Make this section a part of the Standard Specifications:

"SECTION 673 - RING NET DRAPERY SYSTEM

673.01 Description.

(A) General Requirements. Furnish materials, labor, and equipment necessary to install the ring net drapery systems to the limits shown on the plans and as specified herein, in place, complete and operational. Ring net drapery systems shall meet the following minimum general requirements

(1) Be designed to withstand the static and dynamic forces generated from rocks or soil used in similar application and capacity.

(2) The material manufacturer shall be regularly engaged in the manufacturing of slope stabilization systems used in similar application and capacity. The manufacturer shall supply written evidence demonstrating certification of a quality assurance program upon request by the Engineer.

(3) Demonstrate satisfactory performance in similar applications and capacity. Performance results and examples of previous installations under a permanently installed system shall be made available to the Engineer upon request.

(4) Retain the load imposed by the rocks outcrops shown in the plans with no distress of connecting elements. Engineering calculations verifying contract requirements shall be made available to the Engineer upon request.

(5) Comprised of readily available components to the extent practical and shall require minimal maintenance. The system shall be resistant to corrosion, UV degradation, and thermal deterioration.

(B) Slope and Foundation Conditions. The Contractor should expect to encounter a broad range of foundation materials when installing support anchors, including very hard rock, fractured rock, loose boulders, clinker, soil, and voids and shall be prepared to install the anchors for the ring net drapery system per these documents at no additional cost to the State.

The Engineer has made no investigation of the subsurface conditions where the work is to be performed under this contract. The Contractor may perform such subsurface investigation at his/her own discretion. Cost for such work shall be considered incidental to the cost of the ring net

drapery system. The Contractor shall be familiar with the typical Kauai surface and subsurface materials or obstacles to be encountered.

(C) Submittals. Shall submit six (6) sets of complete working drawings to the Engineer for approval. Working drawings shall be 24" x 36" in size and include the project name, contract number and the manufacturer's name, address and telephone number.

Submit ring net drapery system specifications, including manufacturer's drawings, certifications, all material data sheets, and installation guidelines. Include documentation for netting, anchors, wire ropes, and any miscellaneous materials. Also include written documentation from the manufacturer verifying that the ring net drapery system as a whole will meet or exceed the requirements of this project.

Submit proposed grout mix design specifications, including manufacturer's data sheets and catalog cuts, plus the procedure and equipment used for placing the grout.

Submit details of proposed drilling methods and equipment. Submit manufacturer's specifications for anchor materials and sizes and model numbers for drill bits.

The Contractor shall allow the Engineer fourteen (14) calendar days to review the working drawings after the complete sets of drawings have been received. Fabrication of the ring net drapery system shall commence only after the review and approval of the working drawings by the Engineer.

673.02 Materials.

(A) Approved Manufacturer's Systems.

GEOBRUGG
Brugg Cable Products
333 South State Street
Suite V #311
Lake Oswego, OR 97034
(503) 534-9020

Maccaferri Gabions
3650 Seaport Blvd.
West Sacramento, CA 95691
(800) 328-5805

(B) Materials.

(1) Netting. The netting shall be ring net and wire mesh and shall meet the following minimum requirements:

(a) Ring Net. Ring net shall be made from interlocking steel rings, each ring with a maximum diameter of 13-inches. Rings shall be composed of steel wire coiled into a loop, with minimum of 10 loops per ring. Each ring must have a traction test breaking strength (on a 50mm or smaller diameter mandrel) greater than 90 kN. Each ring shall connect to at least four adjoining rings by passing through them. All ring net shall be powder coated, flat black color, to 3 mils thickness.

The ring net wire shall be high tensile strength carbon steel wire with a minimum 0.118-inch (3 millimeter) diameter and the minimum breaking strength of the wire shall be 1,100 N/mm^2.

The ring net wire shall be galvanized with a 95% Zinc to 5% Aluminum coating with a minimum weight of 0.410 oz/ft^2 (125 g/m^2).

(b) Wire Mesh. Wire mesh shall be a double twist mesh, or approved equal. Mesh shall be manufactured in accordance with ASTM A975.

Wire mesh shall consist of woven double-twisted hexagonal steel wire mesh with a minimum diameter of 0.106 inches (2.70 mm) and a nominal mesh opening of 3.25 inches. Wire mesh shall have a minimum tensile strength of 42.3 kN/m.

Wire shall be galvanized and PVC coated. All wire mesh shall be powder coated, flat black color.

Wire mesh shall be installed over the ring net as detailed in the approved plan set and as recommended by the manufacturer. All connections and overlaps shall meet the requirements of the manufacturer's specifications.

