

TECHNICAL SPECIFICATIONS
FOR
PUUKAPU HYBRID WATER SYSTEM
WAIMEA, ISLAND OF HAWAII, HAWAII

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All applicable sections of the following are incorporated by reference (inclusive):

1. WATER SYSTEM STANDARDS, of the Department of Water Supply - County of Hawaii, Board of Water Supply - City and County of Honolulu, Department of Water - County of Kauai, and Department of Water Supply - County of Maui, State of Hawaii, dated 2002, as amended (bound separately).

CAUTION: For measurement and payment purposes, if there are discrepancies between these technical specifications, the Standard Specifications, and the proposal schedule, **measurement and payment will be in accordance with the PROPOSAL SCHEDULE.**

SECTION 01010 - GENERAL REQUIREMENTS

PART 1 - GENERAL

- 1.01 GENERAL REQUIREMENTS AND COVENANTS: The General Conditions, General Specifications, Special Provisions, and other applicable documents preceding these specifications shall govern all work specified hereinafter in all Divisions and Sections.
- 1.02 APPLICABLE REGULATIONS: The Contractor shall comply with all local laws, ordinances, rules and regulations pertaining to such work and must obtain all required permits, licenses, and certificates and publish and post all notices required thereby.
- 1.03 DESCRIPTION OF THE WORK: These specifications are divided for convenience into titled divisions and sections as set forth in the TABLE OF CONTENTS preceding these specifications and shall not be considered an accurate or complete segregation of the several units of labor and materials. No responsibility, either direct or implied is assumed by the Department of Hawaiian Home Lands (DHHL) for omissions or duplications of the subject matter. The Contractor will be held responsible for the complete work whenever or wherever the parts are described in one or more trade heads. Any mention in these sections or indication on the drawings of articles, materials, operations, or methods, require that the Contractor furnish each item so mentioned or indicated, of the kind, type, or design and quality of each item so mentioned on the drawings, and that the Contractor furnish all labor, materials, equipment, incidentals and supervision necessary to complete the work in accordance with the drawings and the true meaning and intent of these specifications, even though such mention of articles, materials, operations, methods, quality, qualifications or condition is not expressed in complete sentences.

Where devices or items, or parts thereof are referred to in the singular, it is intended that such references shall apply to as many such devices, items, or parts as are required to properly complete the work.

Schedule of work included in these specification sections are given for convenience and shall not be considered as a comprehensive list of items necessary to complete the work of any section.

The Contractor shall employ the usual standard practice of coordinating the work covered in each section with the work of other sections. The necessary information and the items, accessories, anchors, connections, patterns, templates, etc., shall be delivered when required in order to prevent any delay in the progress and completion of the work.

- 1.04 PLANS AND SPECIFICATIONS: These specifications are intended to cover all labor, materials and standards of workmanship employed in the work indicated on the plans and called for in the specifications or reasonably implied therein. The plans and specifications complement one another. Any part of the work mentioned in one and not represented in the other, shall be done the same as if it had been mentioned or represented in both.

The Contractor shall not alter from the drawings and specifications. In the event of errors or discrepancies, the Contractor shall immediately notify the Engineer.

All figured dimensions take precedence over scaled measurements. No important dimension shall be determined by scale.

Specifications and drawings are prepared in abbreviated form and may include incomplete sentences. Omissions of words or phrases such as "the Contractor shall", "as shown on the drawing", "a", "an", and "the", are intentional. Omitted words and phrases shall be provided by inference to form complete sentences.

- 1.05 **REFERENCE STANDARDS:** All work shall be done in accordance with the most current standards listed below as amended and/or amplified herein.

ASA American Standards Association

ASTM American Society for Testing and Materials

AISC American Institute of Steel Construction

ACI American Concrete Institute

UBC Uniform Building Code - current edition

END OF SECTION

SECTION 01340 - DRAWINGS TO BE FURNISHED BY CONTRACTOR

The following shall supplement the General Conditions.

- 1.01 Shop drawings and submittals shall be made in accordance with Section 5.5 - Shop Drawings and Other Submittals of the General Conditions.
- 1.02 The Contractor's stamp and verification of drawings shall consist of the following format:

KAWAIHAE 304.5' AND 632' RESERVOIRS
SYSTEM IMPROVEMENTS AND EARTHQUAKE REPAIR WORK
DHHL CONTRACT NO. IFB-08-HHL-003

(Contractor's Name) _____

(Signature) _____ (Date) _____

This submittal has been checked and verified in accordance with the requirements of the contract documents and any equipment submitted herewith can be installed in the allocated spaces.

Submittal No. _____

Specification Section No. _____

Paragraph No. _____

Contract Drawing Ref. _____

Subcontractor _____

Supplier _____

Manufacturer _____

Exceptions Taken: Yes _____ No _____

Details of Exception _____

- 1.03 The person signing the Contractor's submittal stamp shall be the one designated under the contract agreement with the DHHL. The signature shall be in original ink. Stamped signature will not be acceptable. Submittal for shall be completely filled out, signed and dated.

- 1.04 All changes made to the submittal drawings by the Contractor in the form of written or typewritten markings shall be initialed and dated by the Contractor.
- 1.05 When the Contractor takes any exception to the submittal drawings, such exception shall be brought to the attention of the Engineer. The exception shall be submitted with the shop drawings together with sufficient details and justifications.
- 1.06 Within 30 days after receipt of notice to proceed, the Contractor shall submit to the Engineer in duplicate, a schedule, listing all items that will be submitted for review and approval action by the DHHL, the State Department of Transportation, or the County. The schedule shall include, among other things, a list of shop drawings and manufacturer's literature, certificates of compliance, material samples, and guarantees. The schedule shall indicate the type of item, contract requirement reference; the Contractor's scheduled date for submitting the above items and projected needs for approval answers and procurement dates. In preparing the schedule, adequate time (minimum of 15 days) shall be allowed for review and approval; additional time shall be allowed to provide for possible resubmittal. Also, the scheduling shall be coordinated with the approved progress schedule.
- 1.07 The Contractor shall maintain at the job site two sets of full size contract drawings, marking them in red to show all variations between the construction actually provided and that indicated or specified in the contract documents, including buried or concealed herein, or where variations in scope or character of work from that of the original contract are authorized, the drawings shall be marked to define the construction actually provided. Where equipment installation is involved, the size, manufacturer's name, model number and power input or output characteristics are applicable shall be shown on the as-built drawings. The representations of such changes shall conform to standard and detail as necessary to clearly portray the as-built construction. The drawings shall be maintained and updated on a daily basis.

Monthly and final payments of the Contractor shall be subject to prior approval of the drawings.

On completion of the work, both sets of marked-up drawings shall be delivered to the Engineer, and shall be subject to his approval before acceptance.

END OF SECTION

SECTION 01430 - ENVIRONMENTAL PROTECTION

PART 1 - GENERAL

- 1.01 **GENERAL:** This section covers prevention of environmental pollution and damage during and as the result of construction operations under this contract and for those measures set forth in other sections of the TECHNICAL SPECIFICATIONS. For the purpose of this specification, environmental pollution and damage is defined as the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to utility of the environment for aesthetic, cultural and/or historical purposes. The control of environmental pollution and damage requires consideration of air, water, and land, and includes management of visual aesthetics, noise, solid waste, as well as other pollutants. It is the responsibility of the Contractor to investigate and comply with all applicable Federal, State and County laws and regulations concerning environmental protection and pollution control, and to secure all necessary permits.
- 1.02 **SUBMITTALS:** The Contractor shall submit an environmental protection plan in accordance with the provisions as herein specified. Environmental protection plan shall include but not be limited to the following:
- A. Methods for protection of features to be preserved within authorized work areas. The Contractor shall prepare a listing of methods to protect resources needing protection; i.e., trees, shrubs, vines, grasses and ground cover, landscape features, air and water quality, fish and wildlife, soil, historical, archaeological, and cultural resources.
 - B. Procedures to be implemented to provide the required environmental protection and to comply with all applicable laws and regulations. The Contractor shall set out the procedures to be followed to correct pollution of the environment due to accident, natural causes, or failure to follow the procedures set out in accordance with the environmental protection plan.
 - C. Drawings showing locations of any proposed temporary excavations or embankments for haul roads, stream crossings, material storage areas, structures, sanitary facilities, and stockpiles or spoil material.
 - D. Environmental monitoring plans for the job site, including land, water, air and noise monitoring.
 - E. Methods of protecting surface and groundwater during construction activities.
 - F. Training for his personnel during the construction period.
- 1.03 **IMPLEMENTATION:** After receipt of Notice to Proceed, the Contractor shall submit in writing the above environmental protection plan for approval of the Engineer within 5 days after Notice to Proceed. Approval of the contractor's plan will not relieve the Contractor of his responsibility for adequate and continuing control of pollutants and their environmental protection measures.

- 1.04 SUBCONTRACTORS: Assurance of compliance with this section by subcontractors will be the responsibility of the Contractor.
- 1.05 NOTIFICATION: The Engineer will notify the Contractor in writing of any observed noncompliance with the aforementioned Federal, State or local laws or regulations, permits, and other elements of the Contractor's environmental protection plan. The Contractor shall, after receipt of such notice, inform the Engineer of proposed corrective action and take such action as may be approved. If the Contractor fails to comply promptly, the Engineer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No time extensions shall be granted or costs or damages allowed to the Contractor for any such suspension.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

- 3.01 PROTECTION OF ENVIRONMENTAL RESOURCES: The environmental resources within the project boundaries and those affected outside the limits of permanent work under this contract shall be protected during the entire period of this contract. The Contractor shall confine his activities to areas defined by the drawings and specifications.
- 3.02 PROTECTION OF LAND RESOURCES: Prior to the beginning of any construction, the Contractor shall identify all land resources to be preserved within the Contractor's work area. Except in areas indicated on the drawings or specified to be cleared, the Contractor shall not remove, cut, deface, injure, or destroy land resources including trees, shrubs, vines, grasses, topsoil, and land forms without special permission from the Engineer. No ropes, cables, or guys shall be fastened to or attached to any trees for anchorage unless specifically authorized. Where such special emergency use is permitted, the Contractor shall provide effective protection for land and vegetation resources at all times as defined in the following subparagraphs.
- A. Work Area Limits: Prior to any construction, the Contractor shall mark the areas that are not required to accomplish all work to be performed under this contract. Isolated areas within the general work area, which are to be saved and protected shall also be marked or fenced. Monuments and markers shall be protected before construction operations commence. Where construction operations are to be conducted during darkness, the markers shall be visible. The Contractor shall convey to his personnel the purpose of marking and/or protection of all necessary objects.
- B. Protection of Landscape: Trees, shrubs, vines, grasses, land forms and other landscape features indicated and defined on the drawings to be preserved shall be clearly identified by marking, fencing, or wrapping with boards, or any other approved techniques.
- C. Reduction of Exposure of Unprotected Erodible Soils: Earthwork brought to final grade shall be finished as indicated and specified. Side slopes and back slopes shall be protected as soon as practicable upon completion of rough grading. All earthwork shall be planned and conducted to minimize the duration of exposure of unprotected soils. Runoff from the construction site shall be controlled by construction of diversion ditches, benches, and berms to retard and divert runoff

to protected drainage courses.

- D. Disposal of Solid Waste by Removal From State Property: The Contractor shall transport all solid waste off State property and dispose of it in compliance with Federal, State and local requirements for solid waste disposal.
- E. Disposal of Chemical Waste: Chemical waste shall be stored in corrosion resistant containers, removed from the work area and disposed of in accordance with Federal, State, and local regulations.

3.03 PROTECTION OF WATER RESOURCES: The Contractor shall keep construction activities under surveillance, management and control to avoid pollution of surface and groundwaters. Special management techniques as shall be implemented to control water pollution.

- A. Protection of Waterways: Construction of drainage facilities as well as performance of other contract work which will contribute to the control of siltation shall be carried out in conjunction with the earthwork operations or as soon as thereafter as is practicable.

Prior to or during any suspension of construction operations for any appreciable length of time, the Contractor shall provide for any temporary erosion control measures deemed necessary. Such measures shall be continued until the permanent drainage facilities have been constructed and when called for, until the protective ground cover is sufficiently established to be an effective erosion deterrent. Should such measures fail and an appreciable quantity of material begins to erode into the natural waterway, the Contractor shall act immediately to bring the siltation under control.

- B. Pollution: The Contractor shall exercise every reasonable precaution throughout the life of the project to prevent pollution of rivers, streams or impoundments. Pollutants such as chemicals, fuels, lubricants, bitumens, raw sewage and other harmful waste shall not be discharged into or alongside of the stream, or into natural or manmade channels leading thereto. The Contractor shall also comply with the applicable regulations of the State Department of Land and Natural Resources and other statutes relating to the prevention and abatement of pollution.

The Contractor shall conduct his operations near harbors, bays, swimming and water recreation areas, to avoid and minimize pollution. He shall comply with the applicable regulations of the United States Department of Interior, State Department of Health and other authority having jurisdiction.

Monitoring of water areas affected by construction activities shall be the responsibility of the Contractor. All water areas affected by construction activities shall be monitored by the Contractor.

3.04 PROTECTION OF FISH AND WILDLIFE RESOURCES: The Contractor shall keep construction activities under surveillance, management and control to minimize interference with, disturbance to and damage of fish and wildlife.

3.05 **PROTECTION OF AIR RESOURCES:** The Contractor shall keep construction activities under surveillance, management and control to minimize pollution of air resources. All activities, equipment, processed, and work operated or performed by the Contractor in accomplishing the specified construction shall be in strict accordance with the State of Hawaii Public Health Regulations, Chapter 43, "Air Pollution Control." Special management techniques as set out below shall be implemented to control air pollution by the construction activities, which are included in the contract.

- A. **Particulates:** Dust particles, aerosols, and gaseous by-products from all construction activities and processing and preparation of materials shall be controlled at all times, including weekends, holidays and hours when work is not in progress. The Contractor shall maintain all excavations, stockpiles, haul roads, permanent and temporary access roads, plant sites, spoil areas, borrow areas, and all other work areas within or outside the project boundaries free from particulates which would cause the air pollution standards mentioned above to be exceeded or which would cause a hazard or a nuisance. Sprinkling or other methods approved by the Engineer will be permitted to control particulates in the work area. Sprinkling, to be efficient, must be repeated at such intervals as to keep the disturbed area damp at all times. The Contractor must have sufficient competent equipment available to accomplish this task. Particulate control shall be performed as the work proceeds and whenever a particulate nuisance or hazard occurs.
- B. Hydrocarbons and carbon monoxide emissions from equipment shall be controlled to Federal and State allowable limits at all times.
- C. Odors shall be controlled at all times for all construction activities, processing and preparation of materials.
- D. Monitoring of air quality shall be the responsibility of the Contractor. All air areas affected by the construction activities shall be monitored by the Contractor.

3.06 **PROTECTION FROM SOUND INTRUSIONS:** The Contractor shall adhere to the requirements of the Department of Health and shall implement acceptable noise abatement methods to minimize the construction noise level.

Noise shall be kept within acceptable levels at all times in conformance with Title II, Administration Rules, Chapter 43, Community Noise Control, State Department of Health, Public Health Regulations. The Contractor shall obtain the pay for community noise permit from the State Department of Health when the construction equipment or other devices emit noise at levels exceeding the allowable limits.

All internal combustion engine-powered equipment shall have mufflers to minimize noise and shall be properly maintained to reduce noise to acceptable levels.

3.07 **POST CONSTRUCTION CLEANUP:** The Contractor shall clean up areas used for construction.

- 3.08 RESTORATION OF LANDSCAPE DAMAGE: The Contractor shall restore all landscape features damaged or destroyed during construction operations outside the limits of the approved work areas. Such restoration shall be in accordance with the plan submitted for approval by the Engineer. This work will be accomplished at the Contractor's expense.
- 3.09 MAINTENANCE OF POLLUTION CONTROL FACILITIES: The Contractor shall maintain all constructed facilities and portable pollution control devices for the duration of the contract or for that length of time construction activities create the particular pollutant.
- 3.10 TRAINING OF CONTRACTOR PERSONNEL IN POLLUTION CONTROL: The Contractor shall train his personnel in all phases of environmental protection. The training shall include methods of detecting and avoiding pollution, familiarization with pollution standards, both statutory and contractual, and installation and care of facilities (vegetative covers and instruments required for monitoring purposes) to ensure adequate and continuous environmental pollution control.

