The following Section shall be made part of the Standard Specifications:

"SECTION 621 – ENHANCED VEHICLE CLASSIFICATION TRAFFIC COUNTING SYSTEM

621.01 Description. The work includes furnishing labor, materials, tools, machinery, and equipment to install a new Enhanced Vehicular Classification (EVC) traffic counting system along Route 72, milepost 13.89. The Contractor shall make improvements as shown in the contract plans, or as ordered by the Engineer, including the following.

(A) Provide necessary provisions for traffic counting operations by installing and testing piezoelectric sensors, vehicle detector loops, installing conduit, cable wiring, controller cabinet, constructing cabinet foundation, providing power and electrical connections, warning sign and system integration and testing according to the contract.

(B) Provide underground conduit systems including trenching, structural excavation, furnish and install pull boxes, backfilling and restoration work.

(C) Conduct required testing for the vehicle detector loops and piezo sensors. Submit for acceptance test procedures and criteria for acceptance test results to the Engineer. Notify the Engineer a minimum of one (1) week before the date scheduled for testing.

(D) Coordinate and arrange for inspection of work with the Engineer. Arrange for a representative from piezo sensor's manufacturer to supervise installation of piezo sensors.

(E) Turn over to the Engineer a complete and operating vehicle counting system according to the contract.

Furnish and install incidental parts necessary to complete the vehicular counting and classification system as though such parts were in the contract.

Electrical equipment shall conform to the NEMA Standards and this contract. Materials and workmanship shall conform to "National Electric Code", (the code); General Order Nos. 6, and 10 of the Hawaii Public Utilities Commission; ASTM standards; the ANSI and applicable revisions for all the above codes and standards and local ordinances that may apply.

621.02 Materials.

(A) Enhanced Vehicular Classification (EVC) Traffic Counting System. The EVC system is intended to count vehicle volume and perform vehicle classification, including but not, limited to the thirteen (13) FHWA vehicle types, and data for environmental impact analysis per FHWA requirements.

(1) General Requirements. Install EVC system in each lane at the location shown on the contract plans. The EVC system contains a set of piezoelectric sensors and magnetic loop detectors. The EVC system will be used to classify the number of axles in accordance with FHWA requirements.

The EVC system shall also be capable of monitoring traffic volume data using one or more magnetic induction vehicle detector loops. Such loops shall be installed as called for in the contract plans.

(2) EVC System Components. Installation and setup per manufacturer's recommendation for all sensors, lead-in cables, and related components.

(a) Traffic Classification Data System Requirements.

1. In-Road Piezo and Classification Sensor System. A Piezo Sensor System is the type of classification sensor system required for this project.

(i) The piezo sensors shall have an operating life of a minimum of one (1) year from the date of acceptance. Sensor failure during this period shall require replacement of the faulty unit at the Contractor's expense for furnishing, delivering and installing the replacement equipment, system, and components including any traffic control measures required for the safe installation of the replacement sensor.

(ii) Install piezo sensors under the supervision of the manufacturer's representative for the Piezo system. All necessary components, process, system modifications, and installation requirements shall be provided as incidentals to the system.

(iii) Piezo Sensor System: The following are requirements for the Piezoelectric Sensor system:

a) Configuration: Install piezoelectric sensors in the roadway for each lane in both traffic directions.

b) Class 1 BL unencapsulated piezo-electric sensors must be supplied complete with custom length lead-in coaxial cable with pre-made termination connectors. The sensor design and installation technique must have been proven reliable in conditions (soil and environmental), similar to those in Hawaii.

c) Piezo Sensor shall be Class I Weigh in Motion Sensor, 11-foot length (or based on actual roadway width), complete with coaxial lead cable (non-spliced). The sensor shall have 16 gauge flat braided silver plated copper wire center core with highly compressed piezoelectric copolymer P(VDF-TrFE) and outer sheath of 0.16-inch thick brass meeting CDA-260 and ASTM B87-88 requirements. The sensor shall be approximately 0.26-inches wide with a maximum thickness of 0.063-inches (plus/minus 0.05 inches). Insulation resistance between core and shield shall be greater than 500M ohms. Piezoelectric coefficient shall be greater or equal to 20 pC/N nominal.