(2) Anchor System. The anchors shall be wire rope anchors meeting the minimum requirements listed below.

Wire rope anchors shall be single 1-inch minimum diameter wire rope of 6 by 19 construction, type 316 stainless steel (SS) strands with a minimum breaking strength of 80,000 lbs.

Anchors shall meet all minimum requirements for bore hole diameter, embedment depth, spacing and number as indicated by the drawings.

All anchors shall be embedded and fully grouted to withstand a design test load of 13.33 tons. The Contractor may be required to pull-test up to 25% of all anchors at the discretion of the Engineer. All anchor testing shall be done in the field under the observation of the Engineer. Taglines shall be used at each anchor location. Tagline connections shall be per the manufacturer's recommendations and shall have the same material requirements as the wire rope anchors.

(3) Boundary Wire Ropes. Boundary wire ropes shall be stainless steel type 316 and shall have a minimum diameter of 7/8 inch, unless specified larger elsewhere, and shall be powder coated, Jet Flat Black to 1/64-inch minimum film thickness. The ropes shall be 6 by 19 construction (or equivalent), IWRC, with a minimum breaking strength of 58,000 lbs. Boundary wire ropes shall be as shown in the plans with two (2) cables at the top support.

(4) Seam Rope. Seam ropes or shackles shall be used to fasten adjacent net panels to each other and to secure the net panels to the support rope system. Seam ropes shall be 5/8-inch diameter wire rope and shackles shall be minimum 3/4 inch, both stainless steel type 316, powder coated, black in color. The seam rope shall be laced through each ring net panel openings in the adjoining zone and tensioned by hand to provide adequate contact between the ring net panels and the support rope system. At the point of connection of ring net panels, each ring shall be connected to at least four (4) overlapping rings (four point contact) using seam rope and/or manufacturer approved shackles. The Contractor shall submit shop drawings for the mesh panel assembly for review and approval as specified under **Subsection 673.01 (C) – Submittals** in this section.

(5) Tag Lines. Tag lines shall be utilized at the top of the ring net drapery system as shown on the plans. Tag lines shall be approximately 8 feet long wire rope cable with a minimum diameter of 1-inch, and shall be stainless steel type 316, powder coated, black color.

(6) Miscellaneous Materials. All miscellaneous materials such as wire rope clips, thimbles, rings, bolts, nuts, washers, plates, shackles, turnbuckles, etc. shall be Type 316 stainless steel.

(7) Color Coating. All exposed components of the ring net drapery system, such as shackles, clips, cables, etc. shall have a powder coating of black pigmentation applied using an electrostatic spray gun or equivalent process. All other exposed components that have not been powder coated shall have an applied coating of rubberized paint, flat black color, using a two coat system. The Contractor shall provide rubberized paint submittal for approval by the Engineer prior to use.

(8) Anchor Grout. Grout for the anchors shall consist of cement grout capable of permanently developing the bond and internal strength necessary for the tensioning required for the project. Cement grout shall be a prepackaged non-shrink, non-expanding, and non-metallic grout with a minimum compressive strength of 5,000 psi in three (3) days. If a non-prepackaged grout is used, the Contractor shall submit to the Engineer for review and approval, the desired mix design along with compression test results performed by an independent laboratory proving the mix will achieve the minimum compressive strength specified above. Submit all grout material information and compression test results, performed for the purpose of this project, to the Engineer for approval. Cement grout shall be capable of being hydraulically pumped to the bottom of the drill hole allowing it to rise upwards filling all cavities of the drill hole. Batch mixing shall be per the manufacturer's recommendations.

(9) Auxiliary Short Anchors. Where required by the Engineer (not shown on the design drawings), auxiliary short anchors shall be installed at local depressions where gaps between the slope surface and the ring net drapery system exceed 12 inches. Auxiliary short anchors shall be as shown on the plans. Contractor shall submit all manufacturer's literature for materials to the Engineer for review and approval prior to construction. The Contractor shall allow for thirty (30) auxiliary short anchors in his/her bid and shall consider the cost incidental to the cost of the ring net drapery system.

(10) Cable Lashing. Cable lashing shall be the same as the boundary wire ropes for the ring net drapery system and shall be installed as detailed on the approved plan set. Cable lashing locations shall be coordinated in the field with the Engineer prior to anchor drilling. Contractor shall submit manufacturer's literature for installation instructions and data sheets for all cable lashing

materials to the Engineer for review prior to construction. The Contractor shall allow in his/her bid for thirteen (13) lashing cables, ten (10) wire rope anchors and all other supplemental materials necessary for installation of each cable lashing system including wire rope clips, thimbles, turnbuckles, etc. as shown on the plans and consider the cost for full installation of the cable lashing systems incidental to the cost of the ring net drapery system.

