STANDARD SPECIFICATIONS

For

PUBLIC WORKS

CONSTRUCTION

SEPTEMBER 1986

DEPARTMENTS OF PUBLIC WORKS

COUNTY OF KAUAI

CITY AND COUNTY OF HONOLULU

COUNTY OF MAUI

COUNTY OF HAWAII

OF THE STATE OF HAWAII

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COUNTY ENGINEER
COUNTY OF KAUAI

DIRECTOR AND CHIEF ENGINEER
CITY AND COUNTY OF HONOLULU

DIRECTOR
COUNTY OF MAUI

CHIEF ENGINEER
COUNTY OF HAWAII

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SECTION 1 - DEFINITIONS

1.1 GENERAL PROVISIONS - The general provisions of construction contracts for the respective Counties are incorporated by reference and made a part of this "Standard Specifications for Public Works Construction." The applicable general provisions shall govern the work in the County where the project is located.

1.2 COUNTY - County shall mean the County of Hawaii, City and County of Honolulu, County of Kauai or the County of Maui, in which the project is located.

1.3 AGENCY - The legal entity for which the work is being performed.

1.4 ENGINEER - The head of the Department of Public Works in the County where the project is located.

1.5 EXISTING UTILITIES - The term existing utilities refers to those utilities of the Federal government, State, County, public utility companies, and other private firms having an easement or a franchise to operate within public rights-of-way. These include sewer, water, storm drain, street light, electric power, gas, signal and communication cables.

1.6 MAXIMUM DENSITY - The maximum density shall be the density of the material or mixture of materials at the optimum moisture content as determined in the laboratory by compaction tests performed in accordance with ASTM D 1557, "Methods of Test for Moisture - Density Relation of Soils, Using 10-Lb. Rammer and 18-Inch Drop - Method D."

1.7 ROAD PRISM - The section of the road between the right-of-way lines and including cut or fill slope sections outside of the normal right-of-way lines.

1.8 SPECIAL PROVISIONS - The special provisions are specific clauses setting forth conditions and requirements peculiar to the work and supplemental to the general provisions and to this Standard Specifications.

1.9 STANDARD DETAILS - The "Standard Details" of the Department of Public Works and any subsequent amendments and additions of the County in which the project is located.

1.10 SUBBASE - A layer of specified material of planned thickness between the base course and the subgrade.

1.11 SUBGRADE - That portion of the roadbed on which a pavement, surfacing, base, subbase or layer of any other material is to be placed.

SECTION 10 - CLEARING AND GRUBBING

10.1 DESCRIPTION

A. Clearing. This item shall consist of clearing and disposing of all materials, vegetation, trees, fences, rubbish, loose boulders, rocks, and other objectionable material within the areas shown on the plans. It shall include removing buildings, fences, lumber, trash piles, and other obstructions interfering with the proposed work; salvaging and stockpiling designated materials; and disposing of debris.

B. Grubbing. This item shall consist of grubbing the areas outlined on the plans or as defined in the special provisions. The work shall include the removal of tree stumps, large roots, buried logs, junk, and other objectionable materials at or below the ground surface not prescribed under the item of "Clearing." Unless specified otherwise in the special provisions, the removal of top soil is not a part of this work.

C. Clearing and Grubbing. This item shall include all clearing and grubbing work as described hereinabove.

10.2 CONSTRUCTION DETAILS

A. Existing Materials. All materials, unless designated otherwise, on the ground surface within the project site shall be removed and disposed of at an approved dump site. The Contractor shall be responsible for the protection of existing improvements abutting the project site and of existing trees and other improvements designated to remain within the site.

Trees and structures to be cleared which are located next to overhead power lines shall be cut or demolished in sections so as not to endanger the power lines.

All materials below the ground surface such as tree stumps, large roots, logs, junk, and other objectionable materials, shall be removed and disposed as directed by the Engineer.

All buildings and structures shall be removed to a depth of not less than 2' below the ground surface. The work shall include removal of interior foundation systems and construction, walls, slabs on grade and underground and overhead utility service connections. The floors of concrete basements, pits and structures that are not required to be

moved and which are located within the project limits shall be broken in such a manner that will prevent the entrapment of water.