1) Embed piezo sensors in a grout with clips for mounting at 6" intervals. The sensors shall be of the type suitable for the application. Install piezo lead-in cables and piezo sensors in slots cut in the road surface, approximately 3/4" wide x 2" deep and provide supporting clips at 6-inch centers.

2) Lay sensor in a groove at 1-inch below the surface of the roadway or as recommended by the manufacturer. Secure sensor in

place along the entire length of the sensor in the slot by quick setting grout clips.

3) Sensor shall be manufactured to produce uniform, high amplitude piezoelectric output with signal to noise ratio of 10:1 minimum.

4) Groove shall be constructed in strict accordance with specifications of the manufacturer. Install sensor straight and flat in groove.

5) Epoxy fill voids of the groove. The epoxy grout fill shall be prepared in accordance with the manufacturer's instructions, and shall result in a concave finish approximately 1/16-inch above the surface of pavement or as shown on the plans. The grout curing requirements of the manufacturer shall be complied with and traffic loading shall not be permitted until the grout is fully cured.

6) Passive signal cable shall be RG 58 rated for underground direct burial, with outer jacket of 0.187-inch outside diameter and nominal capacitance of 27 pF/Ft, with factory termination to sensor and BNC connector. Each cable shall have field measured custom length to suit the installation conditions. In the event that the cables provided have insufficient length to reach the equipment harness inside the cabinet, the cables shall be rejected and splicing to lengthen the cable will not be allowed.

7) Install sensor in clean saw cut grooves in strict conformance to the

sensor manufacturer's installation requirements.

8) Hot tar shall not be used. Installation of encapsulating material shall be allowed to cure and shall be ground flat.

9) Do not allow traffic on the completed system until the manufacturer's representative approves all conditions of the installation with the acceptance by the Engineer. Thereafter, testing in accordance with the manufacturer's requirements shall be completed before public traffic is allowed.

10) Grooves shall be made by wet cutting. Dry cutting shall not be allowed.

11) Overall length of the passive cable shall be 300-feet maximum or as required. Provide loop of 5-feet in handhole for each cable.

12) In the event that heating of the encapsulating material is allowed by the Engineer, the temperature of the material shall not be allowed to exceed 170 degrees F. In the event that the temperature exceeds the maximum allowed, the entire sensor system installed shall be replaced.

13) Provide adequate power for all test equipment to meet the detailed and specific requirements of the manufacturer for all tests required for certification and acceptance. Provide all necessary equipment to perform the required tests.

d) Two (2) 11-foot piezoelectric sensors (or as determined by the Engineer) must be

supplied for each lane for both directions as shown on the plans.

e) The sensors shall be able to withstand at least one million cycles and interface with the counting equipment to perform the above mentioned applications.

f) The sensors shall include all mounting hardware and installation grout. The supplied installation grout must be suitable for installation in both asphalt and Portland cement pavements. The installation grout must require no special equipment to facilitate installation. The grout must have a short curing time (less than 75 minutes) to minimize lane closure time. The grout should be of sufficient consistency to prevent "running" when being applied on road surfaces with a drainage cross-slope. Particulate matter within the grout must not separate or settle. The grout must not shrink during the curing process.

(iv) Sensor (inductive) loops shall be furnished and installed in each traffic lane to measure speed and length of vehicles and also to classify vehicles in conjunction with the axle detectors. Refer to the configuration shown in the construction plans.

(v) If the number and configuration of the in-roadway sensors, and sensor loops, need to be modified from the number and configuration shown in the construction plans, the Contractor shall inform the State at the time of submitting the proposal, or earlier, and submit Shop Drawings of the revised configuration for approval.

(vi) Grout and Epoxy. The sensor manufacturer must approve and the Engineer must accept all grout and epoxy used for the sensor installation.