END OF SECTION

SECTION 01440 - ARCHAEOLOGICAL FINDINGS

PART 1 - GENERAL

- 1.01 PRESERVATION AND RECOVERY OF HISTORICAL, ARCHAEOLOGICAL, AND CULTURAL RESOURCES: Existing historical, archaeological, and cultural resources within the Contractor's work area will be so designated by the Engineer if any have been identified. The Contractor shall take precautions to preserve all such resources as they existed at the time they were pointed out to him. The Contractor shall provide and install all protection for these resources so designated and shall be responsible for their preservation during this contract. If during excavation or other construction activities in areas with existing or known resources, as well as in any other work area, any previously unidentified or unanticipated resources are discovered or found, all activities that may damage or alter such resources shall be temporarily suspended. Such temporary suspension of work shall not be attributable to the Contractor. These resources of cultural remains (prehistoric or historic surface or subsurface) include but are not limited to: any human skeletal remains or burials; artifacts; shell, midden, bone, charcoal, or other deposits; rocks or coral alignments, parings, wall, or other constructed features; and any indication or agricultural or other uses. Upon such discovery or find, the Contractor shall immediately notify the Engineer. When so notified, the Engineer will notify the State Historic Preservation Officer (SHPO) for further direction.

As directed by the Engineer, the Contractor may be allowed to continue any operation which would not further disturb the site(s); however, all work within the protected area shall be suspended until the Engineer is notified by the SHPO that all investigations or salvage operations have been completed.

END OF SECTION

SECTION 01750 - GUARANTEE

The Contractor guarantees all materials and equipment furnished to be in operable condition upon final acceptance of the work and that all such materials and equipment conform to the requirements of this contract and be fit for the use intended.

He further guarantees all such materials and equipment against defects and poor workmanship and the Contractor guarantees their work to meet the criteria and operating requirements specified in the bid documents.

The period of this guarantee shall commence upon acceptance of the work by the appropriate agency, and shall extend through the project performance evaluation period not to exceed 1 year for all materials and equipment, provided that this period shall be extended from the time of correction of any defect or failures, corrected under the terms of this guarantee, for a like period for the corrected work.

The Contractor shall correct all defects or failures discovered within the guarantee period. The appropriate agency will give the Contractor prompt written notice of such defects or failures following their discovery. The Contractor shall commence corrective work within 10 days following notification and shall diligently prosecute such work to completion. The Contractor shall bear all costs of corrective work, which shall include necessary disassembly, transportation, reassembly and retesting, as well as repair or replacement of the defective material or equipment, and any necessary disassembly and reassembly of adjacent work.

Any period that a particular equipment is not operable due to its failure shall not be considered as a part of the guarantee period. The guarantee period shall be extended for a like period. If due to failure of other equipment the equipment is unable to perform its intended function, the guarantee period shall be extended for a like period. Time that equipment is operating shall be counted as applying to the warranty. Such time shall be determined by use of plant operator's log or other suitable documentation.

If the Contractor fails to perform corrective work in the manner and within the time stated, the Department of Hawaiian Home Lands (DHHL) may proceed to have such work performed at the Contractor's expense and his sureties will be liable therefor. The DHHL shall be entitled to reasonable attorney's fees and court costs necessarily incurred by the Contractor's refusal to honor and pay such costs of corrective work.

The Contractor's performance bond shall continue in full force and effect during the period of this guarantee.

The rights and remedies of the DHHL under this provision do not preclude the exercise of any other rights or remedies provided by this contract or by law with respect to unsatisfactory work performed by the Contractor.

This guarantee shall be deemed supplemental to guarantee provisions provided in other sections of the specifications for the individual units and systems of units so specified.

END OF SECTION

DIVISION 2 - SITE WORK

SECTION 02100 - CLEARING AND GRUBBING

PART 1 - GENERAL

1.01 GENERAL CONDITIONS: The General Conditions and Special Provisions preceding these specifications shall govern this section of the work.

1.02 WORK INCLUDED

- A. Furnish all labor, materials, equipment and tools necessary to accomplish all clearing and grubbing work as indicated on the plans and as specified herein.
- B. It shall be the responsibility of the Contractor to examine the project site and determine for himself the existing conditions.
- C. Obvious conditions of the site existing on the date of the bid opening shall be accepted as part of the work, even though they may not be clearly indicated on the plans and/or described herein or may vary therefrom.
- D. All debris of any kind accumulated from clearing or grubbing shall be disposed of off-site weekly and the whole area left clean. The Contractor shall be required to make all necessary arrangements related to the proposed place of disposal.
- E. Burning onsite will not be permitted.

PART 2 – PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 SEQUENCE OF WORK: All sequence of work shall be subject to the approval of the Engineer.

3.02 PROTECTION

- A. Adequate precautions shall be taken before commencing and during the course of the work to insure the protection of life, limb and property.
- B. The Contractor shall protect from damage all surrounding structures, trees, plants, grass, walks, pavements, utility boxes, etc. Any damages will be repaired or replaced by the Contractor to the satisfaction of the Engineer and at no cost to the State or DHHL.

- 3.03 PERMITS: The Contractor shall apply for and obtain the necessary permits prior to the commencement of work. The Contractor shall pay for all fees.
- 3.04 BARRICADE: Erect temporary barricade to prevent people and animals from entering the project area, to the extent as approved by the Engineer. Such barricades shall not be less than 5'-0" in height. The extent of barricades may be adjusted as necessary with the approval of the Engineer. This work shall be accomplished to the satisfaction of the Department and at no extra cost to the Department. Barricades shall be removed upon completion of work and job site premises left clean.
- 3.05 MAINTAINING TRAFFIC
- A. The Contractor shall conduct operations with minimum interference to streets, driveways, sidewalks, etc.
 - B. When necessary, the Contractor shall provide, erect and maintain lights, barriers, etc., as required by traffic and safety regulations with special attention to protection of life.
- 3.06 CONSTRUCTION LINES, LEVELS AND GRADES
- A. The Contractor shall verify all lines, levels and elevations indicated on the plans before any clearing, excavation or construction begins. Any discrepancy shall be immediately brought to the attention of the Engineer and any change shall be made in accordance with his instruction. The Contractor shall not be entitled to extra payment if he fails to report the discrepancies before proceeding with any work whether within the area affected or not.
 - B. All lines and grades shall be established by a Surveyor licensed in the State of Hawaii.
- 3.07 CLEARING AND GRUBBING
- A. The Contractor shall clear off and remove from the entire area within the area to be graded, all rubbish, grass and weeds, stumps, large roots, buried logs, garbage, boulders, asphalt, concrete or masonry, abandoned vehicles, boats, appliances, fences and other unsuitable material. Where soft wet soils are encountered, light equipment should be used.
 - B. The Contractor shall grub the ground surface within the area to be graded of all grass and weeds to 6 inches below present grades. Grub out tree root structures.
 - C. Any stumps and roots larger than 3 inches in diameter shall be removed to a depth not less than 18 inches below the original grade level. Fill voids with select fill to maintain indicated grade. Providing material to fill void, placement and compaction to be considered incidental.
 - D. No excavation or filling shall be undertaken until area has been cleared and grubbed.

- 3.08 VERIFICATION OF EXISTING GRADES: Verify existing grades, inverts, and improvements before any clearing and grubbing work is done. Immediately bring to the attention of the Engineer any discrepancy, and make any changes in accordance with his instructions. Starting of clearing and grubbing operations will be construed to mean that the Contractor agrees that the existing grades, inverts, and improvements are essentially correct as indicated. No extra compensation will be allowed if existing grades, inverts, and improvements are in error after verification thereof or if he fails to report the discrepancies before proceeding with any work.
- 3.09 CLEAN-UP: Clean up and remove all debris accumulated from construction operations from time to time, when and as directed by the Engineer. Upon completion of the construction work and before final acceptance of work, remove all surplus materials, equipment, etc., and leave entire job site clean and neat.

END OF SECTION

SECTION 02210 – SITE EARTHWORK

PART 1 – GENERAL

1.01 GENERAL CONDITIONS: The General Conditions and Special Provisions preceding these specifications shall govern this section of the work.

1.02 WORK INCLUDED: Furnish all labor, materials, services, equipment and related items necessary to excavate, fill, remove, transport, stockpile and dispose of all materials within the limits of the project required to construct the site work improvements in accordance with these specifications, dimensions, sections and details shown on the plans, and the approval of the Department.

1.03 RELATED WORK IN OTHER SECTIONS

SUBSURFACE SOIL DATA: The Contractor is expected to examine the site and decide for himself the character of materials to be encountered.

1.04 PROTECTION

A. Erosion Control: The Contractor shall incorporate into his work schedule the Temporary Erosion Control Measures and the Permanent Erosion Control procedures indicated on the plans and as specified in the contract.

B. Dust Control: Every effort shall be made by the Contractor to keep dust to a minimum. Spraying the ground with water or other means of control shall be used wherever possible. The Contractor shall have an adequate supply of water for moisture conditioning of fill material.

Without limiting the generality or applicability of other indemnity provisions of the contract, the Contractor agrees that he shall indemnify and hold harmless the Department from and against all suits, actions, claims, demands, damages, costs and expenses (including but not limited to attorney's fees) arising out of any damage to any property whatsoever or injury to any person whomsoever, in any way caused or contributed to by dust from the Contractor's operations.

C. Existing Utilities and Work Areas: The Contractor shall be responsible for the protection of existing surface and subsurface utilities and poles within and abutting the project site, trench excavations and other work areas.

D. Finished Grades and Subgrades: All subgrades shall be kept moist until covered by subbase, base course, or concrete. All finished grades shall be kept moist until covered by landscaping or other permanent groundcover. Where shrinkage cracks are noted after compaction of the subgrade or finished grade, the subgrade or finished grade shall be rescarified, moisture-conditioned to above the optimum moisture content, and recompacted to the specified requirement at no additional cost to the Department. During construction, the Contractor shall properly grade and maintain all excavated surfaces to provide positive drainage and prevent ponding of water. In the event that ponding of water caused

softening of the subgrades, the Contractor shall remove the soft soils and shall backfill the excavation with compacted fill at no additional cost to the Department.

PART 2 – PRODUCTS

Not Used

PART 3 – EXECUTION

3.01 MASS GRADING

- A. Excavations: All excavation shall be made to the lines and grades as shown on the project plans.

Suitable material from excavation shall be used in the fill, and unsuitable material free of organic material from excavation shall be disposed of offsite unless otherwise directed by the engineer.

- B. Slopes: For fill slopes consisting of granular materials (six inches or less in size) and cut slopes, maximum slopes of two horizontal to one vertical (2:1) shall be used. Fill slopes shall be constructed by overfilling and cutting back to the required slope ratio.

- C. Drainage: Care shall be exercised during grading so that areas involved will drain properly. Water shall be prevented from running over the slopes by the temporary berms or drainage swales. Runoff diversion by ditches shall be completed in the time specified in the Proposal.

- D. Supervision: At all times, the Contractor shall have a responsible field superintendent on the project in full charge of the work with authority to make decisions. He shall cooperate with the Engineer in carrying out the work. Any instructions given to him by the Engineer shall be considered to have been given to the Contractor personally.

- E. Rainy Weather: No fill shall be placed, spread or rolled during unfavorable weather. When the work is interrupted by rain, operations shall not be resumed until field tests by the Engineer indicate that conditions will permit satisfactory results.

- F. Unforeseen Conditions: If unforeseen or undetected soil conditions such as soft spots, existing utility trenches, structure foundations, voids or cavities, boulders, seepage water or expansive soil pockets, etc. are encountered, the Contractor at his sole expense shall make all necessary corrective measures in the field as such conditions are detected. Providing, placing and compacting of replacement materials shall be at the Contractor's expense and at no additional cost to the State or DHHL.

- 3.02 UNSUITABLE EXCAVATED MATERIAL: The Contractor shall remove from the site all unsuitable excavated material unless specified otherwise by the Engineer. The unsuitable material not containing organic material shall be hauled and placed in the excavation for coralline material where shown on the drawings. Unsuitable material containing organic material shall be disposed of off-site.

Removal, including hauling and disposal, of the unsuitable material will not be paid for directly, but shall be considered incidental to the project.

END OF SECTION

SECTION 02270 – TEMPORARY SOIL EROSION CONTROL

PART 1 – GENERAL

- 1.01 GENERAL CONDITIONS: The General Conditions and Special Provisions preceding these specifications shall govern this section of the work.
- 1.02 WORK INCLUDED: Submit three (3) sets of the erosion control materials for approval by the Engineer. Furnish all labor, materials, services, equipment and related items necessary to implement the temporary erosion control measures, submitted separately, as required by these specifications and as ordered by the Engineer during the life of the contract to control water pollution through the use of berms, dikes, dams, sediment basins, fiber mats, netting, gravel, mulches, grasses, slope drains, and other erosion control devices or methods.
- A. Temporary erosion and siltation control measures as described herein shall be applied to any erodible material within this project, including local material sources and work areas.
 - B. The Contractor shall be responsible for providing the necessary erosion control measures which are shown on the plans or which may be ordered by the Engineer. All grading operations shall be performed in conformance with the applicable provisions of the "Water Pollution Control and Water Quality Standards" contained in the "Public Health Regulations," State Department of Health.
 - C. The Contractor shall be responsible for promptly (next day after storms) removing all silt and debris resulting from his work and deposited in drainage facilities, roadways, neighboring lands, and other areas.

1.03 RELATED WORK IN OTHER SECTIONS

Site Earthwork..... Section 02210

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Mulches: To be bagasse, hay, straw, fiber mats, netting, wood cellulose, bark, wood chips, or other suitable material acceptable to the Engineer and shall be reasonably clean and free of noxious weeds and deleterious materials.
- B. Slope Drains: To be constructed of fiber mats, plastic sheets, or other materials acceptable to the Engineer.

PART 3 – EXECUTION

3.01 TEMPORARY EROSION CONTROL

- A. The Engineer has the authority to limit the surface area exposed by clearing and grubbing and to limit the surface area exposed by excavation, borrow and fill operations. The Engineer may also direct the Contractor to provide immediate, permanent, or temporary pollution control measures to prevent contamination of streams, lakes, ponds, drainage channels and pipes, roads, neighboring lands, and other areas.

Except for specified measures which may be shown on the plans, the Contractor shall determine the appropriate erosion control measures to use. Such work may involve the construction of temporary berms, dikes, dams, sediment basins, and slope drains, and the use of temporary mulches, mats, and grassing, or the construction and use of other control devices or methods as necessary to control erosion.

- B. The Contractor shall incorporate all erosion control measures shown in the plans. The erosion controls may be modified as necessary to adjust to conditions that develop during construction. All modifications are subject to approval by the Engineer.
- C. The Contractor shall limit the surface area exposed by grubbing, stripping of topsoil, and grading to that which is necessary for him to perform the next operation and which is within his capability and progress in keeping the finish grading, mulching, grassing, and other such pollution control measures current.

The grubbing of the vegetative root mat and stumps and the stripping of topsoil shall be confined within the limits of grading which can be actively and continuously prosecuted within 15 calendar days. The area to be graded shall be limited to the minimum area necessary to accommodate the Contractor's equipment and work force and shall not at any time exceed 15 acres, unless otherwise stated on plans, without prior approval of the Engineer.

Any area remaining bared or cleared for more than 10 calendar days and which is not within the limits of active construction shall be immediately hydro-mulch seeded or remedied as directed by the Engineer at the Contractor's expense without cost to the Department. All areas where finish grading has been completed shall be grassed within three calendar days after the completion of grading for that area.

- D. The Contractor shall, at the end of each work operation in any one day, shape the earthwork in such a manner as to control and direct the runoff to minimize the erosion of soils. He shall construct earth berms along the top edges of embankments or along the property line with adjacent properties, streams and water channels, to intercept any runoff. Temporary slope drains shall be provided by carry runoff from the top of cuts and fills. Temporary facilities for controlled discharges shall be provided for runoff impounded, directed, or controlled by project activities or by any erosion control measure employed.

- E. Cut slopes shall be shaped, topsoil added if necessary, and planted as the work progresses. In no case shall the exposed surface be greater than 15 feet in height. Whenever major excavation is suspended or halted and the slope is bared for more than 15 consecutive days, the exposed surfaces shall be hydro-mulch seeded or protected as directed by the Engineer at the Contractor's expense without cost to the Department of Hawaiian Home Lands.

Fill slopes shall be finished as specified and in accordance with the requirements outlined for cut slopes above.

- F. Construction of berms, cofferdams, or other such construction in or near the vicinity of streams, ponds, waterways, or other bodies of water shall be with approved materials.
- G. The temporary erosion and siltation control measures outlined in these specifications are minimum requirements and shall not preclude the provision of any additional measures which the Contractor may deem necessary. Damages caused by the erosion of soils and the pollution of downstream areas shall be the responsibility of the Contractor and all costs for repairing, correcting, replacing and cleaning damaged or polluted facilities shall be borne by the Contractor.

END OF SECTION

SECTION 02510 –HDPE POTABLE WATER PIPE

PART 1 – GENERAL

- 1.01 DESCRIPTION: The work in this section consists of providing High Density Polyethylene (HDPE) pipe and fittings.
- 1.02 QUALITY ASSURANCE: References, American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), Federal Specifications (FS), International Standards Organization (ISO), and manufacturer's printed recommendations.
- 1.03 SUBMITTALS: Material list naming each product to be used identified by manufacturer and type number, in accordance with Section 01340.
- 1.04 PRODUCT HANDLING: Handle pipe and fittings to insure delivery in a sound undamaged condition.
- 1.05 JOB CONDITIONS: Do not lay pipe when trenches or weather conditions are not suitable for such work.

