyl coated fence fabric on roadway side of posts. Attach fence fabric to longitudinal cables with 9 gauge vinyl coated steel wire ties at 1 ft. intervals. Fence fabric splices shall be overlapped a minimum of four chain link rows. Attach fabric sections by tying both ends of the overlap at 1 ft. intervals, or by a method approved by the Engineer.

Bottom of fence fabric shall be in contact with the ground surface. Add fence fabric material as necessary. Added material shall be overlapped a minimum of four chain link rows. Tie both ends of the overlap at 1 ft. intervals, or as approved by the Engineer.

Attach tie-back cables on uphill side of rebar posts after longitudinal cables have been tightened and chain link fence fabric has been installed. Tie-back cables shall have a maximum sag of ¾ in. measured at the center.

212-3.03 Wire Mesh Slope Protection. Assemble the wire mesh slope protection as detailed on the Standard Sheet 212-6 & 7 Wire Mesh Slope Protection.

Design the grouted wire rope anchors so that the design load (P) is at least equal to 30 kips.

Submit shop drawings to the Engineer for approval not less than two weeks prior to the installation of the wire mesh slope protection. Do not begin work prior to approval. Provide drawings including the following:

a) Proposed start date, completion date and detailed construction sequence.

b) Details of the wire mesh and anchor layout on the existing slope.

c) Proposed anchor drilling method and equipment including hole diameter, method of keeping holes open, and hole clean out procedures.

d) Proposed anchor installation procedure including grout placement procedures, grouting equipment, and the procedure for setting the wire rope anchor centralizers.

e) Method of verifying anchor capacity and equipment setup including details of the jacking frame and appurtenant bracing. Include the calibration data for the stressing device. The calibration shall be performed by an independent testing laboratory within 60 calendar days of the submittal date.

Install grouted wire rope anchors with accompanying centralizers at the top of the rock slope on 12 ft. centers or as indicated by Engineer. Mix grout per manufacturer’s instructions. Wait a minimum of 7 days after grouting before applying any load to the anchors. Proof test each anchor in accordance with §212-3.03 A. Anchor Testing.

Connect vertical wire rope tag lines to the anchors. Connect the horizontal support cable(s) to the
vertical tag lines with steel rings as shown on the attached drawing for this specification. Do not draw cable taut. Maintain a minimum cable sag of ¾ in. on the horizontal support cable between vertical tag lines.

Attach the mesh to the horizontal support cable by a continuous weave through each of the mesh openings with galvanized 5/16 in. seam wire rope, as shown on the attached drawing for this specification.

Install the wire mesh in vertical strips. Overlay horizontal and vertical laps a minimum of 1 ft. and connect with a continuous weave through each of the mesh openings with galvanized 5/16 in. seam wire rope along the edge of the upper mesh strip. The mesh shall be installed in such a manner that the end of a roll curls into the rock face.

Install the wire mesh to cover the specified area of rock face.

A. Anchor Testing. Proof test each anchor. Perform the proof test by incrementally loading and unloading the anchors to 1.5 times the design load (P) in accordance with Table 212-1 Wire Mesh Slope Protection Proof Test Load Schedule. Record the anchor movements to the nearest 0.025 mm at each load increment.

<table>
<thead>
<tr>
<th>Table 212-1 Wire Mesh Slope Protection Proof Test Load Schedule</th>
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</thead>
<tbody>
<tr>
<td>Load</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>AL</td>
</tr>
<tr>
<td>0.25 P</td>
</tr>
<tr>
<td>0.50 P</td>
</tr>
<tr>
<td>0.75 P</td>
</tr>
<tr>
<td>1.00 P</td>
</tr>
<tr>
<td>1.25 P</td>
</tr>
<tr>
<td>1.50 P (Load Hold)²</td>
</tr>
</tbody>
</table>

¹P = Design Load
AL = Alignment Load. The AL necessary to maintain position of the stressing and testing equipment shall not exceed 0.05 P. Set dial gauges to “zero” after the alignment load has been applied.

²Hold each load increment, except for the 1.5 P load, until the deflection stabilizes.

³The load hold portion of the proof test is a maximum test load of 1.50 P, which shall be held constant for 10 minutes. The load hold time shall start when the pump begins to load the anchor from the 1.25 P load to the test load. A load cell shall be used to monitor the constant load. Total movements with respect to an independent fixed reference point shall be recorded at 1 minute, 2, 3, 4, 5, 6, and 10 minutes. If the total movement between 1 minute and 10 minutes exceeds 1/24 in., the test load shall be held for an additional 50 minutes. Total movements shall be recorded at 15, 20, 25, 30, 45 and 60 minutes.