673.03 Construction.

(A) Installation. Install the ring net drapery system in accordance with the requirements of the manufacturer and the contract documents. Prior to construction, mark the limits of the ring net drapery system in the field. Do not begin construction until the limits are reviewed and approved by the Engineer.

(1) Slope Preparation. Vegetation encountered on the slope shall be cleared as specified in **Section 201 – Clearing and Grubbing**. Grubbing is not required and will not be allowed for this project. For trees with diameter larger than 18 inches, the ring net shall be installed around the base per manufacturer's written requirements and approved by the Engineer. All scaling and/or demolition work deemed necessary by the Contractor shall be incidental to the cost of the ring net drapery system. All material and debris resulting from scaling and/or demolition operations shall become property of the Contractor and shall be removed and properly disposed of at an authorized disposal location at no additional cost to the State.

Existing large boulders located within the State right of way, where shown on the plans, shall be removed by the Contractor. The Contractor shall confirm the boulder locations in the field with the Engineer prior to beginning work. All resulting material from boulder removal work shall become property of the Contractor and disposed of at an authorized disposal location. Boulder removal shall be considered incidental to the ring net drapery system.

(2) Layout. Mark the limits of the ring net drapery system in the field as shown on the plans using a surveyor licensed in the state of Hawaii. Top and bottom anchors shall be spaced a maximum of 15 feet and 25 feet apart, respectively. Mark the proposed locations for the ground anchors according to the requirements of the contract documents and approved shop drawings. Contractor shall request inspection of the proposed layout by the Engineer. Do not begin construction until the Engineer has inspected and approved the proposed layout.

(3) Anchors. Drill holes to receive the anchors to the minimum diameter, depth and angle specified below unless stated otherwise by the plans and approved shop drawings. The Contractor shall determine the anchor depth to be used in order to meet the max test load of 20 tons (13.33 tons design test load X 1.5) pullout requirement, and meet the minimum required embedment depth. The Contractor shall notify the Engineer of any unexpected or irregular field conditions encountered during drilling.

Bore holes for all wire rope anchors for the ring net drapery system (top and bottom rows) shall be have a minimum diameter of 3 inches and shall be drilled to accommodate a minimum anchor embedment length of 15 feet into the existing ground surface as shown on the plans.

Clean flush the drill holes of all drill cuttings, sludge, and debris with compressed air prior to inserting the anchor into the hole. Each drilled hole shall be inspected, verified, and approved by the engineer prior to grouting operation.

Install anchors at the center of the drilled hole. Install PVC centralizers every 4 feet along the anchor, with the first at 1'-0" from anchor bottom. Any installed anchor touching the side of the hole is grounds for rejection of the anchor at the Contractor's expense. Securely fasten the centralizers to the anchor prior to inserting into the bore hole.

Fill the hole with cement grout. Pump all grout from the bottom of the hole to the top using a grout tube. The grout tube must extend to the bottom of the hole, and shall remain at the bottom of the hole until the hole is completely filled to the top. No top grouting shall be allowed. Remove grout tube immediately after grouting. Contractor shall revisit each grouted anchor hole after initial grouting operations and add more grout where determined necessary by the Engineer, during which the Contractor shall reinsert the grout tube and pump the additional grout from bottom to top similar to earlier grouting operations.

It is anticipated that the Contractor may encounter cracks and fractures within the subsurface during drilling and grouting operation. The Contractor shall be prepared to manage complete anchor installation under the above conditions without any additional cost to the State. Use of grout socks shall be at the discretion of the Contractor. Grout sock diameter shall be a minimum of 40% larger than the drilled anchor holes. Anchors installed with grout socks shall still meet pull out testing

requirements. Contractor shall submit grout sock information for approval by the Engineer.

Provide the Engineer with a schedule of grouting at least 5 days prior to grouting. All grouting operations shall be performed according to the schedule and shall be observed by the Engineer. Grouting performed not in the presence of the Engineer shall be grounds for rejection of the anchor. Notify the Engineer in writing at least 3 working days prior for any changes to the scheduled grouting operation.

(4) Testing. Testing shall be performed against a temporary yoke or load frame. No part of the yoke or load frame shall bear within 2 feet of the anchor. At the discretion of the Engineer, a number of anchors equivalent or up to 25% of total anchors installed may be tested. Engineer shall choose which anchors will be tested. Testing may only be performed after the grout for the anchor has cured for at least 72 hours and attained the specified 3-day compressive strength.