PART 2 – PRODUCTS

2.01 PIPE

- A. 3 Inches and Larger - Pipe shall be manufactured from a PE 3408 resin listed with the Plastic Pipe Institute (PPI) as TR-4. The resin material will meet the specifications of ASTM D3350 with a cell classification of PE:345464C. Pipe shall have a manufacturing standard of ASTM F714. Pipe O.D. sizes 4" to 24" shall be available in both steel pipe sizes (IPS) and ductile iron pipe sizes (DIPS). Pipe O.D. sizes 26" to 54" shall be available in steel pipe sizes (IPS). Pipe shall be DR 11 (160psi WPR) for pipe sizes up to 36" unless otherwise specified on the plans. The pipe shall contain no recycled compounds except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All pipes shall be suitable for use as pressure conduits, listed as NSF 61, and per AWWA C906 Pressure Class (PC) 160 have a nominal burst value of three and one-half times the Working Pressure Rating (WPR) of the pipe. Peak flow water velocity of 5 ft/sec shall be used in the hydraulics engineering design.

2.02 FITTINGS

- A. Butt Fusion Fittings - Fittings shall be PE3408 HDPE, Cell Classification of 345464C as determined by ASTM D3350-02, and approved for AWWA use. Butt Fusion Fittings shall have a manufacturing standard of ASTM D3261. Molded & fabricated fittings shall have a pressure rating equal to the pipe unless otherwise specified in the plans. Fabricated fittings are to be manufactured using Data Loggers. Temperature, fusion pressure and a graphic representation of the fusion cycle shall be part of the quality control records. All fittings shall be suitable for use as pressure conduits, and per AWWA C906, have nominal burst

values of three and one-half times the Working Pressure Rating (WPR) of the fitting.

- B. Electrofusion Fittings - Fittings shall be PE3408 HDPE, Cell Classification of 345464C as determined by ASTM D3350-02. Electrofusion Fittings shall have a manufacturing standard of ASTM F1055. Fittings shall have a pressure rating equal to the pipe unless otherwise specified on the plans. All electrofusion fittings shall be suitable for use as pressure conduits, and per AWWA C906, have nominal burst values of three and one-half times the Working Pressure Rating (WPR) of the fitting.
- C. Flanged and Mechanical Joint Adapters - Flanged and Mechanical Joint Adapters shall be PE 3408 HDPE, Cell Classification of 345464C as determined by ASTM D3350-02. Flanged and Mechanical Joint Adapters shall have a manufacturing standard of ASTM D3261. Fittings shall have a pressure rating equal to the pipe unless otherwise specified on the plans.

PART 3 – EXECUTION

3.01 GENERAL

- A. Pipe and Fittings: Size as indicated on the plans. Install as shown in accordance with manufacturer's recommendations.

3.02 HAULING, UNLOADING AND DISTRIBUTING PIPE

- A. During loading, transportation and unloading, every precaution shall be taken to prevent injury to the pipe. No pipe shall be dropped from cars or trucks, or allowed to roll down slides without proper retaining ropes. During transportation each pipe shall rest on suitable pads, strips, skids or blocks securely wedged or tied in place. Any pipe damaged shall be replaced.

3.03 FUSION

- A. Sections of polyethylene pipe should be joined into continuous lengths on the jobsite above ground. The joining method shall be the butt fusion method and shall be performed in strict accordance with the pipe manufacturer's recommendations. The butt fusion equipment used in the joining procedures should be capable of meeting all conditions recommended by the pipe manufacturer, including, but not limited to, temperature requirements of 400 degrees Fahrenheit, alignment, and an interfacial fusion pressure of 75 PSI. The butt fusion joining will produce a joint weld strength equal to or greater than the tensile strength of the pipe itself. All welds will be made using a Data Logger to record temperature, fusion pressure, with a graphic representation of the fusion cycle shall be part of the Quality Control records.
- B. Sidewall fusions for connections to outlet piping shall be performed in accordance with HDPE pipe and fitting manufacturer's specifications. The heating irons used for sidewall fusion shall have an inside diameter equal to the

outside diameter of the HDPE pipe being fused. The size of the heating iron shall be ¼ inch larger than the size of the outlet branch being fused.

- C. Mechanical joining will be used where the butt fusion method can not be used. Mechanical joining will be accomplished by either using a HDPE flange adapter with a Ductile Iron back-up ring or HDPE Mechanical Joint adapter with a Ductile Iron back-up ring.
- D. Socket fusion, hot gas fusion, threading, solvents, and epoxies will not be used to join HDPE pipe.

3.04 INSPECTION

- A. Inspect the pipe for defects before installation and fusion. Defective, damaged or unsound pipe will be rejected.

3.05 TESTING

- A. Pressure testing shall be conducted in accordance with ASTM F2164, Field Leak Testing of Polyethylene Pressure Piping Systems Using Hydrostatic Pressure. The HDPE pipe shall be filled with water, raised to test pressure and allowed to stabilize. The test pressure shall be 1.5 times the operating pressure at the lowest point in the system. In accordance with section 9.8, the pipe shall pass if the final pressure is within 5% of the test pressure for 1 hour. For safety reasons, hydrostatic testing only will be used.

END OF SECTION

SECTION 05600 – Prefabricated Steel Water Tank

PART 1 – GENERAL

1.01 Qualifications of Tank Supplier/Manufacturer.

- A. Tank Supplier/Manufacturer shall maintain production facilities specializing in the design and fabrication of corrugated, galvanized steel water tanks with liners and shall maintain a licensed professional engineer on its staff. Tank shall be manufactured by Scafco Corporation or approved equal.

1.02 Qualifications of Tank Erector

- A. Tank Erector shall be licensed to perform General Engineering “A” construction work in the State of Hawaii and shall have erected, at least, 5 storage tanks of similar design and size in the State of Hawaii.

1.03 Design Criteria

- A. Tank Size. Tank shall conform to the size and capacity requirements shown on the construction plans.
- B. Tank Design Standards. Tank bolt together tank shall conform to AWWA D-103-97. The tank design shall allow for 90 mph wind load per UBC Exposure C. The tank design shall allow for AWWA D-103-87 Seismic Zone 4. The tank design shall allow for a 16 psf live load on the tank roof.

PART 2 – PRODUCTS

2.01 Tank Materials

- A. Wall Staves - All wall sheets to 17 Ga. conform to ASTM A-446, C, Fy = 45,000 P.S.I G-90 galvanized or better. All wall sheets 15 Ga. or thicker conform to ASTM A653 SQ, Grade 57 653 SQ commercial quality. Sheets standard corrugation 2 2/3" x 1/2". Sheets have 42 2/3" x 112 1/2" typical coverage.
- B. Bolting Hardware - All bolts are grade 8, with neoprene washer. Bolts have mechanical zinc plating .0006" thick. Vertical seams are bolted at 1 1/3" on center. Horizontal seams are bolted at 9 3/8" on center.

- C. Vinyl Liner - Tank liner construction of 25 mil vinyl side and bottom, FDA approved for potable water. Tank liner shall be protected from tank steel body and tank floor with geotextile material.
- D. Tank Roof - Tank roof sheets shall be triangular sections of galvanized steel with raised ribs along each side, flat area between ribs, and a 90 degree formed deep edge at the eave. Panels are manufactured from G-90 galvanized steel conforming to ASTM A 446, Grade C, or better. Tank roof shall be self supporting and shall have a 15 degree pitch. Tank roof shall include an entry hatch, an apex vent/access manway and safety steps of cold formed steel angle.
- E. Tank Coatings - Tank interior shall be coated with suitable heavy solids zinc or aluminum urethane primer following a wash system suitable for coating system. Tank exterior shall be coated with a primer and top coat system for galvanized steel following as wash system suitable for the coatings. Color shall be per Engineer.

PART 3 - EXECUTION

3.01 Tank Erection

- A. Tank shall be erected on a foundation and pad per the manufacturer's recommended foundation design for soil with a bearing capacity of 2,000 psf.
- B. Tank shall be erected by an experience tank erector using a tank jacking system to prevent damage to the liner.
- C. Tank penetrations shall be through the tank floor using fittings per the manufacturer's recommended design.

3.02 Testing and Disinfection

- A. Finished structure shall be filled and checked for leaks. Water shall be supplied by the Engineer.
- B. Tank shall be disinfected in accordance with AWWA standard D-652. Tank shall be sampled and pass microbiological testing before facility is placed in operation.

END OF SECTION

DIVISION 15 - MECHANICAL

SECTION 15050 - PUMP STATION MECHANICAL EQUIPMENT

PART 1 - GENERAL

- 1.01 The following shall supplement DIVISION 300 - CONSTRUCTION, Section 304.04 – PUMP STATION MECHANICAL EQUIPMENT in the Water System Standards, 2002.

PART 2 - PRODUCTS

2.01. GENERAL DESCRIPTION

A. Pump Piping and Valves:

Pump suction and discharge piping and valves, including silent check valve, butterfly valves, air release valves, flow switches, tank level transmitters, pressure gages, and all necessary appurtenances and piping shall be furnished as shown on the plans.

1. Check Valves:

- a) Number required: Two (2)
- b) Size of valves: 4 inch (P-2)
2 inch (P-1)
- c) Minimum pressure rating of valve: 150 psi
- d) Class of flange: 125 lb., ANSI B16.1

2. Air Release Valves:

- a) Number required: Two (2)
- b) Size of valves: 1/2 inch
- c) Minimum pressure rating of valve: 300 psi
- d) Location: As shown on plans

3. Butterfly Valves:

- a) Number required: Eight (8)
- b) Size of valve:
 - 6 inches (P-3 suction and discharge)
 - 6 inches (P-2 and P-1 main line suction and discharge)
 - 4 inches (P-2 suction and discharge)
 - 2 inches (P-1 suction and discharge)
- c) Minimum pressure rating of valve: 150/300 psi
- d) Class of valve flange:
 - 6 inches (P-3 suction and discharge) – 250 lb
 - 6 inches (P-2 and P-1 main line suction and discharge) – 125 lb
 - 4 inches (P-2 suction and discharge) – 125 lb
 - 2 inches (P-1 suction and discharge) – 125 lb

4. Pump Flow Switches:

- a) Total Number Required: Three (3)
- b) Pipe Size: 6 inch (P-3 discharge line)
2 inch (P-1 discharge line)
4 inch (P-2 discharge line)
- c) Vane Area: As recommended by the manufacturer
- d) Flow Rate: 125 gpm (P-3)
20 gpm (P-1)
50 gpm (P-2)
- e) Minimum Pressure Rating: 300 psi
- f) Location: As shown on plans

5. Tank Level Transmitters:

- a) Total Number Required: Three (3)
- b) Range: 0-30 feet
- c) Location: At reservoirs

6. Pressure Gages:

- a) Total Number Required: Four (4)
- b) Range:
Pump No. 1 & Pump No. 2:
0-30 psi (At pump suction)
0-200 psi (At pump discharge)
Pump No. 3:
0-30 psi (At pump suction)
0-300 psi (At pump discharge)

B. SILENT CHECK VALVE

The pump discharge silent check valve shall be wafer type, center-guided check valve, APCO Globe Style Series 300, or approved equal. The valve body shall be semi-steel or cast iron with bronze trim, stainless steel spring and bronze-bushed center-guides. The valve shall be installed between flanges on the discharge line of the pump.

C. AIR RELEASE VALVE

Air release valve shall be screwed inlet, simple lever, APCO No. 50, Valve and Primer Corporation or approved equal. The valve body shall be cast iron with brass seat, stainless steel float and bronze linkage.

D. BUTTERFLY VALVE

The flanged rubber-seated butterfly valve and handwheel operator shall conform in all respects with AWWA C504, unless otherwise stated in these specifications. The valve shall be Dezurik, Henry Pratt, Clow, Allis-Chalmers, American Valve and Hydrant, Mueller, or approved equal.

The valve shall be designed for a differential pressure of 250 psi for the Class 125 valve, and 400 psi for the Class 250 valve. The valve shall be equipped with a right angle handwheel type manual operator, with a handwheel, enclosed gear, indicator and scale, and adjustable stops. The operator shall be of the worm gear type with an alloy steel worm shaft and bronze worm gear. The operator shall be capable of holding the valve in any open position.

E. FLOW SWITCH

The flow switch shall be an OMEGA Model FSW 42A-SS, with an internal screw adjustment which provides continuous switch adjustment while in operation. Multiple drag disks and strips shall be provided with each unit to provide incremental switch point adjustment to match flow condition. Spare drag disks or strips shall be delivered to the owner as spare parts. The flow switch shall be a single pole double-throw snap switch, 15 Amp, 120 volts, 60 Hz power. "Duct Seal" is to be used to seal the flow switch chamber from the incoming conduit and packed tightly around the leads.

F. TANK LEVEL TRANSMITTER:

- a) TRANSMITTER: The transmitter shall be a Rosemount Model 3051CD, Foxboro Model 841G, Bristol Model 2508, Yokogawa EJA530A, ABB 264 GS or approved equal. The transmitter shall transmit a 4 to 20 milliamp DC signal proportional to pressure.

Power supply for the instrument shall be 24 volt, DC power.

- b) PRESSURE SNUBBER: Pressure snubber shall be furnished with all gages and pressure instruments and shall be RAY, or approved equal.
- c) GAUGE COCK: Gauge cocks shall be furnished for all gauges and pressure instruments and shall be Ashcroft No. 1094, or approved equal, bronze, extra heavy ground key cocks with lever handle and union.
- d) PAYMENT: Payment for pressure transmitter and appurtenant equipment shall be made as a lump sum bid item.

G. PRESSURE GAGE

The diameter of the dial shall be 3-1/2 inches with a standard pressure range specified on the plans, liquid filled, 1 percent full scale accuracy, and a minimum ASME Grade 1A rating. The gage shall be all welded stainless steel construction. Process connection shall be 1/4-inch NPT with a brass snubber, petcock, and union between gage and pipe. Pressure gage shall be Ashcroft Model 1009 or approved equal. Pressure snubbers shall be furnished with all gages and pressure instruments and shall be RAY or approved equal. Gage, snubber and petcock union shall be supplied as a unit and shall be located as shown on the plans.

PART 3 - EXECUTION

2.01. PUMP DISCHARGE PIPING AND VALVES PAYMENT

No separate payments will be made for the work covered by this section of the specifications. All costs in connection with furnishing and installing of the various items shall be included in the Lump Sum Price Bid of which the item is a part.

2.02 COMPENSATION

Payment for the furnishing and installing of equipment will be made at the Lump Sum Price Bid of which the item is a part and shall be full compensation for all work in connection therewith, complete and finished in accordance with the drawings and specifications.

SECTION 15100 – BOOSTER PUMPS

PART 1 – GENERAL

1.01 The following shall supplement DIVISION 300- CONSTRUCTION, Section 304.01 - PUMPS of the Water System Standards, 2002

1.02 WARRANTY

The Contractor shall guarantee the equipment covered by these specifications against any defective material and workmanship for one year after the date of acceptance of the installed pump unit. The Contractor shall replace and correct all defective parts within this period and pay for all costs thereof including shipping, removal and reinstallation of the necessary parts. It shall be understood that any shipping damages shall be corrected and paid for by the Contractor, and final acceptance and payment will be subject to satisfactory delivery of the equipment.

PART 2 – PRODUCTS

2.01 BOOSTER PUMPS:

The following requirements are for the furnishing and installation of the booster pumps, motors, diesel engine, and appurtenances.

A. SKID MOUNTED VERTICAL CENTRIFUGAL BOOSTER PUMPING UNIT (P-3):

This section of the specification covers the furnishing and installing of one new skid mounted, factory fabricated, duplex, vertical, motor-driven, centrifugal pumping unit.

1. Pump Characteristics:

Number Required: Two (2)

Pump Rated Capacity and Head: 125 gpm at 560 ft. head

Pump used to dimension plans and specify pump performance

characteristics: Gould Pumps, model 4SV2F0K46M1 (3500 rpm, 6 Stages)

2. Motor Characteristics:

Number Required: Two (2)

Electrical Motor Rating: 20 HP

Power: 3-Phase, 60 Hertz, 208 Volts

3. Booster Pump Description:

Booster pump system shall be skid-mounted factory fabricated duplex pump constant speed pumping unit, with automatic start/stop, manual override, and lead/lag capability.

a) Each pump shall provide flow of 125 gpm at 560 feet head with a

minimum suction pressure of (-)4 feet gauge and a maximum suction pressure of 25 feet gauge.