(b) Vehicle Inductive Loops. Install two vehicle inductive loops per lane for measuring volume, speed and vehicle length. The inductive loops shall be completely tested prior to shipment with no splices and ready to install.

(Note: The lead-in wire(s) for the new inductive loops can be spliced (soldered connection/waterproof insulation) to existing lead-in wires at the existing or new pull box. Ensure sufficient wire lengths for the piezo sensors must be provided to be able to connect wires into the terminal block inside cabinet without splices. HDOT or its representative will make the final connection into the terminal block inside the cabinet, however, the Contractor shall label the wires clearly to identify traffic direction, lane number, and sequence of loops and piezo sensors in each lane per direction).

Each loop and its two (2) lead-in-wires, shall be one continuous piece of #14 AWG, 19 strand bare copper, IMSA 51-conforming to the requirements of ASTM B-3 as manufactured by Berkshire Electric Cable Company or approved equal. The loop cable shall be continuous within the roadway. The loop itself includes four (4) turns of wire of a size, as specified in the contract. Do not twist lead-in-wires from one loop pair with another loop pair.

Embed loop and lead-in-wires in a three-eight (3/8) inch minimum width saw-cut in the pavement. Saw cut depth to the top layer of wire shall be at least two (2) inches deep. The saw cut groove shall be air blown to remove debris before installing the loop cable. Fill the saw cut groove with approved epoxy sealer.

Install Vehicle Detector Loops such that they are centered in the lane relative to the final lane striping. Replace loops not centered in each lane relative to the final lane stripping at no additional cost to the State.

(c) EVC Controller Cabinet. The new EVC controller cabinet shall house all required communications and control equipment necessary to control the EVC System and to remotely communicate with the Department of Transportation, Highways Division, Planning Branch via modem.

The EVC controller cabinet shall consist of a ground-mounted cabinet similar to a CALTRANS Model 332 Controller

Cabinet or approved equal capable of housing and mounting the data collection unit.

Each 332 Cabinet shall meet the following additional requirements:

1. Cabinets fabricated from 0.125 anodized Aluminum.

2. Cabinet's Main Breakers shall be rated as 50 amps.

3. Front and back fluorescent lights activated upon opening any door.

4. Convenience GFI Receptacles.

5. Door locks of solid brass rim Best Lock Series 516RL3XA7559-606 including 2 keys.

6. Labeling by Silk-Screening only.

7. Attach One each 24" x 36" Cabinet Print in a weatherproof plastic jacket to front and back cabinet doors.

8. The cabinet shall be painted with an "anti-graffiti" type paint in conformance with Section 708 of the Standard Specifications.

Internal wiring shall be modified to meet the functional needs of the EVC System.

(d) Electrical Conductors shall be as follows:

1. Type 1 Home-Run Cable Tie in Loop Detector Stubs to the Cabinet. Polyethylene insulated, Stranded-Tinned-Copper14 AWG; 2 Conductor Cable; Stranded Tinned-Copper Drain Wire; Aluminum - Polyester Shielded; Polyethylene Jacketed; 600 Volts Rated; IMSA Spec. 50-2 Certified.

2. Type 2 Detector-Loop Cable for installation into the roadway sawcut; 12 AWG Stranded

THHN; 600 Volts; inserted into a Polyethylene Tube, .25" max. dia. IMSA Spec 51-5 Certified. Cable inclusive in the Detector Loop Bid.

3. The remaining cables required for the installation of the EVC station shall be as required by the manufacturer's requirements and recommendations.