Anchor assemblies shall be pullout tested by the contractor in the presence of the Engineer. A pullout test consists of incrementally loading the anchor assembly to the maximum test load or failure point, whichever occurs first. Failure point shall be the point where the movement of the anchor continues without an increase in the load or when the anchor has displaced 2 inches. The failure load corresponding to the failure point shall be recorded as part of the test data. The Engineer shall determine the test loading schedule at the time of testing. Maximum test load shall be up to 150% of the design test load (13.33 tons design test load X 1.5).

During the load test the contractor shall monitor and record displacement of the anchors using two (2) dial gauges relative to a stable reference point which is founded a minimum distance of 3 feet from the anchor and test load reaction points. Each test load shall be held long enough until a stable reading can be obtained. Maximum test load shall be held until stable and for a minimum of 10 minutes.

The pullout test shall be conducted by measuring the test load applied to the anchor and the anchor end movement at each load using the two (2) dial gauges.

Applied test loads shall be measured by the Contractor with either a calibrated pressure gage or a load cell. Movements of the end of the anchor shall be measured and recorded during the load tests.

The pressure gage shall have an accurately reading dial at least 6 inches in diameter and each jack and its gage shall be calibrated as a unit with the cylinder extension in the approximate position that it will be at final jacking force, and shall be accompanied by a certified calibration chart. The gage shall have been calibrated within one-year prior to use on the project.

Prior to testing, submit to the Engineer for approval a description of test setup and equipment to be used during testing, and all calibration sheets.

The anchor shall be unloaded only after completion of the test.

If more than 25% of the anchors tested fail, all anchors shall be tested at the Contractor's expense. The Contractor shall replace and re-test all failed anchors at no additional cost to the State.

(5) Netting. Install the ring net underneath the wire mesh panels in accordance with the requirements of the manufacturer and the contract documents. The maximum gap between the ring net and wire mesh shall not exceed 2 inches at any location.

Anchor the ring net drapery system first at the uppermost boundary of the slope area to be covered before draping and securing over the slope.

Place the ring net drapery panels on the slope in a manner that will follow the contours of the slope and minimize gaps and large voids between the mesh and the ground surface as directed by the Engineer. The maximum gap between the mesh and the ground surface shall not exceed 12 inches. Install auxiliary short anchors, as required by the Engineer, at areas with large gaps between the slope and the ring net drapery system. Auxiliary short anchors shall be as specified in **Subsection 673.02 (B) (9) – Auxiliary Short Anchors** and as shown on the plans. Place outcroppings or breaks in the slope surface to be restrained below the ring net drapery panels under the center of the panel or panels.

Fasten the ring net drapery panels together to create a uniform blanket when two or more panels are used at one site location. There shall be no discontinuity in the ring net drapery system. Connection of the panels to each other shall be equal to or greater than the strength of the panel. Seam ropes or shackles shall be used to connect adjacent panels to each other and to secure panels to the boundary rope as specified in **Subsection 673.02 (B) (4) – Seam Rope**.

Once all fasteners have been torqued to proper tightening, JB Weld, or approved equal, shall be used to permanently secure all top nuts at each threaded connection throughout, with the exception of the shackles.

(6) Temporary Moveable Barrier. A temporary barrier shall be utilized by the Contractor to protect the safety of the public and the adjacent roadway during all slope disturbing activities including top anchor drilling. Temporary barrier shall be in accordance with **Section 645.01 (D) – Temporary Moveable Barrier**.

(B) Final Cleanup. All work area shall be clean and free of grout and cement residue. Spilled grout shall be collected and disposed of. All surplus earth and debris resulting from ring net drapery system installation shall be secured or removed from the site. All equipment wash water shall be contained and disposed of offsite. No wash water shall be dumped on site.

(C) Certificate of Compliance. The Contractor shall provide the Engineer with a Certificate of Compliance from the ring net drapery system manufacturer.

673.04 Measurement. Ring net drapery system installation shall be measured per square foot of netting completely installed. All other costs of slope preparation, vegetative and tree clearing, material, labor, and equipment including that for auxiliary short anchors and cable lashing shall be considered incidental work and shall not be measured for payment.

Pull out tests shall be measured at the contract unit price per each anchor tested. All costs for material and labor associated with anchor testing, including testing of any replaced anchors, shall be considered incidental.

673.05 Payment. The cost for this work will be paid on a unit price basis per square foot of accepted ring net drapery system in accordance with the contract documents.

Pay Item	**Pay Unit**
Ring Net Drapery System	Square Foot
Pull Out Tests	Each"

END OF SECTION 673