- b) Pumps shall be 316L stainless steel vertical inline centrifugal type with mechanical seal, ceramic shaft bushings.
- c) Motors shall be NEMA Premium Efficiency totally enclosed fan-cooled type. Minimum class F insulation, 1.15 service factor.
- d) Piping shall be Schedule 40, type 304 stainless steel. Isolation valves shall be brass body full port ball valves. Pump discharge shall be equipped with spring-loaded non-slam check valve. Provide glycerin filled bourdon tube type pressure gauges for both suction and discharge manifolds. Gauges shall be 2.5 inch diameter and have stainless steel housings. Flanges shall be Class 250.
- e) Expansion tank shall be provided on the pump discharge header, sized for the pump system capacity. Stainless steel tank with butyl diaphragm, factory pre-charged for system pressure.
- f) Factory installed booster pump control panel with disconnects and starters. Panel shall be a NEMA 3R stainless steel enclosure with integral latches. Pump controller shall have programmable pump logic. The controller shall provide a LCD display and keypad for data entry. Program settings shall be changeable and stored in non-volatile memory without the use of a backup battery. Standard system functions shall include: loss of suction, lack of NPSHa, pump run-out protection, "dead-head" protection, quadratic differential flow calculation, system curve compensation, low suction tank level shutdown, pump start-stop input, adjustable timed alternation of primary-standby pump operation, overpressure shutdown, and low flow shutdown.

B. PHOTOVOLTAIC VERTICAL MULTISTAGE CENTRIFUGAL PUMP (P-1):

This section of the specification covers the furnishing and installing of one new vertical, multistage, motor-driven, centrifugal pumping unit.

1. Pump Characteristics:

Number Required: One (1)

Pump Rated Capacity and Head: 20 gpm at 370 ft. head

Pump used to dimension plans and specify pump performance characteristics: Gould Pumps, Model 2SVB (3500 rpm, 11 Stages)

2. Motor Characteristics:

Number Required: One (1)

Electrical Motor Rating: 5 HP

Power: 3-Phase, 60 Hertz, 208 Volts

3. **Booster Pump Description:**

Booster pump system shall be photovoltaic powered vertical inline centrifugal type with mechanical seal, ceramic shaft bushings. Pump shall provide indicated flow and head with a minimum suction pressure of 0 feet gauge and a maximum suction pressure of 25 feet gauge. Pump shall be of 316L stainless steel. Motor shall be NEMA Premium Efficiency totally enclosed fan-cooled type. Minimum class F insulation, 1.15 service factor. Flanges shall be Class 125.

C DIESEL DRIVEN HORIZONTAL REGENERATIVE TURBINE PUMP (P-2):

This section of the specification covers the furnishing and installing of one new horizontal, multistage, diesel driven, regenerative turbine pumping unit.

1. **Pump Characteristics:**

Number Required: One (1)

Pump Rated Capacity and Head: 50 gpm at 370 ft. head

Pump used to dimension plans and specify pump performance characteristics: MTH Pumps, Model 153L (1750 rpm)

2. **Engine Characteristics:**

Number Required: One (1)

Diesel Engine Rating: 33 HP at 1750 RPM

Engine used to dimension plans and specify pump performance characteristics: Deutz Corporation, Model D2011L031 (1750 rpm)

3. **Diesel Driven Regenerative Turbine Pump Description:**

a) Booster pump system shall be regenerative turbine type with ceramic mechanical seals. Pump shall provide indicated flow and head with a minimum suction pressure of 0 feet gauge and a maximum suction pressure of 25 feet gauge. Pump shall be all bronze construction. Flanges shall be Class 125.

b) Engine shall be air-cooled, 3 cylinder, 142 cid, diesel engine with factory installed control panel, gauge panel, starter, alternator, air cleaner, exhaust muffler and extension, flywheel and rigid motor mounts.

c) Provide fuel tank, piping, valves and hoses for a complete operating system. Fuel tank shall be UL listed single wall 150 gallon capacity, with vent cap, lockable fill cap, strainer, tank gauge, drain plug, and plugged openings for additional connections. Elevate tank above engine fuel pump.

D. SUBSTITUTION OF SPECIFIED PUMP UNITS

Pumping units to be furnished are that used to specify pump unit performance characteristics or their approved equal. This specific model has been used to dimension plans. Substitute pump units can be used only if the following conditions are met:

1. All changes in dimensions resulting from the substitution of the specified pump and motor/engine shall be the responsibility of the Contractor.
2. The substitute pump and motor/engine must have performance characteristics equal to or better than the specified pump unit. Specific performance characteristics that shall be compared are the required horsepower, efficiency and head capacity curve. The pump and motor/engine shall be OEM units and be provided with manufacturer's data.

E. PRELIMINARY PUMP CHARACTERISTIC CURVE

The Contractor shall submit three copies of the preliminary pump characteristic curve for approval prior to ordering and shipping the unit. The curve shall show the proposed head, efficiency and brake horsepower versus capacity characteristics of the pump to be furnished.

F. INSTALLATION INSTRUCTIONS AND MAINTENANCE MANUAL

The pump manufacturer shall also provide at least four copies of the instructions for the installation of the pumping unit and proper maintenance of the same in bound folders.

PART 3 - EXECUTION

3.01 EQUIPMENT ASSEMBLY

Alignment of rotating shaft centers at couplings shall not exceed proper allowance for the expansions of the driving and driven units when operating; and faces of coupling halves, with coupling square on their shafts, shall be parallel.

Shimming and grouting of equipment bases and supports shall be performed after final positioning at proper elevation, with all piping, leveling and aligning completed and with anchors tightened. Once grouted, the item shall not be operated or subjected to other vibration or stresses until the grout has reached an age of seven days minimum.

The Contractor shall do lubrication of all moving parts with the lubricants recommended by the manufacturer. Rotating equipment, which has been shipped dismantled for assembly in the field or is not shipped with lubricants, shall have the bearings flushed clean and lubricated when assembly is complete.

All surfaces of equipment shall be cleaned prior to assembling and erecting. All internal surfaces shall be maintained clean and free of dirt, water, loose scale and all other foreign

materials during assembling and erecting, and shall subsequently be thoroughly cleaned prior to initial operation or use.

3.02 PAINTING

Paintings of new pump units, all exposed pipes, fittings, and valves associated with the new booster pump stations shall be as specified herein and in Division 300 - Construction, Section 303.27 Painting, of the Water System Standards, 2002. Paint shall be delivered to the site in factory-sealed containers and applied in accordance with the manufacturer's instructions. All surfaces to be painted shall be thoroughly cleaned of dirt, dust, oil or grease with clean, dry rags and solvents. Rust, mill scale, stain and any other injurious materials shall be removed by scraping, chipping, wire brushing or sand blasting. Drop cloths and other suitable covering shall be used to eliminate paint drips or overspray beyond the painted surfaces. Do not paint stainless steel surfaces. Provide corrosion resistant coating for all ferrous surfaces exposed to weather.

3.03 LAYOUT DRAWINGS

Three sets of the pump and piping layout drawings shall be submitted for approval to the Owner prior to construction. All dimensions of the pump, valves, piping, fittings, and appurtenances shall be shown.

3.04 FIELD TESTING OF PUMP UNIT

After installation of all equipment and before any field tests are conducted, the pump shall be operated continuously for a period as determined by the Engineer. The Contractor shall make his own arrangements and pay for power and other costs.

Throughout the operating test, the pumping unit shall run smoothly without vibration or heating of the bearings. If, during or as a result of this test, any structural or mechanical defect or weakness develops, or if the equipment fails to deliver its required discharge at the respective head under required conditions, the Owner reserves the right to reject any part or all of the equipment and demand reconstruction or replacement to meet the requirements of these specifications at no cost to the Owner.

After the operating test has been completed to the satisfaction of the Engineer, a pump test shall be made for each pump, covering a period of not less than two hours. This test shall be made by the Contractor in the presence of the Engineer. The capacity of the pumping unit will be tested under the head capacity conditions specified.

All gauges and equipment required for tests, which are not available in the permanent equipment, will be furnished, installed and tested by the Contractor. All gauges and equipment shall be calibrated and calibration curves shall be submitted to the Engineer.

The quantity of water delivered shall be based on the readings of the contractor furnished flow meter. No special calibration will be made. Tests shall be made with the electric current normally furnished by Hawaii Electric Light Company, Ltd. and the photovoltaic system. No adjustment of the electrical power will be allowed.

3.05 AS-BUILT DRAWINGS

The Contractor at no additional cost shall return one set of red marked as-built drawings to the Owner.

3.06 PACKING AND SHIPMENT

Pump equipment shall be packed in substantial containers to protect them adequately from damages during normal handling in transit.

3.07 STORAGE

The Contractor shall, as a minimum, comply with the following requirements for protection of all equipment during storage.

Equipment shall be stored off the ground, properly supported on skids, blocking, cribbing or other suitable support. Equipment having saddle or dollies shall be supported mainly from these supports. Equipment supports shall be leveled and aligned on wedges or shims as necessary to prevent any twisting or bending stresses on the supported equipment.

At the time of delivery, the factory-installed closures on nozzles and equipment openings shall be inspected for weather-tightness. Any closures, which are punctured, or missing shall be replaced with temporary closures and made weather-tight. All closures shall be maintained weather-tight and left in place until the Engineer or his representative authorizes removal.

Motor and controls shall be stored only in an enclosed cover, except that if outdoor storage of a short duration is necessary, these items may, for that period, be stored off the ground and fully covered with a suitable waterproof covering free from punctures or tears and secured against displacement. The protective measure for all such outdoor storage will be provisional upon approval by the Engineer.

3.08 COORDINATION OF WORK

The Contractor's work and installation of equipment and materials shall be closely coordinated with the project manager and other contractors working on the site to avoid all possible interferences, delays, omissions, and overlapping of responsibilities.

3.09 PAYMENT

The pumping units, which includes motor/engine and appurtenances as provided above, will be paid for at the applicable contract unit price, upon delivery and installation at the project site.

Price shall be full compensation for furnishing, handling, installing, and testing pumping unit; and for all equipment, tools, labor, materials, including drawings and instruction books, and incidentals necessary to complete the work.

Payment for the item shall be made as follows:

Forty percent of the total cost for the item will be paid when the complete pumping unit is acceptably delivered at the job site.

An additional 40 percent of the total cost for the item will be paid after the pumping unit has been installed.

The remaining 20 percent of the total cost for the item will be paid after the pumping unit has been tested and accepted.

DIVISION 16 - ELECTRICAL

SECTION 16050 - BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 GENERAL CONDITIONS: The General Conditions and Special Provisions preceding these specifications shall govern this section of the work.

1.02 WORK INCLUDED:

- A. The Contractor shall furnish all labor, materials (except as hereinafter noted), tools, equipment and appliances required to provide and install all Electrical Work, complete, as indicated on the drawings and/or as herein specified. The drawings note various sizes of equipment as determined for basis of design; the electrical work, however, shall be installed to comply with the equipment furnished by the successful supplier. The work shall include but not necessarily be limited to, the following:
 - 1. Equipment utilizing electricity shall be provided by respective sections of specification. Installation of complete power wiring to equipment shall be part of electrical work.
 - 2. Connection and testing of appliances and equipment furnished by others requiring electrical connections.
 - 3. It is the intent of these Specifications and other Contract Documents to require an installation complete in every detail. Consequently, the Contractor will be responsible for minor details or for any special construction which may be found necessary to properly furnish, install, adjust, test, and place in successful and continuous operation, the lighting system and the cost of same shall be included in the contract price.
 - 4. Before bidding on this work, carefully examine each of the drawings and the site. By submitting a proposal of the work included in this contract, the Contractor shall be deemed to have made such examination and to be familiar with and accept all conditions of the job site.
 - 5. Test complete installation and correct all defects and malfunctions of material and workmanship.

1.03 RELATED SECTIONS:

- A. DIVISION 15 – MECHANICAL sections.
- B. This section applies to all sections of DIVISION 16, ELECTRICAL, of this project specification unless specified otherwise in the individual sections.

1.04 CODES AND STANDARDS:

A. The materials and completed work shall conform to the requirements of all locally applicable codes and regulations; General Order No. 10, Public Utilities Commission, State of Hawaii; regulations and standard practices of respective utility companies; applicable instructions of manufacturers of equipment and materials supplied for this project; and of standards referenced herein. Applicable rules, standards and specifications of the following associations shall apply to materials and workmanship.

1. American National Standards Institute (ANSI).
2. American Society for Testing and Materials (ASTM).
3. American with Disabilities Act Accessibility Guidelines (ADAAG).
4. Disability and Communication Access Board (DCAB) Interpretive Opinion.
5. Edison Electric Institute (EEI).
6. Electronic Industries Alliance (EIA).
7. Institute of Electrical and Electronics Engineers (IEEE).
8. Insulated Power Cable Engineers Association (IPCEA).
9. National Board of Fire Underwriters (NBFU).
10. National Electrical Code (NEC).
11. National Electrical Manufacturers Association (NEMA).
12. National Fire Protection Association (NFPA).
13. U.S. Department of Commerce, National Bureau of Standards (National Electrical Safety Code).
14. Underwriters' Laboratories, Inc. (UL).

1.05 APPLICABLE PUBLICATIONS: The publications listed herein shall form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.06 SUBMITTALS:

A. Shop Drawings:

1. Submit, in accordance with Section 01330 – SUBMITTAL PROCEDURES, complete shop drawings and manufacturer's literature for review before any work is fabricated.

2. Shop drawings and catalogue cuts for materials shall clearly specify compliance with and/or deviation from specified material. Certification shall not contain statements to imply that the item does not meet requirements specified, such as "as good as"; and "achieve the same end use and results as materials formulated in accordance with the referenced publications". Certifications shall simply state that the item conforms to the requirements specified. Certificates shall be printed on the manufacturer's letterhead and shall be signed by the manufacturer's official authorized to sign certificates of compliance. Review of shop drawings and catalogue cuts shall not release Contractor from complying with intent of specification and drawings.
- B. Operation and Maintenance Manuals: Provide operational manual in 8 ½ x 11 inch three-ring binders. Sections shall be separated by heavy plastic dividers with tabs that identify the material in the section. Drawings shall be folded blue lines, with the title block visible, and placed in 8 ½ x 11 inch plastic pockets with reinforced holes. Manuals shall include, but not be limited, to the following:
1. An instruction manual with pertinent items and information highlighted.
 2. An outline drawing, including front view and sectional views with items and devices identified.
 3. All system components shall be clearly specified as to the type, manufacturer, and model number for later needs for replacement and service.
 4. Prices for spare parts and supply list that identify readily available sources.
 5. Routine and field acceptance test reports.
 6. Troubleshooting and routine maintenance procedures.
 7. Manufacturer's recommended maintenance schedule.
 8. Description and requirements for installation, operation, and safety.
 9. Date of purchase.

1.07 DELIVERY, STORAGE, AND HANDLING:

- A. Equipment delivered and placed in storage shall be kept clean and protected from physical damage, weather, humidity and temperature variation, dirt, dust, corrosive marine environment, and any other contaminants.
- B. All materials shall be delivered to project site in original unopened containers, and shall be kept clean and protected during transit and job storage. Coordinate deliveries to avoid interferences or construction delays. Use all means necessary to protect the materials of this division before, during, and after

installation and to protect the installed work and materials of all other trades. In the event of damage, immediately make all repairs and replacements necessary to the satisfaction of the Engineer and at no increase in cost to the contract.

- C. Coordinate deliveries to avoid interferences or construction delays.
- D. Use all means necessary to protect the materials of this division before, during, and after installation and to protect the installed work and materials of all other trades.
- E. In the event of damage, immediately make all repairs and replacements necessary to the satisfaction of the Engineer and at no increase in cost to the contract.

1.08 QUALITY ASSURANCE:

- A. In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Engineer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.
- B. Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products that are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2-years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class or equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000-hours, exclusive of the manufacturers' factory or laboratory tests, are furnished. Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.
- C. All materials shall be new, except as specifically noted, and shall meet requirements of NFPA 70 and also bear the label of Underwriter's Laboratories whenever standards have been established and label service is normally and regularly furnished by the agency.
- D. Contractor shall afford every opportunity for the Engineer to ascertain skill and competency of labor. Concealed work shall be reopened at random as directed during formal inspections by the Engineer or Electrical Inspector.
- E. The responsibility for performance to this specification shall not be divided among individual component manufacturers, but must be assumed solely by the

primary manufacturer. This includes system design, manufacture, test, and having a local supplier responsible for service, parts, and warranty for the total system.

F. Products that are assembled from individual component parts strictly for conformance to this project are not acceptable.