(f) Excavation Warning Signs. The Contractor shall furnish and install two (2) warning signs and appropriate mountings on each side of the roadway adjacent to the sensor lead-in cable runs or as close as possible. Signs and mountings shall conform to the requirements of Section 712.20 (Signs) of the Standard Specifications and Standard Plan TE-01. Signs shall be a minimum of 12 inches by 18 inches. Sign text shall read as follows:

WARNING
BURIED TRAFFIC SIGNAL LINES
NOTIFY HWY-PLANNING BRANCH AT
(808) 587-6352 BEFORE DIGGING/EXCAVATION

The first line of text shall be a minimum of two (2) inches in height. Subsequent lines of text shall be one (1) inch in height. No border is necessary, but a margin of one-quarter (1/4) inch shall be maintained. For the letters and background, use black and yellow paints, respectively. The first line of text shall be centered. Subsequent lines shall also be centered, however, the Contractor shall have the option to move the wording within these lines to allow for best fit. Furnishing warning signs, mountings, and installation shall be incidental to the Contract.

(B) Other Materials. Concrete shall conform to the requirements of Section 601 - Structural Concrete. Other materials shall meet the requirements specified in the following:

Trench Backfill Material	Subsection 703.21
Conduits	Subsection 712.27
Concrete Pull Box	Subsection 712.06(B)
Conductors and Cables	Subsection 770.06

621.03 Construction Requirements.

(A) Equipment List and Drawings. Submit the equipment list to the Engineer for acceptance.

Submit an 'As Built' or corrected plan showing in detail the construction changes per Section 648 – Field Posted Drawings.

(B) Excavation and Backfill. Excavation and backfill shall conform to Section 204 - Excavation and Backfill for Miscellaneous Facilities. Place the material from the excavation to prevent damage and obstruction to vehicular and pedestrian traffic and interference with surface drainage.

(C) Installation.

(1) Provide supervision for the EVC installation and testing of the entire EVC system.

(a) Install piezo (EVC) sensors under supervision of EVC system Contractor.

(b) Provide other work necessary such that the completed sensors is ready for HDOT's use.

(2) Vehicle Detectors. Install vehicle inductive loops according to the contract plans, or as ordered by the Engineer and as required by the EVC system Contractor, or as recommended by the manufacturer.

(3) Conduits. Conduits, if any, shall be direct burial and concrete encased as shown in the contract. Conduits shall be PVC, Schedule 80.

Install the ducts to drain towards either one or both pullboxes. Conduits shall not drain towards the EVC Controller cabinet.

Intake directional changes in the conduits, such as bends and changes to clear obstructions with curved segments using accepted deflection couplings or with short lengths of straight ducts and couplings. The deflection angle between two adjacent lengths of ducts shall not exceed six degrees (6°). The bends shall not have a radius of less than twelve (12) times the nominal size of the conduit. The Contractor may use factory-made ells.

Square and trim the ends after cutting to remove rough edges. The connections shall be of the solvent weld type. Make the solvent weld joints according to the conduit manufacturer's recommendations and as accepted.

Seal the ends of the duct with plugs at the end of each day of work, whenever problems interrupt the duct installation work and whenever ducts are subject to submergence in water.

Keep the conduits clean during construction.

Use only hand shovels in compacting concrete encasements. Cure the concrete for at least 72 hours before permitting vehicular traffic to run over the concrete.

Provide each conduit run with a No. 10 gage flexible, zinc coated pull wire extending through its entire length. Double an additional two feet back into the conduit at each end of the run. Conduits and sleeves entering pullboxes shall end flush in the wall with ends ground smooth. Plug the conduits and sleeves temporarily.

Give the exterior portions of the direct burial steel conduits not encased in concrete two coats of asphaltic base paint.

The entire length of a conduit run between pullboxes or standards shall be of one type of material.

The completed duct lines shall be subject to a field test. Pass a bullet-shaped test mandrel about fourteen (14) inches long with a diameter 0.5 inch less than the inside diameter of the ducts through the entire length of each duct run. The Engineer will consider scouring found on the mandrel deeper than one thirty-seconds inch an indication of burrs and/or obstructions in the duct run. Normal abrasion between the duct line and bottom of mandrel is not an indication of burrs and/or obstructions in the duct run. Remove such burrs and/or obstructions. Pass the test mandrel through again. Repeat the process until the Contractor gets a satisfactory result.