No part of the temporary yoke or load frame shall bear within 3 ft. of the anchor.
Plot the movement versus load for each increment.
An anchor will be accepted by the Engineer if the creep rate at 1.5P does not exceed 1/24 in. per log cycle of time. If an anchor fails the proof test, install a new anchor at no cost to the State.

212-3.04 Wire Mesh Drape. Assemble the wire mesh drape as detailed on the Standard Sheet 212-8
**ROCK SLOPE REINFORCEMENT AND CATCHMENT SYSTEMS**

*Wire Mesh Drape.*

Install untensioned resin rock bolts at the top of the rockslope on 50 ft. centers (maximum) or as shown in the contract documents. Proof test the first rock bolt per resin lot number to 20 kips in accordance with §212-3.03 A. Anchor Testing.

Place ¾ in. diameter guide rail cable horizontally across the top of the rock slope, secured by 1 ¼ in. diameter resin rock bolts. Maintain a minimum cable sag of 2 ft. to 3 ft. between rock bolts. Do not draw cable taut. Splices of the guide rail cable will not be allowed.

Fold the mesh over or under the guide rail cable a minimum of 1 ft. and connect the horizontal lap with galvanized tie wire with a continuous weave through each of the mesh openings.

Install the wire mesh in vertical strips, each lapped over the other by a minimum of 1 ft. Connect the adjacent vertical strips by either a continuous weave of galvanized tie wire along the edge of the outer mesh strips only, or with hog rings or metal ties on a 6 in. staggered pattern along the edges of both panels. When used, overlay horizontal laps a minimum of 1 ft. and connect with a continuous weave of galvanized tie wire along the edge of the upper mesh strip.

Install the wire mesh to cover the area of rock face identified in the contract documents.

Repair all damaged galvanized surfaces in accordance with §719-01 Galvanized Coatings and Repair Methods.

**212-3.05 Temporary Rock Catchment Barrier.** Assemble and maintain the temporary rock catchment barrier as detailed on the Standard Sheet 212-9 & 10 Temporary Rock Catchment Barrier.

**A. Precast Concrete Barrier Units.** Each run, or bay, of precast concrete barrier units (precast concrete column support, precast temporary concrete barrier and precast concrete beam) shall be fastened together to form a continuous chain. After placement, each successive unit shall be moved longitudinally to remove any slack in the connecting joint. The units at each end of a run or bay shall be connected as shown on Standard Sheet 619-01 Temporary Concrete Barrier. To reduce movement of the barrier in areas where limited deflection is desired, one of the anchoring methods shown on Standard Sheet 619-01 Temporary Concrete Barrier shall be used. Where shown in the contract documents, the ends of the barrier run shall be fitted with an impact attenuation device or a tapered end section and flared back.

The empty space within each concrete barrier unit shall be filled with sand for the full height (32 in.) of the unit. The back of the concrete barrier units shall also be covered with sand to the full height of the unit. The sand shall then be laid back at the angle of repose of the material to a minimum sand thickness of 18 in. as shown in detail “E” on Standard Sheet 212-9 Temporary Rock Catchment Barrier. The cost of installing and removing the sand, including the final cleaning of the pavement and shoulder, shall be included in the bid price for this Item.

The Contractor shall provide and maintain delineation of temporary barriers. This delineation shall make the barrier visible to approaching traffic, as well as to traffic which is adjacent to the barrier. The Contractor shall have the choice of using one or more of the following: warning lights, delineators, pavement marking, reflective tape placed on the barrier, reflective paint, or any other device subject to the approval of the Engineer. The delineation devices shall be maintained dirt and snow free, and be visible throughout the term of the contract including shutdown periods.

**B. Net Support Columns.** The W5 x 16 posts shall be installed in the 6 in. x 6 in. x ¼ in. structural steel tubes cast in the precast concrete column support units. The columns shall be inserted flush with the bottom of the precast concrete column supports.

**C. Net Support and Lateral Anchor Ropes.** The 5/8 in. net support wire ropes shall be installed as shown in detail “B” on Standard Sheet 212-9 Temporary Rock Catchment Barrier. The net support wire rope shall have maximum sag of 2 in. At both end sections and at every 125 ft. section of temporary catchment barrier (five precast concrete barrier units) install lateral anchors as shown in detail “C” on Standard Sheet 212-9 Temporary Rock Catchment Barrier. The wire rope loop at a ¾ in. shackle
ROCK SLOPE REINFORCEMENT AND CATCHMENT SYSTEMS

connection shall be secured with three (3) wire rope clips as shown in detail “J” on Standard Sheet 212-10 Temporary Rock Catchment Barrier.

D. Rock Catchment Fence Fabric. The rock catchment fence fabric (wire rope net, chain link fence fabric and synthetic fabric) shall be attached to the support rope after the concrete barrier units have been installed.