G. Systems Responsibility:

1. All materials shall be provided under the supervision of a single systems house, chosen by the Contractor, which is regularly engaged in the design and installation of such systems of similar scope and complexity. Contractor is responsible to the State or DHHL for performance of all systems as specified.
2. Equipment specified herein shall be provided by the manufacturer nominated in the listing set forth below. The nominated manufacturer shall assume complete responsibility for the efficiency, sufficiency and reliability of all equipment and appurtenances specified. As a condition precedent to the Engineer's review of submittals required under these specifications, the Contractor shall furnish the manufacturers' statements accepting unit responsibility. The purpose of this provision is to both ensure compatibility of all components specified under the specific technical specification and also to provide sole source responsibility for system performance and maintenance. Notwithstanding these provisions, however, the Contractor is not relieved of his responsibility for the indicated portions of the work. Equipment to be furnished under the provisions and requirements set forth above shall include the following:

Applicable Item	Responsible Manufacturer
Solar Array Assembly Battery Assembly Charger Controller Wireless I/O Interface Transmitter/Receiver Antenna Assembly Fusing Limit Value Switch System Enclosure Wiring and Appurtenances	Solar Interface Systems Manufacturer

1.09 WARRANTY:

- A. Any item of material, apparatus, and equipment furnished and installed, or construction by the Contractor showing defects in design, construction, quality or workmanship shall be replaced by such new material, apparatus or parts as may be found necessary to make such defective portion of the complete system conform to the true intent and meaning of the specification and/or the drawings. The Contractor or his surety, free of all expense to the State or DHHL, shall make such repairs or replacement.

- B. The equipment items shall be supported by service organizations which are reasonable convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.10 COORDINATION WITH OTHER TRADES, AND SUPPLIERS:

- A. During bidding and construction, Contractor shall coordinate his work with other trades and suppliers to avoid conflicts, omissions and overlapping of responsibilities.
- B. Contractor shall notify other trades and suppliers of the project voltages, characteristics, properties and other limitations.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Raceways and Fittings:
 - 1. Rigid Metallic Conduit and Fittings: Galvanized rigid steel, 3/4" minimum diameter; NEMA C80.1, UL 6. Ferrous fittings shall be threaded-type, split couplings are unacceptable, with cadmium- or zinc- coating; UL 514B.
 - 2. Plastic-Coated Rigid Steel Conduit and Fittings: Conduit system, including fittings and mounting appurtenances, shall be hot dip galvanized inside and out with clear coated urethane over hot galvanized threads, with polyvinylchloride (PVC) jacket and red urethane interior coating. Conduit shall be round bore, smooth inside finish, electrical type, and for use with approved threaded fittings. The PVC jacket shall be bonded to the galvanized steel and shall have a minimum thickness of 40 mils. Robroy "Plasti-Bond REDH20T" conduit system or equal; NEMA RN1.
 - 3. Non-metallic rigid conduit and Fittings: PVC Schedule 40 or 80; NEMA TC2, UL 651 and NEMA TC3, UL 514B.
 - 4. Flexible Metal Conduit: UL 1, liquid-tight flexible steel conduit per UL 360. Ferrous fittings shall be cadmium- or zinc- coated, UL 514B.
 - 5. Fittings for Metal Conduit and Flexible Metal Conduit: UL 514B, ferrous fittings shall be cadmium-coated or zinc-coated in accordance with UL 514B.
- B. Wires and Cables:
 - 1. Conductors shall be 600-volt, copper, No. 12 AWG minimum; No. 10 AWG and smaller, solid and round; No. 8 AWG and larger, 7 or 19 strands concentric; insulation type THWN conforming to UL 83, unless

otherwise noted. Color shall be green for grounding conductors. Color of ungrounded conductors in different voltage systems shall be as follows:

- a. 208/120 volt, 3-phase: Phase A - black; Phase B - yellow; Phase C - red.
 - b. DC wiring: Negative power connection (-) - black; Positive power connection (+) - red.
2. Bonding conductors shall be solid bare copper wire for sizes No. 8 AWG and smaller diameter conforming to ASTM B1; stranded bare copper wire for sizes No. 6 SWG and larger diameter conforming to ASTM B8, Class B.
- C. Splices and Termination Components: UL 486A, as applicable, for wire connectors and UL 510 for insulating tapes. Connectors for No. 10 AWG and smaller diameter wires shall be insulated, pressure-type in accordance with UL 486A or UL 486C (twist-on splicing connector). Provide solderless terminal lugs on stranded conductors.
- D. Outlet and Small Junction Boxes: Exposed boxes and weather-exposed boxes shall be cast iron, or ferrous alloy, prime painted and enamel finished, with threaded hubs for conduit connection. All screws for weather-exposed boxes shall be Type 316 stainless steel.
- E. Large Junction Boxes: For exterior and damp or wet locations, the box shall be type 316 stainless steel with matching gasketed cover. All screws shall be type 316 stainless steel.
- F. Equipment Disconnect Switch: Heavy-duty, horse-power rated when used as motor disconnect, lever-operated contacts, spring-loaded, NEC standard fuse rejection type holders when used with current limiting fuses. NEMA-4x enclosure shall be fabricated from Type 316 stainless steel, and (where available) prime painted and enamel finished according to NEMA specifications. General Electric Co. type TH or approved equal.
- G. Individual Circuit Breaker: Individual circuit breaker shall consist of molded plastic case circuit breaker with toggle operated mechanism and thermal-magnetic overload trips. Interchangeable trip shall be provided when available. Toggle positions "On" and "Off", engraved or embossed on body. NEMA 4X enclosure shall be fabricated from Type 316 stainless steel.
- H. Metering Equipment: Metering equipment shall be sealable type and size as noted, conforming to regulations of the local utility company. Meter sockets shall be equipped with test by-pass facilities when required. Enclosures shall be sealable and rated NEMA 3R, Type 316 Stainless Steel.
- I. Hardware, Supports, Backing, Etc.: All hardware, supports, backing and other accessories necessary to install electrical equipment shall be provided. Type 316 stainless steel for corrosion protection in damp or wet locations; non-ferrous materials shall be brass or bronze.

- J. Grounding and Bonding Equipment: Ground rods shall be 5/8" x 10'-0" copper-clad steel core. Copperweld Steel Company or equal acceptable to the Engineer.
- K. Nameplates: NFPA 70; provide permanently engraved, fully descriptive identification nameplate for each equipment enclosures, and switches. Each nameplate inscription shall identify the function and, when applicable, the position. Laminated plastic nameplates shall be 1/8-inch thick melamine plastic, black with white center core; minimum 1-inch by 2-1/2 inch dimensions; and minimum 1/4-inch high normal block lettering. Embossed tape, press type, etc., are not acceptable.
 - 1. Switches, etc.: By designation/use, voltage, phase, amperage and circuit number (as applicable).
 - 2. Cabinets: By designation/use.
- L. Pull Wire: Pull wire shall be plastic having a minimum tensile strength of 200 pounds.
- M. Factory Applied Finish: Provide manufacturer's coatings for touch-up work.
- N. All equipment and mounting hardware provided shall be Type 316 Stainless Steel, unless otherwise noted.

PART 3 - EXECUTION

3.01 GENERAL:

- A. Rules and Permit: The entire installation shall be made in strict accordance with the latest rules and regulations of the National Board of Fire Underwriters, the currently adopted edition of the National Electrical Code; ADAAG; DCAB interpretive opinion; the local Electrical Bureau; General Order No. 10, Public Utilities Commission, State of Hawaii; regulations and standard practices of respective local utility company; applicable instructions of manufacturers of equipment and materials supplied for this project; and standards referenced herein. The Contractor shall obtain and pay for all required permits as required by local laws and rules, and licenses and royalties as necessary to accomplish work. The proper local authorities shall inspect all work as it progresses. The Contractor shall pay all required inspection and testing fees and shall deliver certificates of completion and inspection to the Engineer before final payment will be made. Costs of permits and inspection fees shall be included in the Contractor's bid price.
- B. Construction Methods: Construction shall conform to construction practices as recommended by the American Electricians Handbook by Croft (latest edition), Edison Electric Institute, Institute of Electrical and Electronics Engineers, National Electrical Code, National Electrical Safety Code, and applicable

instructions/recommendations of manufacturers of equipment and material supplied for this project.

- C. **Materials and Workmanship:** All labor and materials of every kind shall be subject to the approval of the Engineer, who shall be afforded every facility for ascertaining the competence of such labor and examining such materials, as he may deem necessary. Materials shall be new and shall bear the inspection label of the Underwriters' Laboratories, Inc. Brand names and catalog numbers used in this specification indicate the standards of design and quality required. Substitution of other brands or catalog numbers shall be as approved by the Engineer.
- D. **Record Drawings:** The Contractor shall maintain an accurate and adequate record of each change as it occurs, regardless of how ordered.
- E. **Drawings and Specification:** This specification is intended to cover all labor, materials and standards of workmanship to be employed in the work indicated on the drawings and called for in the specification or reasonably implied therein. The drawings and specification supplement one another. Any part of the work mentioned in one and not represented in the other, shall be done the same as if it has been mentioned in both. The Contractor shall not make alterations in the drawings and specification.
- F. **Discrepancies and Interpretations:**
 - 1. Should the Contractor find any discrepancies in or omissions from any of the documents or be in doubt as to their meaning, he shall advise the Engineer who will issue any necessary clarification within a time period which does not disrupt the progress of the work.
 - 2. All interpretation and supplemental instructions will be in the form of a written addendum to the Contract Documents.
 - 3. Should any discrepancy arise from the failure of the Contractor to notify the Engineer, the higher quality or larger quantity of item shall prevail. The Engineer shall make the final interpretation and judgment.
 - 4. In the event of a discrepancy between small scale drawings and large scale details, or between drawings and specification, on which is in violation of any regulations, ordinances, laws or codes, the discrepancy, if known by the Contractor, shall be immediately brought to the attention of the Engineer for a decision before proceeding with the particular work involved. Work carried out disregarding these instructions will be subject to removal and replacement at the Contractor's expense.
- G. **Symbols:** The standard electrical symbols together with the special symbols, notes and instructions shown on the drawings indicate the work and outlets required and are all to be included as a part of this specification.
- H. **Coordination:** This specification is accompanied by sections, elevations, and site plans indicating locations of all telemetering equipment, pump controller,

switches, circuit runs, and other electrical apparatus and wiring. These locations are approximate and, before installing, the Contractor shall study the adjacent civil and mechanical details/plans and actually make the installation in the most logical manner. Any outlet may be relocated within ten feet before installation at the direction of the Engineer. The circuit routing is typical only and may be varied in any logical manner.

3.02 INSTALLATION:

- A. Electrical installations, including weatherproof locations and ducts, plenums and other air-handling spaces, shall conform to requirements of NFPA 70 and IEEE C2 and to requirements specified herein.
- B. Grounding and Bonding: Provide in accordance with NFPA 70. Ground exposed, non-current-carrying metallic parts of electrical equipment, metallic raceway systems, grounding conductor in metallic and non-metallic raceways, telecommunications system grounds, grounding conductor of multiconductor cable, and neutral conductor of wiring systems.
 - 1. Grounding conductor shall be separate from electrical system neutral conductor. Provide insulated green equipment grounding conductor for circuit(s) installed in conduit and raceways. All grounding wire runs within building shall be routed together with circuit conductors.
 - 2. Ground Rods: Provide cone pointed ground rods. The resistance to ground shall be measured using the fall-of-potential method described in IEEE Std 81. The maximum resistance of a driven ground shall not exceed 25 ohms under normally dry conditions. If this resistance cannot be obtained with a single rod, one additional rod not less than 6-feet on centers shall be provided. If the resultant resistance exceeds 25 ohms measure not less than 48 hours after rainfall, notify the Engineer who will decide on the number of ground rods to add.
 - 3. Make grounding connections that are buried or otherwise normally inaccessible, by exothermic weld or compression connector.
 - a. Make exothermic welds strictly in accordance with the weld manufacturer's written recommendations. Welds which are "puffed up" or which show convex surfaces indicating improper cleaning is not acceptable. Mechanical connectors are not required at exothermic welds.
 - b. Make compression connections using a hydraulic compression tool to provide the correct circumferential pressure. Tools and dies shall be as recommended by the manufacturer. An embossing die code or other standard method shall provide visible indication that a connector has been adequately compressed on the ground wire.
 - 4. Protect ground cables crossing expansion joints or similar separations in structures and pavements by use of approved devices or methods of

installation that provide the necessary slack in the cable across the joint to permit movement. Use stranded or other approved flexible copper cable across such separations.

- C. **Wiring System:** Provide insulated conductors installed in rigid steel conduit, except where specifically indicated or specified otherwise or required by NFPA 70 to be installed otherwise. Conceal conduit under floor slabs on-grade (do not install conduits horizontally in slabs on-grade).
1. Below grade or below slab on-grade, use Schedule 40 PVC (do not use above grade, except where indicated otherwise).
 - a. Provide separate ground wire and rise out of ground with PVC jacketed rigid steel conduit when exposed (PVC coating shall extend from at least 2 inches within the concrete to the first coupling or fitting outside the concrete, minimum of 12 inches from penetration). Protect exposed PVC jacket from damage with protective PVC schedule 80 sleeve, extending at least 2 inches within concrete and extending minimum of 12 inches from penetration; fill completely all spacing between PVC-coated conduit and protective sleeve with suitable sealant that will not shrink or crack and is compatible with PVC-jacket and suitable for environment involved.
 - b. Conduit run under floor slab shall be located a minimum of 12-inches below the vapor barrier. Seal around conduits at penetrations thru vapor barrier.
 - c. Where conduits rise through floor slabs, curved portion of bends shall not be visible above finished slab.
 2. Provide flexible conduit between 3 and 6 feet in length for equipment subject to vibration, noise transmission, or movement; and for motors. Install flexible conduit to allow 20 percent slack. Minimum flexible steel conduit size shall be ½ inch diameter. Provide separate ground conductor across flexible connections.
 3. Raceway system shall be continuous from outlet to outlet or fitting to fitting so that electrical continuity is obtained between all raceways of the system.
 4. Make bends and offsets with hickey or conduit-bending machine. Do not use vise or pipe tee. Flattened or crushed raceway not acceptable.
 5. Use of running threads not permitted. Where standard threaded couplings cannot join conduits, approved water-tight conduit unions shall be used.
 6. Fasten conduits to sheet metal boxes and cabinets with two locknuts where required by NFPA 70, where insulated bushings are used, and where bushings cannot be brought into firm contact with the box;

otherwise, use at least minimum single locknut and bushing. Install bushings on ends of conduits and provide insulating type where required by NFPA 70.

D. Conductors:

1. Mechanical means for pulling shall be torque-limiting type and not used for #2 AWG and smaller wires.
2. Pulling tension shall not exceed wire manufacturer's recommendations. Monitor pulling tension during cable installation to ensure maximum pulling tension is not exceeded.
3. Where necessary, use lubricants that are specifically recommended by the cable manufacturer for assisting in pulling cables through conduit. Lubricant shall not be deleterious to the cable sheath, jacket, or outer coverings.
4. Form neatly in enclosures and boxes for minimum of crossovers.
5. Provide conductor identification within each enclosure where tap, splice, or termination is made. For conductors No. 6 AWG and smaller diameter, color-coding shall be by factory-applied, color-impregnated insulation. For conductors No. 4 AWG and larger diameter, color-coding shall be by colored nylon cable ties and plates; or heat shrink-type sleeves.

E. Pull Wire: Pull wire shall be placed in all empty raceways ten feet in length or longer. Leave minimum 36-inches of slack at each end of pull wire.

F. Splicing of Wire and Cable: Make splices in accessible locations. Make splices in conductors No. 10 AWG and smaller diameter with insulated, pressure-type connector. Make splices in conductors No. 8 AWG and larger diameter with solderless connector and cover with insulation material equivalent to conductor insulation.

G. Boxes: Provide boxes in raceway systems wherever required for pulling of wires, and making connections. Boxes for metallic raceways shall be cast-metal, hub-type when located in damp or wet locations, when surface mounted on outside of exterior surfaces, when surface mounted on interior surfaces exposed up to 7-feet above finish floors, and when specifically indicated. Boxes in other locations shall be sheet steel. Each box shall have volume required by NFPA 70 for number of conductors enclosed in box.

1. Provide gaskets for boxes installed in damp or wet locations.
2. Tag all circuits passing through common pull box to indicate clearly electrical characteristics, circuit number, and panel designation.
3. Wires shall be neatly formed in boxes for minimum of crossovers.