(D) Electrical Service. Electric power shall be 120 volts, 60 cycles. Install the service underground in a steel conduit of the size shown in the contract from the local power company's pole to the controller.

Furnish and install service connections such as conduits, weatherhead, wires and meter loop, and comply with the power company's requirement for electrical service. The cost of service connections shall be the responsibility of the contractor.

(E) Inspection and Testing.

(1) Preliminary Arrangements. The equipment shall be given requisite factory tests as necessary to determine that the workmanship and materials are free from defects and to establish that the design and construction are satisfactory.

Arrange for and conduct shop tests of the equipment to establish compliance of the contract documents and all applicable codes and standards. Furnish certified reports showing the results of all such tests. Test facilities shall be subject to prior inspection by the Engineer. Notify the Engineer at least 21 calendar days before the scheduled start of a test so that the Engineer may elect to witness any or all such tests. Furnish protection of equipment to prevent damage during the test period. All repair or replacement costs of any item damaged as a result directly or indirectly of the test will be at no cost to the State.

Unless otherwise noted in the contract documents, shop testing and inspection of the components or the complete system shall be in accordance with the Contractor's standard practice. Supply a list of all the Contractor's standard testing with the equipment submittal. The Engineer shall not be charged for any of the preliminary testing.

(2) Inspection. The Engineer reserves the right to inspect all material during fabrication and before shipment and shall have access to the manufacturer's or Contractor's plant as required.

(3) Tests.

(a) After installation of piezo sensors, perform and furnish written test results for each piezo sensor showing:

1) Resistance: The resistance should be at least 1 MegaOhm.

2) Capacitance: The capacitance should range from 5 to 20 nano Farads.

3) Dissipation Factor: The reading should be less than 0.04.

Provide all testing equipment such as BK 875A or equivalent LCR meter, Fluke 75 or higher/equivalent

multimeter, Megohmmeter, and Scope meter or oscilloscope for the above tests.

(b) After the installation of the inductive loop detectors, furnish written test results for each loop sensor showing:

1) Induced voltage (V)

2) f = Frequency of Loop (KHz)

3) L = Inductance of Loop (uH)

4) R = Resistance of Loop (Ohm)

5) Meg Test = Loop insulation resistance should be > 100M ohm

Correct any defects discovered as a result of the Static tests at no additional cost to the State.

(4) Acceptance of EVC System.

(a) The EVC system shall not be accepted and payment shall not be made until the system has successfully met the required testing.

(b) Inspection. The Owner reserves the right to inspect all material during fabrication and before shipment and shall have access to the manufacturer's or Contractor's plant as required.

(5) Restoring Pavements and Other Improvements. Restore the existing pavements and other improvements disturbed by excavation to their original condition according to the contract. Materials used for restoration work shall meet specifications match thickness, texture, and color whenever applicable. The grades of the restored surfaces shall match the existing grades or as indicated in the contract plans.

(6) Warranty. Materials and equipment installed for permanent construction shall be new. Use first-class material and equipment throughout the performance of the contract.

Secure from the manufacturer(s), a warranty or warranties guaranteeing equipment from defects in materials, design and

workmanship for not less than twelve (12) months from the date of acceptance.

When requiring adjustments or repairs during the warranty period, adjust or repair the existing unit within twenty-four (24) hours from the time of notification.

When requiring repairs that need factory corrections during the warranty period, replace the existing unit with an accepted temporary operational replacement unit within twenty-four (24) hours from the time of notification until the Contractor can install the new unit. Install the new, identical non-defective unit within thirty (30) days from the time of notification.

621.04 Method of Measurement. The new Enhanced Vehicular Classification (EVC) Traffic Counting System will be paid for on a lump sum basis. Measurement for payment will not apply.

621.05 Basis of Payment. The Engineer will pay for the accepted EVC system on a lump sum basis. Payment will be full compensation for the work prescribed in this section and the contract documents.

The Engineer will pay for the following pay item when included in the proposal schedule:

Pay Item	**Pay Unit**
EVC Traffic Counting System	Lump Sum"

END OF SECTION 621