The wire rope net panels shall be attached to the support ropes with ¾ in. shackles spaced approximately 3 ft. apart. The chain link fence fabric, 12 ft. in height, shall be attached to the wire rope net with hog rings or twist ties. The area between two adjacent wire rope net panels shall be covered with chain link fence fabric. The layer of synthetic fabric, with a minimum height of 10 ½ ft., shall be attached to the chain link fence.

212-3.06 Move Temporary Rock Catchment Barrier. Move and reset the temporary rock catchment barrier in accordance with the requirements of §212-3.05 Temporary Rock Catchment Barrier.

212-4 METHOD OF MEASUREMENT

212-4.01 Wire Rope Rock Catchment Fence. Wire rope rock catchment fence will be measured as the number of linear feet of fencing, measured from center-to-center of end posts.

212-4.02 Chain Link Rock Catchment Fence. Chain link rock catchment fence will be measured as the number of linear feet of fence, measured along the top of the fence between the terminal posts. An allowance of 10 linear feet will be added for each terminal section anchorage and for each intermediate section anchorage installed.

212-4.03 Wire Mesh Slope Protection. Wire mesh slope protection will be measured as the number of square feet of rock face satisfactorily covered. No measurement will be made of wire mesh used in any overlap.

212-4.04 Wire Mesh Drape. Wire mesh drape will be measured as the number of square feet of rock face satisfactorily covered. No measurement will be made of wire mesh used in any overlap.

212-4.05 Temporary Rock Catchment Barrier. Temporary rock catchment barrier will be measured as the number of linear feet of barrier, measured along the centerline of the uppermost concrete barrier surface, from one end anchor to the other.

212-4.06 Move Temporary Rock Catchment Barrier. Moving temporary rock catchment barrier will be measured as the number of linear feet of barrier moved, measured along the centerline of the uppermost concrete barrier surface, from one end anchor to the other.

212-5 BASIS OF PAYMENT

212-5.01 Wire Rope Rock Catchment Fence. The unit price bid per linear feet for wire rope rock catchment fence shall include the costs of furnishing all labor, material and equipment necessary to complete the work.

212-5.02 Chain Link Rock Catchment Fence. The unit price bid per linear feet for chain link rock catchment fence shall include the costs of furnishing all labor, material and equipment necessary to complete the work.

212-5.03 Wire Mesh Slope Protection. The unit price bid per square feet for wire mesh slope
protection shall include the costs of furnishing all labor, material and equipment necessary to complete the work, including anchor testing and disposal of any material removed from the slope.

212-5.04 Wire Mesh Drape. The unit price bid per square feet for wire mesh drape shall include the costs of furnishing all labor, material and equipment necessary to complete the work, including anchor testing and disposal of any material removed from the slope.

212-5.05 Temporary Rock Catchment Barrier. The unit price bid per linear feet for temporary rock catchment barrier shall include the costs of furnishing all labor, material and equipment necessary to erect, maintain, and remove the required barrier, including any required connection devices, end treatments, delineation or guiding devices, and devices for pinning and connecting temporary precast concrete barrier units.

After placement, 90% of the item unit price will be paid. The remaining 10% will be paid when the rock catchment barrier has been removed.

212-5.06 Move Temporary Rock Catchment Barrier. The unit price bid per linear feet for moving temporary rock catchment barrier shall include the costs of furnishing all labor, material and equipment necessary to remove, transport, erect, and maintain the required barrier, including any required connection devices, end treatments, delineation or guiding devices, and devices for pinning and connecting temporary precast concrete barrier units.

Movements necessary to maintain, realign, or replace damaged units will not be considered as moving temporary rock catchment barrier and shall be done at no additional cost to the State.

Payment will be made under:

<table>
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<tr>
<th>Item No.</th>
<th>Item</th>
<th>Pay Unit</th>
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<tbody>
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<td>212.0106</td>
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</tr>
<tr>
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<td>Wire Rope Rock Catchment Fence (Medium Impact – 8 ft.)</td>
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<td>Wire Rope Rock Catchment Fence (Medium Impact – 10 ft.)</td>
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<td>212.0112</td>
<td>Wire Rope Rock Catchment Fence (Medium Impact – 12 ft.)</td>
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<td>Chain Link Rock Catchment Fence</td>
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<tr>
<td>212.0202</td>
<td>Vinyl Coated Chain Link Rock Catchment Fence</td>
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<td>Wire Mesh Slope Protection</td>
<td>Square Feet</td>
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<td>212.04</td>
<td>Wire Mesh Drape</td>
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<td>Move Temporary Rock Catchment Barrier (10 ft.)</td>
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