- H. Nameplate Mounting: Fasten nameplates to the device with a minimum of two screws or two rivets.
- I. Workmanship: Lay out work in advance. Exercise care where cutting, channeling, chasing, or drilling of surfaces that are necessary for proper installation, support, or anchorage of raceways, or other electrical work. Repair damage to structures, piping, and equipment using skilled craftsmen of trades involved to the satisfaction of the Engineer and at no additional cost to the State or DHHL.
- J. Finishing:
 - 1. Repair any surface damaged or marred by notching, drilling or any other process necessary for installation of electrical work. Cutting, repairs and refinishing subject to the approval of the Engineer. Need for remedial work as determined by Engineer as attributable to poor coordination and workmanship shall be cause for reconstruction to the satisfaction of the Engineer at Contractor's expense.
 - 2. Close unused knockouts in boxes or enclosures with metal knockout seals in conformance with NFPA 70.
 - 3. Wipe clean all exposed raceways and enclosures with rag and solvent. Unfinished raceways and enclosures shall be prime-painted and finished to blend into background or as directed by the Engineer. Do not cover nameplates. Factory finished enclosures shall not be painted.
 - 4. Painting shall be as specified elsewhere in contract specification. Correct damage to factory applied coatings per manufacturer's recommendations and instructions at no increase in contract amount.
- K. Miscellaneous Details:
 - 1. Attachment of electrical equipment to wood by non-ferrous wood screws. Attachment to concrete by expansion anchors. Powder-charge-driven studs and anchors permitted only with prior approval.
 - 2. Complete all panel circuit directories, using typewriter. Verify "room" and "use" designations before typing.
 - 3. Tag all empty conduits in terminal cabinets and boxes giving destination. Use fiber disc tags in bushing.
 - 4. Dissimilar metals in contact anywhere in the system shall be avoided to eliminate the possibility of galvanic action. Where contact is unavoidable, suitable insulation shall be provided between adjoining surfaces so as to eliminate direct contact and any resultant electrolysis. The insulation shall be bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators or washer, or other acceptable materials, as applicable.

3.03 CLEAN-UP:

- A. During the progress of work, all rubbish, waste lumber, displaced materials, etc. shall be removed as soon as possible and upon completion of the work, Contractor shall remove from the construction site and from all public and private property, at his own expense, all temporary structures, rubbish and waste material resulting from his operations and leave the premise in broom clean condition as acceptable to the Engineer.
- B. All equipment, fixtures and appurtenances supplied and installed for this project shall be thoroughly cleaned and ready for use.

3.04 TESTING AND INSPECTION:

- A. Furnish all necessary test equipment (newly calibrated) and personnel. Test complete installation and correct all defects of material and workmanship as well as all malfunctions of equipment and systems prior to final inspection at no increase in contract amount. Complete installation shall be tested to insure proper operation according to functions specified herein; and in other sections of these specifications, on drawings and conform to industry practice.
- B. Conduct a preliminary test to ensure that the requisite degree of operational and installation parameters are provided.
 - 1. Each device subject to manual operation shall be operated at least five times, demonstrating satisfactory operation each time.
 - 2. The Contractor shall test all portions of the electrical system furnished by him for proper operation and freedom from accidental or unspecified grounds, shorts and wrong connections.
 - 3. Test grounding system to ensure continuity, and that resistance to ground is not excessive and as specified herein. Test each ground rod for resistance to ground before making connections to rod; tie grounding system together and test for resistance to ground. Make resistance measurements in dry weather, not earlier than 48 hours after rainfall. Submit written results of each test to Engineer, and indicate location of rods as well as resistance and soil conditions at time measurements were made.
- C. If the Engineer (or Engineer's representative) discovers any errors, the Contractor, at his own expense, shall go over all similar portions of the entire job, taking the necessary or directed remedial action.
- D. The Contractor shall retape splices that have been bared for inspection at no increase in the contract amount.
- E. Wherever test or inspection reveals faulty equipment or installation, the Contractor shall take corrective action, at his own expense, repairing or replacing equipment or installation as directed.

END OF SECTION

SECTION 16100 - EXTERIOR UNDERGROUND ELECTRICAL WORK

PART 1 - GENERAL

- 1.01 GENERAL CONDITIONS: The General Conditions and Special Provisions preceding these specifications shall govern this section of the work.
- 1.02 WORK INCLUDED: The work shall include but not necessarily be limited to, the following:
- A. Complete underground electrical ductline system, including trenches, ducts, and cables.
 - B. Testing and cleaning of completed underground ductlines and immediately installing end plugs.
 - C. Provide pullwire in all empty ducts and conduits, unless indicated otherwise.
- 1.03 RELATED SECTIONS:
- A. Division 2 – SITEWORK sections.
 - B. Division 3 – CONCRETE sections.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Non-metallic Conduit and Ducts: Conduit accessories, such as couplings, spacers, plugs, etc., shall be of similar type material as the conduits and ducts, suitable for intended use and as recommended by the manufacturer of conduits and ducts.
 - 1. For direct burial use, PVC Schedule 80, UL 651.
 - 2. For concrete encasement, PVC Schedule 40, UL 651.
 - 3. Compounds for sealing conduit and ducts shall have a putty-like consistency workable with the hands at temperatures as low as 35°F, shall neither slump at a temperature of 300°F, nor harden materially when exposed to the air. Compounds shall adhere to clean surfaces of fiber or plastic ducts; metallic conduits or conduit coatings; concrete, masonry, or lead; any cable sheaths, jackets, covers, or insulation materials; and the common metals. Compounds shall form a seal without dissolving, noticeably changing characteristics, or removing any of the ingredients. Compounds shall have no injurious effect upon the hands or workmen or upon materials.
- B. Buried Warning and Identification Tape: Provide detectable aluminum foil plastic-backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried conduits for entire length of ductline

system. Tape shall be detectable by an electronic detection instrument. Provide tape in rolls, 3-inches minimum width, color coded for the utility involved with warning and identification imprinted in bold black letters continuously and repeatedly over entire tape length. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material.

- C. Concrete and Reinforcement: Concrete work shall have minimum 3000-psi compressive strength and conform to the requirements of Division 3 – CONCRETE. Concrete reinforcing shall be as specified in Division 3 – CONCRETE.

PART 3 - EXECUTION

3.01 GENERAL:

- A. Existing underground utilities indicated on the drawings are approximate in location. It is not the intention of the drawings to imply that all existing utilities are drawn and located. It shall be the responsibility of the Contractor to tone affected areas and take all necessary precautions prior to doing any excavation work. The Contractor at no cost to the State or DHHL shall repair any damage to existing utilities.
- B. Installation shall comply with the requirements and recommendations of NFPA 70 and IEEE C2 as applicable.
- C. Contractor shall become familiar with details of the work, shall verify dimensions in the field, and shall advise the Engineer of any discrepancy before performing any work.

3.02 INSTALLATION:

- A. Duct Lines:
 - 1. Numbers and sizes of ducts shall be as indicated. Ducts shall be installed promptly after excavation in order to keep the trenches open as short a time as possible. Duct lines shall be laid with a minimum slope of 4-inches per 100-feet. Depending on the contour of the finished grade, the high point may be at a terminal, handhole, or between handholes.
 - 2. Short-radius manufactured 90° duct bends may be used only for equipment risers, unless specifically indicated as acceptable. The minimum manufactured bend radius shall be 18-inches for ducts of less than 3-inches in diameter. Otherwise, long sweep bends having a minimum radius of 25-feet shall be used for a change of direction of more than 5°, either horizontally or vertically. Both curved and straight sections may be used to form long sweep bends, but the maximum curve used shall be 30° and manufactured bends shall be used.
 - 3. Ducts shall be kept clean of concrete, dirt, or foreign substances during construction. Field cuts requiring tapers shall be made with proper tools

and match factory tapers. A coupling recommended by the duct manufacturer shall be used whenever an existing duct is connected to a duct of different material or shape. Ducts shall be stored to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Ducts shall be thoroughly cleaned before being laid. Plastic ducts shall be stored on a flat surface and protected from direct rays of the sun.

4. **Concrete Encasement:** Ducts requiring concrete encasements shall comply with NFPA 70. The separation between adjacent electric power and communications ducts shall conform to IEEE C2. Duct line encasements shall be monolithic construction. Where a connection is made to a previously poured encasement, the new encasement shall be well bonded or doweled to the existing encasement. At any point, tops of concrete encasements shall be not less than the cover requirements listed in NFPA 70. Separators or spacing blocks shall be made of concrete, plastic, or a combination of these materials placed not farther apart than 4-feet on centers. Ducts shall be securely anchored to prevent movement during the placement of concrete and joints shall be staggered at least 6-inches vertically. When pouring concrete, prevent heavy masses of concrete from falling directly on ducts. If unavoidable, protect ducts with plank. Direct flow of concrete down sides of duct bank to bottom, allowing concrete to rise between ducts, filling all open spaces uniformly. To insure against voids in concrete, work a long, flat splicing bar or spatula liberally and carefully up and down the vertical rows of ducts. Mechanical vibrators shall be used for stacked duct banks of three ducts or higher. Cure concrete for a minimum of 72 hours before permitting traffic and/or backfilling.
5. **Non-Encased Direct-Burial:** Provide minimum 3-inches of earth around each duct, except that between adjacent electric power and communication ducts, 12-inches of earth is required. Bottoms of trenches shall be graded toward handholes and shall be smooth; where rocks, soft spots and/or sharp-edge materials are encountered, excavate the bottom for an additional 3-inches, fill and compact, to approximate densities of surrounding firm soil, level with original bottom with sand or earth free from particles that would be retained on ½-inch sieve before installing ducts. Joints in adjacent tiers of duct shall be vertically staggered at least 6-inches. The first 6-inch layer of backfill cover shall be sand or earth free from particles that would be retained on ½-inch sieve, compacted as previously specified. The rest of the excavation shall be backfilled and compacted in 3- to 6-inches layers. Duct banks may be held in alignment with earth. However, high-tiered banks shall use a wooden frame or equivalent form to hold ducts in alignment prior to backfilling.
6. **Joints:** Joints in each type of duct shall be made up in accordance with the manufacturer's recommendations for the particular type of duct and coupling selected. Duct joints shall be made by brushing plastic solvent cement on insides of plastic coupling fittings and on outsides of duct ends. Each duct and fitting shall then be slipped together with a quick ¼-turn twist to set the joint tightly.

7. **Test Mandrel:** As each section of a duct line is completed from structure to structure, draw a flexible testing mandrel approximately 14-inches long with a diameter of ½-inch less than the inside diameter of the conduit through each conduit. If burrs or obstructions are encountered, that section shall be replaced at no additional cost to the State or DHHL and retested. When no burrs or obstructions are encountered, draw a stiff bristle brush through the conduit, until conduit is clear of particles of earth, sand, and gravel; then immediately install end plugs.
8. **Conduit Plugs and Pull Rope:** Conduit indicated as being unused or empty shall be provided with plugs on each end. Plugs shall contain a weephole or screen to allow water drainage. Provide pull rope having 3-feet of slack at each end of unused or empty conduits.
9. **Connections to Equipment Enclosures or Boxers:** Conduits shall be extended to termination point as indicated. After installation of cables, conduits shall be sealed with sealing compound to prevent entrance of moisture or gases, rodents, insects, or other foreign matter.
10. **Duct Line Markers:** Bury detectable warning and identification tape with the printed side up at a depth of 12-inches below the top surface of earth or the top surface of the subgrade under pavements.

B. Conductors:

1. **Cable Pulling:** Pull cables down grade with the feed-in point at the handholes, pullboxes, or buildings of the highest elevation. Use flexible cable feeds to convey cables through handhole openings and into duct runs. Do not exceed the specified cable bending radii when installing cable under any conditions, including turnips into equipment enclosures. If basket-grip type cable-pulling devices are used to pull cable in place, cut off the section of cable under the grip before splicing and terminating.
2. **Cable Lubricants:** Use lubricants that are specifically recommended by the cable manufacturer for assisting in pulling jacketed cables. Lubricant shall not be deleterious to the cable sheath, jacket, or outer coverings.
3. **Cable Pulling Tensions:** Tensions shall not exceed the maximum pulling tension recommended by the cable manufacturer. Monitor pulling tension during cable installation to ensure maximum pulling tension is not exceeded.

- C. Construction Joints:** During construction wherever a construction joint is necessary in a duct bank, prevent debris such as mud, and, dirt from entering ducts by providing suitable conduit plugs. Fit concrete envelope of a partially completed duct bank with reinforcing steel extending a minimum of 2 feet back into the envelope and a minimum of 2 feet beyond the end of the envelope. Provide one No. 4 bar in each corner, 3 inches from the edge of the envelope. Secure corner bars with two No. 3 ties, spaced approximately 1 foot apart. Restrain reinforcing assembly from moving during concrete pouring.

D. Excavation, Trenching and Backfilling: Except as covered herein, excavation, trenching, and backfilling shall conform to the requirements of Division 2 – SITEWORK.

1. Trench Excavation:

- a. Dimensions and locations of trenches for ductlines shall be as indicated on the drawings. Trench width and depths shall be sufficient to accommodate proper installation of conduit banks.
- b. Where a trench is excavated on slope, sides are to be vertical, and depth measured at lowest side. All measurements are to be based on final grades.
- c. Bottom of trenches to be flat, well graded, clean and smooth.
- d. Trenches shall be widened at concrete transformer pad sites to permit proper entry of conduits.
- e. Sheathing and bracing as required shall be provided to support sides of excavations from cave-ins.
- f. Provide drainage and pumps to keep trenches dry.
- g. Saw cut all edges of existing sidewalks and pavement before trenching.
- h. Excavate trenches along straight lines from structure to structure before ducts are laid or structure constructed so the elevation can be adjusted, if necessary, to avoid unseen obstruction.
- i. Slope trenches so that duct banks shall have a continuous slope downward toward underground structures and away from buildings.

2. Backfill:

- a. Backfilling shall be to finished grades indicated on accompanying drawings.
- b. Backfill material shall be completely free of wood or other debris.
- c. Backfill material shall be placed in maximum of 8" layers in loose thickness before compacting. Backfill shall be thoroughly compacted with hand or mechanical tampers to 95% of ASTM D1557 maximum dry density. In no case shall tamping be accomplished by using the wheels or tracks of a vehicle. Jetting or flooding of backfill will not be permitted.
- d. Backfill over concrete encased ducts shall be backfill Type A.

- e. At road crossings, backfill shall be 8" thickness of backfill Type A and remaining backfill may be normal road base course.

E. Concrete:

1. Concrete work shall conform to the requirements of Division 3 -- CONCRETE.
2. Convey concrete from mixer to forms rapidly to prevent segregation. Free drop shall be limited to five feet, unless authorized by inspector.
3. Placing:
 - a. Clean and remove all debris from inside forms and trenches before placing concrete.
 - b. Place concrete only on clean damp surfaces, free from water.
 - c. Place concrete in forms, in horizontal layers not exceeding 18" thickness.
 - d. Place concrete to avoid segregation of materials and displacement of ducts, inserts and reinforcing.
 - e. Vibrate structural concrete thoroughly during and immediately after placing to insure dense watertight concrete.
4. Forming:
 - a. Forms shall be of good sound lumber with sufficient strength and conforming to shapes and dimensions indicated on the drawings.
 - b. Forms shall be treated with non-staining form oil immediately before each use.
5. Patching: Patch all voids, pour joints and holes before concrete is thoroughly dry. Use mortar of same proportions as original concrete.
6. Curing: Curing of concrete shall be accomplished by impervious membrane method with liquid membrane compound. Apply two or more coats to obtain a total of one gallon for each 150 square feet of concrete surface.
7. Reinforcing Steel:
 - a. Clean reinforcing of mill or rust scale and form to dimensions indicated.
 - b. Install reinforcing in proper locations and secure in place to prevent movement during concrete placing or vibrating.

F. Reconditioning of Surfaces:

1. Unpaved Surfaces: Restore to their original elevation and condition unpaved surfaces disturbed during installation of duct. Preserve sod and topsoil removed during excavation and reinstall after backfilling is completed. Replace sod that is damaged by sod of quality equal to that removed. When the surface is disturbed in a newly seeded area, re-seed the restored surface with the same quantity and formula of seed as that used in the original seeding.
2. Paving Repairs: Where trenches, pits, or other excavations are made in existing areas of pavement where surface treatment of any kind exists, restore affected surface treatment or pavement to the same thickness and in the same kind as previously existed, except as otherwise indicated, and to match and tie into the adjacent and surrounding existing surfaces.

G. Repairing:

1. The Contractor shall restore all removed or damaged pavement, gutters, curbs, sidewalks, sign posts, trees and landscape damaged by his operations to as near their original condition or better.
2. Any existing underground piping, conduit or structures that are encountered shall be properly shored and protected from damage. Any damage to existing systems resulting from the Contractor's operations shall be repaired at Contractor's expense.

3.03 TESTING AND INSPECTION: Underground conductors, including splices, shall be tested for insulation resistance after they are installed in their final configuration, ready for connection to equipment and prior to energization. The test voltage shall be 500-volts dc, applied for 1-minute between each conductor and ground and between all possible combinations of conductors in the same duct, with all other conductors in the same duct. The minimum allowed value of resistance shall be "R in megohms = (rated voltage in kV + 1) x 1000 / (length of cable in feet)". Each conductor failing this test shall be repaired or replaced and retested until failures have been eliminated, at no cost to the State or DHHL. Submit written results of each test to Engineer, and indicate resistance and weather conditions at time measurements were made.

END OF SECTION

SECTION 16500 – SOLAR PUMP CONTROLLER SYSTEM

PART 1 - GENERAL

- 1.01 GENERAL CONDITIONS: The General Conditions and Special Provisions preceding these specifications shall govern this section of the work.
- 1.02 WORK INCLUDED: The work shall include but not necessarily be limited to, the following:
- A. Complete solar pump controller system, inclusive of solar array and associated fixed mounting assembly, disconnect switch, and low-voltage array wiring.
 - B. Test complete installation and correct all defects and malfunctions of material and workmanship.
- 1.03 RELATED SECTIONS: DIVISION 15 – MECHANICAL sections, for solar pump requirements.
- 1.04 APPLICABLE PUBLICATIONS: The publications listed herein shall form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.
- 1.05 SUBMITTALS: Complete shop drawings and manufacturer's literature shall include, but not be limited to, the following:
- A. Solar Pump Controller and associated solar array, including but not limited to required accessories, and system sizing documentations.
 - B. Fixed mounting assembly for the solar array, including but not limited to dimensions, wind load determined in accordance with AASHTO LTS4, seismic protection, and required accessories. Complete submittals shall be stamped and signed by a licensed professional engineer.
 - C. Disconnect Switch.
- 1.06 QUALIFICATIONS:
- A. The sizing of the solar pump controller system shall be performed by a manufacturer authorized supplier or dealer familiar with sizing solar pumping applications. The Contractor shall be responsible to obtain and verify all data needed to perform the system sizing.
 - B. The design of the solar array's fixed mounting assembly shall be performed by a licensed professional engineer who is regularly engaged in such designs. The professional engineer, registered to practice engineering in the state in which the project is located and responsible for the design, shall stamp and sign the design documents.
- 1.07 SEISMIC PROTECTION: Rigidly mounted equipment furnished under this contract shall be constructed and assembled to withstand the seismic forces in conformance with local codes. The Contractor shall design the bracing. Resistance to lateral forces induced by

earthquakes shall be accomplished without consideration of friction resulting from gravity loads.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Solar Pump Controller: Aero Vironment Inc. Model USPC-5000, Universal Solar Pump Controller, or approved equal.
1. Description: Controller shall convert high voltage, direct current (Vdc) from a photovoltaic (PV) array into highly controlled, three-phase pulse width modulated (PWM) alternating current (Vac) to run a standard 208Vac three-phase water pump motor.
 - a. The controller continuously monitors system performance and incorporates a number of features for pump system protection. In the event of a fault detection, the controller will indicate the type of fault through LED indicators. For most fault modes, the controller will periodically attempt restart. The microprocessor technology gives the controller the capability to monitor the system and automatically shut down in the event of the following:
 - 1) Full reservoir.
 - 2) Underload from a dry well or dry pump.
 - 3) Overload from a bad pump motor (internal electrical short or bad bearing) or fouled pump.
 - 4) Low input power detection (using minimum motor speed selection).
 - b. Automatic shutdown protects the pump and motor from damage during unattended operation.
 - c. In the morning, the controller begins monitoring power from the PV array. When there is enough power to operate the system (based on the preselected conditions), the controller delivers power to the pump motor while monitoring the motor power requirements. If the motor requirements are not too low (dry well) or too high (locked rotor), the system continues to provide power to the pump throughout the day in proportion to the amount of power received from the PV array. Power is always limited to the maximum power specified for the pump motor.
 - d. Proportional power delivered from the PV array allows the system to run at variable speed. Variable speed operation means there is no in-rush or surge of energy during the pump motor start-up, helping to eliminate wear on the motor and pumping system. One of the main causes of pump motor failure is the stress applied to

motors during a full voltage start-up. The controller's variable speed operation ramps up the speed smoothly, which eliminates starting stress. This should allow the pump motor to last longer. There is no starter box or motor starter to purchase, maintain or have fail. The start winding is controlled by the controller and the controller provides motor overload protection.

- e. The microprocessor-controlled converter has customized settings of minimum motor speed, allowing the motor to run more efficiently and maximize the amount of water pumped during a solar day. Proper minimum motor speed settings ensure each pump site will obtain the maximum amount of water possible during marginal solar intensity conditions, like hazy or overcast days.
- 2. **Product Qualification:** The controller conforms to the requirements of UL Standard 1741 (power conditioning units for use in residential photovoltaic power systems) and all requirements of National Electric Code (NEC), including Article 690.
 - 3. **Features:**
 - a. **Universal Pump Motor Interface:** The controller shall be capable of working with most commonly available AC pump motors. The controller characterizes the pump motor operation automatically, so there is no need for special programming. Motors may use three-phase (3 or 4 wire plus ground) or single-phase (start and run windings plus ground) and 208-230Vac or 115/230/240Vac, 50/60 Hz.
 - b. **Universal Photovoltaic Array Interface:** The controller shall be capable of working with most commonly available PV arrays. The controller tracks peak power from PV arrays, regardless of the PV material type – though all the PV modules used must be made from the same material (cannot mix and match material types). Any manufacturing process for producing PV arrays is acceptable, including single or poly-crystalline silicon or thin-film technology.
 - c. **Optimized Operation in Marginal Weather:** A fast foldback algorithm allows the controller to be highly tolerant of varying light intensity caused by changing weather conditions. Rapid changes in light, like the passing of a cloud, have a negative effect on the power from the PV array. The controller compensates for the rapid change in power with minimum interruption, which maximizes the water output of the system during marginal weather conditions. This standard feature is automatic and requires no user adjustments.
 - d. **Underload and Overload Protection:** The controller incorporates user-selectable underload and overload protection. Underload protection can prevent damage in the event of a dry well, dry pump, or a decoupled pump and motor. Overload protection

shuts down the system when there is evidence of a fouled pump or motor, electrical short, bad motor or improper connection to the motor. Adjustable sensitivity fault detection allows the user to minimize nuisance fault conditions.

- e. **Overdrive Feature:** The overdrive feature pushes the pump motor to drive at a speed 5 Hz over the nominal motor frequency. Overdrive results in additional water flow when the PV array can deliver the power. Consult with pump supplier before selecting this feature.
- f. **Selectable Minimum Motor Operating Speed:** Users can select minimum motor operating speed settings as low as 10 Hz to maximize the flow of water when the PV array is producing minimal power due to the angle of the sun or during marginal weather conditions. Setting a motor minimum frequency to a value near that required to achieve flow will minimize the motor and pump wear. If uncertain, use 30 Hz. Consult with pump supplier before selecting 10 Hz.
- g. **Input Protection:** The controller offers high PV array dc voltage input protection via a clamp circuit that protects internal circuit components from over voltage and maintains the input maximum voltage at 400V when connected to the PV array. This standard feature is automatic and requires no user adjustment.
- h. **Smart Restart:** The controller's "smart" restart plan allows the system to achieve maximum water output while minimizing wear on the motor and pump components, as follows:
 - 1) Schedule A – for low input power, underload faults.
 - 2) Schedule B - for overload and system faults.
 - 3) Schedule C – for low input power before achieving minimal speed set by the user.
- i. **Internal Isolation Disconnect Device:** Device disconnects the dc input power for added safety protection during installation and servicing of the unit.
- j. **External Reset Switch:** The reset switch will clear the memory and begin the system start-up sequence.
- k. **Thermal Protection:** The controller automatically limits the maximum power to the pump motor when the ambient temperature is high. Lower power results in a lower internal temperature of the controller unit, allowing the pump motor operation to continue at a reduced level, even on very hot days. This standard feature is automatic and requires no user adjustment.

- I. Remote or Float Switch: A remote on/off switch and a float switch can be wired to the unit for manual or automatic system shutdown. Multiple switches can be wired in series for system shutdown if any switch is opened.
4. Performance Specifications:
 - a. Input Parameters:

Maximum PV Array Open Circuit Voltage:	600Vdc.
Maximum Input Operating Voltage:	400Vdc.
Minimum Starting Voltage:	150Vdc.
Minimum Operating Voltage:	70Vdc.
PV Array Optimal Operating Voltage (for 60 Hz operations):	
115V, 1-phase motor:	210Vdc.
230V, 1-phase motor:	385Vdc.
230V, 3-phase motor:	380Vdc.
Maximum Input Power:	5.5kW.
Maximum PV Array Short Circuit Current:	20A.
 - b. Output Parameters:

Power Max Sustained:	5.0kW (5,000 watts)
Selectable Minimum Frequency:	10,20,30,40 Hz.
Selectable Motor Frequency*:	50,60 Hz.
+5 Hz Overdrive Feature*:	55,65 Hz.
Output Wave Form:	Sine Weighted PWM.
Maximum Output Current:	32A pk/25Arms.
Three-Wire, 3-phase Motor**:	5HP at 208Vac.
Inverter Efficiency for 3-phase Motor:	97% at full power.
Serial Communication:	RS-232C.

* - Maximum speed limited by array voltage and maximum frequency selected.
 ** - Connecting a motor rated higher than indicates will give reduced performance due to input power limitations.
 - c. Environmental Conditions:

Temperature:	-20° to 60°C.
Humidity:	>95% (Non-Condensing)
Noise:	No Audible Noise.
Vibration, Humidity & Corrosion:	MIL-STD-883 & MIL-STD-202F.
Starter Box:	None Required.
Unit Dimensions:	18"Hx9"Wx6"D.
Shipping Dimensions:	20"Hx12"Wx10"D.
Weight:	18 lbs.
 5. Construction: Rugged, lockable NEMA-3 steel enclosure.

6. Normal Operation Modes:
 - a. Peak power tracking, variable speed operation at constant V/Hz.
 - b. Fault detection and system monitoring.
 - c. System protection.
 - d. Internal temperature regulation.
7. Fault Detection Modes (externally displayed):
 - a. System Disabled (switch OFF or reset mode).
 - b. System Fault (module overcurrent, overtemperature or system problem).
 - c. Remote Shutdown (remote switch open).
 - d. Low Input Power (insufficient solar power).
 - e. Output Underload (dry well, disconnected or bad motor).
 - f. Output Overload (locked/fouled rotor, electrical short).
8. Protection Modes:
 - a. Overtemperature (internal temperature regulated and power device protected).
 - b. Overcurrent (max current regulation and power device protected).
 - c. Input Overvoltage (clamping circuit protection).
 - d. Installation (reverse polarity dc connection and output short circuit).

B. Photovoltaic Modules: Kyocera Model KC175GT, or approved equal.

1. Description:
2. Product Qualification: Modules shall meet or exceed the requirements of IEEE Standard 1262-1995, Recommended Practice for Qualification of Photovoltaic Modules, and Underwriters Laboratories (UL) Standard 1703, Standard for Safety for Flat-Plate Photovoltaic Modules and Panels.
3. Construction: The conversion efficiency of the solar cell is over 16%. These cells are encapsulated between a tempered glass cover and a pottant with PVF back sheet to provide efficient protection from the severest environmental conditions. The entire laminate is installed in an

anodized aluminum frame to provide structural strength and ease of installation, and is equipped with plug-in connectors.

4. Performance Specifications:

- a. Electrical Performance under Standard Test Conditions (STC: Irradiance 1000W/m², AM1.5 spectrum, module temperature 25°C):

Maximum Power (P _{max}):	175W (+10%/-5%).
Maximum Power Voltage (V _{mpp}):	23.6V.
Maximum Power Current (I _{mp}):	7.42A.
Open Circuit Voltage (V _{oc}):	29.2V.
Short Circuit Current (I _{sc}):	8.09A.
Max System Voltage:	600V.
Temperature Coefficient of V _{oc} :	-1.09x10 ⁻¹ V/°C.
Temperature Coefficient of I _{sc} :	3.18x10 ⁻³ A/°C.

- b. Electrical Performance at 800W/m², NOCT (Nominal Operating Cell Temperature: 47°C), AM1.5:

Maximum Power (P _{max}):	125W.
Maximum Power Voltage (V _{mpp}):	20.9V.
Maximum Power Current (I _{mp}):	5.99A.
Open Circuit Voltage (V _{oc}):	26.5V.
Short Circuit Current (I _{sc}):	6.53A.

- c. Module Characteristics:

Number per Module:	48 cells.
Dimensions:	50.8"Lx39"Wx1.4"D.
Weight:	35.3 lbs.
Cable:	(+)28.3", (-)70.9".

- d. Junction Box Characteristics:

Dimensions:	4.5"Lx3"Wx0.4"D.
IP Code:	IP65.

- e. Reduction of Efficiency under Low Irradiance (1000W/m² to 200W/m²; module temperature 25°C):

Reduction:	5.1%.
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- C. Solar Array Disconnect Switch: Switch shall be as specified in Section 16050 - BASIC ELECTRICAL MATERIALS and METHODS.

- D. Solar Array Module Output Cables: Conductors shall be 600-volt, stranded copper per ASTM B-8, XLP type USE-2 conforming to UL 44 and 854, sunlight-resistant rated output cables with male and female connectors.

E. Hardware, Supports, Backing, Etc.: As specified in Section 16050 - BASIC ELECTRICAL MATERIALS and METHODS.

1. Do not use aluminum when in contact with earth or concrete.
2. Where connected to dissimilar metals, protect by approved fittings and treatment.

PART 3 - EXECUTION

3.01 **INSTALLATION:** Construction shall conform to NEC 690 and 720, and applicable instructions and recommendations of manufacturers of equipment and material supplied for this project. Plans indicating equipment locations are conceptual only and not for construction. Contractor shall visit site and locate and orient system in logical manner in conformance with manufacturer's recommendations and requirements to optimize performance in all applications.

A. Pump Controller:

1. The photovoltaic array structure, modules and wiring harness must be properly assembled according to the manufacturer's installation instructions before installing the pump controller. Locate the pump controller closest to the array wire harness and near a good electrical ground.
2. The pump controller shall be located out of the path of direct sunlight and away from any heat or moisture, in an area free of vegetation.
3. The pump controller shall be mounted vertically, at a minimum of 12 inches above the ground; 3 feet to 4 feet above ground is optimal. A minimum clearance of 10 inches must be maintained above the controller to allow the lid to rise for wire installation and allow airflow around the heat sink. To completely remove the pump controller cover, 19 inches clearance above is required.

B. Solar Array:

1. Solar array shall be installed in a location where they will receive maximum sunlight throughout the year. Avoid trees, buildings, structures, or obstructions which can cast shadows on the solar modules, especially during the winter months when the arc of the sun is lowest over the horizon.
2. Solar array shall be installed at a tilt angle, orientation, and elevation as recommended by the solar array manufacturer.
3. Array support shall be installed in accordance with the recommendations of the solar array manufacturer. For optimal performance in all applications, clearance between the solar module frame and the mounting surface is required to allow cooler ambient air to circulate around the back of the module.

4. Grounding: Attach all solar module frames to an earth ground in accordance with the NEC. Proper grounding is achieved by connecting the solar module frames and structural members continuously to one another using a suitable grounding conductor.

C. Grounding: Ground per NEC 250 and 690.

3.02 TESTING AND INSPECTIONS:

- A. Pre-Power Polarity Check: Provide polarity correctness check before full power is applied to the system in conformance with pump controller manufacturer's instructions.
- B. Low Power Logic Test: Before the pump is connected to the system, provide a low power logic test in conformance with the pump controller manufacturer's instruction.

END OF SECTION

SECTION 16700 – SOLAR TELEMETERING SYSTEM

PART 1 - GENERAL

- 1.01 **GENERAL CONDITIONS:** The General Conditions and Special Provisions preceding these specifications shall govern this section of the work.
- 1.02 **WORK INCLUDED:** The work shall include but not necessarily be limited to, the following:
- A. Complete telemetering system, inclusive of mounting poles, stand alone solar-power system designed to support wireless applications in remote locations, radio and antenna, input/output modules, limit switch value module, and wiring.
 - B. Test complete installation and correct all defects and malfunctions of material and workmanship.
- 1.03 **RELATED SECTIONS:**
- A. Division 2 – SITEWORK sections.
 - B. DIVISION 15 – MECHANICAL sections, for pressure transmitter, and diesel-driven pump control requirements.
 - C. Section 16500 – SOLAR PUMP CONTROLLER SYSTEM, for pump controller's remote switch input requirements.
- 1.04 **APPLICABLE PUBLICATIONS:** The publications listed herein shall form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.
- 1.05 **SUBMITTALS:** Complete shop drawings and manufacturer's literature shall include, but not be limited to, the following:
- A. Stand alone solar interface system, inclusive of all necessary appurtenances for a complete and operable wireless transmitter system and system sizing documentations.
 - B. Stand alone solar interface system, inclusive of all necessary appurtenances for an operable wireless receiver system and system sizing documentations.
 - C. Mounting pole, including RUS approved Quality Mark "WQC".
- 1.06 **QUALIFICATIONS:** The sizing of the solar telemetering system shall be performed by a manufacturer authorized supplier or dealer familiar with sizing solar telemetering applications. The Contractor shall be responsible to obtain and verify all data needed to perform the system sizing.
- 1.07 **QUALITY ASSURANCE:** Ensure the quality of pressure treated wood poles. Furnish an inspection report (for wood poles) of an independent inspection agency, approved by the Engineer, stating that offered products comply with AWPAC M6 and RUS BULL 345-67 standards. The RUS approved Quality Mark "WQC" on each pole will be accepted, in

lieu of inspection reports, as evidence of compliance with applicable AWP treatment standards.

- 1.08 **SEISMIC PROTECTION:** Rigidly mounted equipment furnished under this contract shall be constructed and assembled to withstand the seismic forces in the project site. The Contractor shall design the bracing. Resistance to lateral forces induced by earthquakes shall be accomplished without consideration of friction resulting from gravity loads.
- 1.09 **DELIVERY, STORAGE, AND HANDLING:** Stack wood poles stored for more than 2 weeks on decay-resisting skids arranged to support the poles without producing noticeable distortion. Store poles to permit free circulation of air; the bottom poles in the stack shall be at least one foot above ground level and growing vegetation. Do not permit decayed or decaying wood to remain underneath stored poles. Do not drag treated poles along the ground. Do not use pole tongs, cant hooks, and other pointed tools capable of producing indentation more than one inch in depth in handling the poles. Do not apply tools to the groundline section of any pole.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. **Solar Interface System:** Stand alone dc solar-powered systems, designed to support wireless applications in remote locations. Phoenix Contact RAD-SOL-SET-24 or approved equal.

1. **Description:** Major components that make up the solar interface system are as follows:

- a. Photovoltaic solar modules.
- b. Solar Module mounting bracket with stainless steel hardware.
- c. NEMA-4 rugged aluminum outdoor equipment enclosure with separate louver ventilated NEMA-3R battery compartment, white powder-coated finish, lockable. 30.128" high x 19.252" wide x 13.295" deep enclosure dimensions.
- d. Sealed, gel-cell, deep-cycle batteries.
- e. Pre-wired and installed electronics panel with charger/load controller, fuses and labeled terminal blocks.

2. **Technical Specifications:**

- a. **Solar Interface System:**

System voltage	24Vdc.
Solar Module input wattage	40/60/80/100W.

- b. Solar Charge Controller: Phoenix Contact RAD-SOL-CHG-24-10 or approved equal.

Nominal voltage	24Vdc.
Rated solar input	10A.
Rated load current	10A.
Regulation voltage	28.2V.
Sealed battery	
Load disconnect	23V.
Load reconnect	25.2V.
Temperature compensation (mV/°C)	-56mV.
Self consumption	10mA.
Operating temperature range	-40 to +85°C.
Wire size	10AWG.

- c. Solar Battery:

Type	Valve-regulated lead-acid, deep-cycle gelled electrolyte.
Alloy	Lead calcium.
Nominal voltage	12V.

- 1) 40-watt System: Phoenix Contact RAD-SOL-BAT-12-40 or approved equal.

Ampere Hour (Ah) capacity	48Ah at a 100 hour discharge rate.
Dimensions	7.75"Lx6.63"Wx6.88"H.
Weight	32.5 lbs.

- 2) 60-watt System: Phoenix Contact RAD-SOL-BAT-12-70 or approved equal.

Ampere Hour (Ah) capacity	70Ah at a 100 hour discharge rate.
Dimensions	10.19"Lx6.63"Wx7"H.
Weight	42 lbs.

- 3) 80/100-watt System: Phoenix Contact RAD-SOL-BAT-12-84 or approved equal.

Ampere Hour (Ah) capacity	84Ah at a 100 hour discharge rate.
Dimensions	10.9"Lx6.8"Wx9.9"H.
Weight	53.5 lbs.

- d. Solar Module: Typical assembly consists of two photovoltaic modules.

- 1) 40-watt System: Phoenix Contact RAD-SOL-PAN-12-20 or approved equal.

Total power output at peak sun	
Volts	16.8V.
Amps	1.19A.
Watts	18W.
Dimensions	
Length	16.7 inches.
Width	19.8 inches.
Thickness	1.97 inches.
Weight	6.5 lbs.
Certification/Approval	UL listed.

- 2) 60-watt System: Phoenix Contact RAD-SOL-PAN-12-30 or approved equal.

Total power output at peak sun	
Volts	16.8V.
Amps	1.78A.
Watts	27W.
Dimensions	
Length	23.4 inches.
Width	19.8 inches.
Thickness	1.97 inches.
Weight	8.5 lbs.
Certification/Approval	UL listed.

- 3) 80-watt System: Phoenix Contact RAD-SOL-PAN-12-40 or approved equal.

Total power output at peak sun	
Volts	16.9V.
Amps	2.34A.
Watts	40W.
Dimensions	
Length	20.7 inches.
Width	25.7 inches.
Thickness	1.42 inches.
Weight	9.9 lbs.
Certification/Approval	UL listed.

- 4) 100-watt System: Phoenix Contact RAD-SOL-PAN-12-50 or approved equal.

Total power output at peak sun	
Volts	16.7V.
Amps	3.00A.
Watts	50W.
Dimensions	
Length	25.2 inches.
Width	25.7 inches.
Thickness	2.1 inches.
Weight	11 lbs.
Certification/Approval	UL listed.

3. Additional Components:

a. Wireless I/O Interface Transmitter/Receiver Set: Phoenix Contact RAD-ISM-900-SET-UD-ANT or approved equal.

1) Description: The set is an integrated radio and I/O module designed to eliminate cable and conduit for one 4-20mA current loop and two digital signals in harsh industrial environments and utilizes 902-928Mhz Industrial, Scientific and Medical (ISM) band Frequency-Hopping spread spectrum technology to guarantee a license-free, interference-free link between remote devices and the Booster Pump Station.

2) Technical Data:

a) General Specifications:

Temperature range	-40 to 70°C (-40 to 158°F).
Humidity	0-95% non-condensing.
Dimensions	4"Lx4.5"Hx0.7"W.
Mounting	DIN rail.
Environmental	NEMA-1.
Approvals	UL and cUL listed (Class I, Div. 2, Groups A,B,C,D).

3) Technical Specifications:

a) Transmitter:

Transmitter power	1W.
Range:	
In-plant, no line of sight	600-1,000 feet.
Line of sight, flat terrain, raised antenna	4-5 miles.
Line of sight, flat terrain, directional antenna*	20+ miles.
Frequency	902-928Mhz.
Power source	12-30Vdc regulated.
Power consumption	8.4W peak (350mA@24Vdc), 1.8W avg. (75mA@24Vdc).
Inputs	1 4-20mA (250Ω impedance), 2 5-30V dc/ac.

* denotes "Requires professional propagation study and installation".

b) Receiver:

Frequency	902-928MHz.
Power source	12-30Vdc regulated.
Power consumption	3W (125Ma@24Vdc).
Outputs	1 4-20mA (12-bit resolution), 3 120Vac, 0.5A dry-contact.
Loop impedance, max.	450-1350 Ω for power supply voltages of 12-30Vdc.
Repeatability	0.02%.
Accuracy	0.2% full scale.

b. Antennas:

- 1) 6.5dB Yagi Antenna for 900MHz (Transmitter): Phoenix Contact RAD-ISM-900-ANT-YAGI-6.5-N or approved equal. Antenna Specifications as follows:

Bottom operating frequency	890MHz.
Top operating frequency	960MHz.
Nominal gain	6.5dBd.
Horizontal Beamwidth (Deg-3dB)	100°.
Vertical Beamwidth (Deg-3dB)	62°.
Front to back ration	15dB.
Length	6.8 inches.
Width	2.38 inches.
Antenna weight	1.3 lbs.
Rated wind velocity	125mph.
Connector	2 feet RG-213 with N-Type Female.

- 2) 3dB Fiberglass Omni Antenna for 900MHz (Receiver): Phoenix Contact RAD-ISM-900-ANT-OMNI-FG-E-N or approved equal. Antenna Specifications as follows:

Bottom operating frequency	902MHz.
Top operating frequency	928MHz.
Nominal gain	3.0dBd.
Horizontal Beamwidth (Deg-3dB)	360°.
Vertical Beamwidth (Deg-3dB)	28°.
Length	51.1 inches.
Width	2.38 inches.
Antenna weight	4 lbs.
Rated wind velocity	125mph.
Connector	N-Type Female.

- c. Low Loss Coaxial Antenna Cables: Phoenix Contact RAD-CAB-LMR500 or approved equal. Technical Data as follows:

Connector type	N(male) at both ends.
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Cable type	LMR-500.
Temperature rating	-40°F to 185°F (-40°C to 85°C).
Outer diameter	0.50 inches.
Min. bending radius	1.25 inches.
Weight	9.7 lbs/100 feet.
Insertion attenuation	Approx. 3.13 dB/100 feet.
Jacket material	Polyethylene.

d. Bulkhead Surge Protection Assembly for 900MHz Radios:
Phoenix Contact CN-UB-280DC-BB-BB-ASSY or approved equal.

1) Description: Assembly is a gas-filled surge protection device designed to protect wireless radio stations from surge voltages caused by lightning or other electrical sources that are induced onto antenna cables.

2) General Specifications:

Max. continuous operation voltage	280Vdc.
Max. circuit operating current	≤5A at 25°C.
Max. high-frequency power with a Standing Wave Ratio (SWR)=1.1 in a 50Ω system	700W.
Rated discharge surge current (8/20μs test curve)	20kA.
Rated discharge surge current (10/1000μs test curve)	100A.
Output voltage tested with 1kV/μs waveform line to shield (ground)	≤700V.
Response time (common mode line to ground)	≤100ns.
Insertion loss (50Ω systems)	≤0.1dB up to 1.2GHz, ≤0.2dB up to 2.2GHz.
DC cutoff frequency (3dB)	>3GHz.
Leakage current, line-ground	≤1μA.
Voltage Standing Wave ratio (SWR)	≤1.1 to 2.0GHz.
Capacitance (common mode)	1.5pF.
Connector type	N, 50Ω.
Temperature range	-20°C to +80°C.

e. Radio Connector Adapter: Phoenix Contact RAD-CON-MCX-N-SS or approved equal. Technical Data as follows:

Length	4 feet.
MCX(M) connector	
Body style	Straight cable connections.
N(M) connector	Straight cable connections.

Cable	Body style	
	Type	RG-316 coaxial.
	Outer diameter	0.098 inches.
	Min. bending radius	1 inch.
	Impedance	50 ohms.
	Max. pulling tension	21 lbs.
	Temperature rating	-70 to 200°C (-94 to 392°F).
	Jacket material	FEP Teflon®.
	Weight	10 lbs per 1,000 feet.
	Attenuation	27.3dB per 100 feet.

f. Limit Value Switch Module: Phoenix Contact MCR-2SP-UI-DC or approved equal.

1) Description: The threshold switches are used to control and monitor automation process. Two threshold values each of which can be set separately are available for the evaluation of an analog input signal (0...10V or 0...20mA; selectable with DIP switches). The input status can be sampled via two relay outputs. The threshold value is set either via coding switches or via externally supplied analog signal values. A combination of both options (adding up the different threshold values) is also possible. It can be defined by means of DIP switches whether the relay is to pick up or to release when a threshold is exceeded/not reached. A relay pick-up delay can be set with two potentiometers within a range from 0 to 4s. The actual-value input is laid out as a differential input.

2) Front Panel Switch/Potentiometer Settings: The front panel features two 2-digit coding switches, two potentiometer knobs, two LED indicators and one supply voltage indicator LED.

a) Coding Switches: Switches are able to set a threshold value within a range of 0...99% of the selected input signal.

b) Potentiometer Knobs: The two knobs are used to set separate pick-up delays for each relay.

c) Two Yellow LEDs are used to indicate the relay status: LED is on = Relay has picked up.

3) Technical Data:

a) Input Data:

Description of input	Analog input.
Configurable/programmable	Yes.

Voltage input signal	0V ... 10V.
Current input signal	0mA ... 20mA.
Max. input voltage	13V.
Max input current	100mA.
Input resistance of voltage input	200k Ω .
Input resistance of current input	50 Ω .
Internal hysteresis	Approx. 100mV. Approx. 200 μ A.
Setting option	2-figure momentary-contact coding switch (0 ... 99%). External analog value definition. 2-figure momentary-contact coding switch (0 ... 99%) and external analog value definition.
Description of input	Setpoint input.
Number of inputs	2.
Configurable/programmable	Yes.
Voltage input signal	0V ... 10V.
Current input signal	0mA ... 20mA.
Max. input voltage	13V.
Max input current	100mA.
Input resistance of voltage input	200k Ω .
Input resistance of current input	50 Ω .

b) Switching Output:

Output name	Relay output.
Contact type	2 PDT contact, pick-up/drop-out (can be switched).
Contact material	Silver cadmium oxide (AgCdO).
Max. switching voltage	250Vac
Service life mechanical	3 x 10 ⁷ cycles.
Setting range of the response delay	8ms ... 4s (adjustable)
Status display	LED

c) Power Supply:

Range of supply voltages	20Vdc ... 30Vdc.
Max. current consumption	<100mA.

d) Connection Data:

Type of connection	Pluggable screw connection.
Conductor cross section solid min.	0.2mm ² .
Conductor cross section solid max.	2.5mm ² .
Conductor cross section stranded min.	0.2mm ² .
Conductor cross section stranded max	2.5mm ² .
Conductor cross section AWG/kcmil min.	24.
Conductor cross section AWG/kcmil max	14.
Stripping length	8mm.
Screw thread	M3.

e) General Data:

No. of channels	2
Length	75mm.
Width	45mm.
Height	108mm.
Max. temperature coefficient	≤0.01%/K.
Step response (10-90%)	8ms.
Ambient temperature (operation)	-20°C ... 65°C.
Color	Green.
Housing material	ABS.
Mounting position	Any.
Conformity	CE compliant.
UL, USA/Canada	cULus.

B. Wood Poles:

1. Provide poles designed for wind loading determined in accordance with AASHTO LTS while supporting all appurtenances indicated. The effective projected areas of appurtenances used in calculations shall be specific for the actual products provided on each pole.
2. ATIS O5.1 and RUS Bull 345-67 of Southern Yellow Pine or Douglas Fir. Poles shall be gained, bored, and roofed before treatment. Poles shall be treated full length with chromated copper arsenate (CCA) or ammoniacal copper arsenate (ACA) according to AWPA C1 and AWPA C4 as referenced in RUS Bull 345-67. Poles shall be branded by manufacturer with manufacturer's mark and date of treatment, height and class of pole, wood species, preservation code, and retention. Place the brand so that

the bottom of the brand or disc is 10 feet from the pole butt for poles up to 50 feet long.

PART 3 - EXECUTION

3.01 INSTALLATION: Construction shall conform to IEEE C2, NFPA 70, applicable instructions and recommendations of manufacturers of equipment and material supplied for this project, and to requirements specified herein. Plans indicating equipment locations are conceptual only and not for construction. Contractor shall visit site and locate and orient system in logical manner in conformance with manufacturer's recommendations and requirements to optimize performance in all applications.

A. Solar Array:

1. Solar array shall be installed in a location where they will receive maximum sunlight throughout the year. Avoid trees, buildings, structures, or obstructions which can cast shadows on the solar modules, especially during the winter months when the arc of the sun is lowest over the horizon.
2. Solar array shall be installed at a tilt angle, orientation, and elevation as recommended by the system manufacturer.

B. Wood Poles:

1. Set poles plumb.
2. Pole holes shall be at least as large at the top as at the bottom and shall be large enough to provide 4 inches of clearance between the pole and the side of the hole.
 - a. Soil Setting: "Setting in Soil" depths shall apply where pole holes are in soil, sand, or gravel or any combination of these.
 - b. Setting on sloping ground: On sloping ground, measure the depth of the hole from the low side of the hole.
 - c. Backfill: Dig holes large enough to permit the proper use of tampers to the full depth of the hole. Place backfill in the hole in 6 inch maximum layers and thoroughly tamp. Place surplus earth around the pole in a conical shape and pack tightly to drain water away.
3. Protective Molding: Protect exposed conductors/cables which are run on surface of wood poles by PVC molding.

C. Grounding: Ground per NEC 250 and 690.

3.02 TESTING AND INSPECTIONS: Before installing fuses to energize the system, check the following parameters:

- A. Check solar module input wiring for proper open-circuit voltage and polarity.
- B. Check battery wiring for proper voltage and polarity.
- C. Check polarity of wiring to loads.
- D. Once battery connections have been made and its polarity has been carefully checked, energize the system by installing the fuses per manufacturer's instructions.

CAUTION: To avoid damage to the electronic components during start-up and shutdown modes, fuses must be removed and reinstalled in the proper sequence, per manufacturer's instructions.

END OF SECTION