B. Sewer, Water Mains, and Drain Pipes. When indicated on the plans or designated in the special provisions, the existing underground sewer, water mains or drain pipes shall be removed and disposed of by the Contractor. In rights-of-way or easement areas, the Contractor shall excavate within the boundaries and shall be responsible for the protection of abutting improvements, trees and shrubberies.

Any damages to abutting improvements shall be the Contractor's responsibility.

C. Hillside Areas. When working on ridges and hillsides, the Contractor shall protect existing improvements and homes on the lower areas or at the bottom of the hills from rolling or falling rocks, boulders, and debris.

All loose rocks and boulders on the slopes shall be carefully removed and disposed of.

D. Burning of Debris. Burning of debris is not permitted.

E. Backfilling. Except in excavation areas all trenches, holes, depressions or pits resulting from clearing and grubbing operations shall be backfilled with embankment material as required by these specifications or as directed. The area shall be left in a neat and finished appearance.

10.3 MEASUREMENT AND PAYMENT

Clearing and/or grubbing shall not be paid for directly but shall be considered as incidental and full compensation shall be considered as included in the bid price for the various items in the bid proposal, unless otherwise specified in the special provisions.

When called for in the special provisions, measurement for payment shall be as follows:

A. Acreage Basis. The item or items of work shall be measured for payment by the acre for the area cleared and/or grubbed within the bounds staked by the Engineer. Areas that do not require clearing and/or grubbing shall be excluded from the measurement.

B. Lump Sum Basis. The item or items of work shall be paid at the lump sum bid price, in which case it shall be full compensation for furnishing all labor, equipment and tools necessary to complete the work as described.

Payment shall be made at the unit price bid per acre or at the lump sum bid price and shall be full compensation for excavation, backfilling and all other required incidentals.

SECTION 11 - TRENCH EXCAVATION AND BACKFILL

11.1 DESCRIPTION

This item of work shall consist of excavating and backfilling for sewers, drains, culverts, electrical ducts and appurtenances to the lines and grades shown on the plans, as directed by the Engineer, and as specified herein. The work includes sheeting and bracing, dewatering, hauling and disposing of excavated materials.

11.2 EXISTING REGULATIONS

A. All excavation work on County streets and highways shall comply with the ordinances of the County relating to streets and sidewalk excavation, the special provisions, and with the requirements herein.

B. Work on Federal-Aid highways and State roads shall comply with the Hawaii Revised Statutes, the standard specifications of the Department of Transportation, State of Hawaii, and all subsequent amendments thereto.

C. The Contractor shall obtain the necessary permits from the Department of Public Works and any other affected agency before he begins work on County streets. He shall obtain the necessary permits from the State Department of Transportation for work on State and Federal-Aid highways.

11.3 BACKFILL MATERIALS

After the pipe or appurtenant structure is installed, inspected, and approved by the Engineer, the trench shall be backfilled with native material and/or imported materials as described herein below.

A. Trench for Pipes.

1) For the first lift from the bottom of the pipe to 12 inches above the pipe barrel, either sandy or granular material such as black sand, beach sand, crushed fine aggregates, finely graded coral passing through a 1-inch sieve or native material which does not contain lumps greater than 1 inch in diameter, organic debris, or adobe shall be used.

2) For the intermediate lift from 12 inches above the pipe barrel to 2 feet below the existing or proposed finished grade, either borrow material conforming to Section 16, "Borrow" or native material which does not contain more than 50% rock, hard lumps of earth of 6 inches in greatest dimension, rocks larger than 6 inches in their largest diameter, adobe or other unsuitable or deleterious materials shall be used.

B. Excavation for Appurtenant Structures. Borrow or native material may be used in backfilling. The material shall meet the requirements as specified in Section 11.3-A-2.

C. For the Surface or Top 2-Foot Lift of All Trenches.

1) Select material conforming to Section 30, "Select Borrow for Subbase Course."

2) Aggregate material conforming to Section 31, "Aggregate Base Course," for the base course layer.

3) Top soil for the top 6-inch layer in trenches across lawn or planting area.

4) The finished surface shall match the original ground surface prior to trenching in material composition and in thickness. The finished product shall be equal to or better than the original.

D. Cold-Mix Asphalt Concrete. Cold-mix asphalt concrete for temporary trench patches shall conform with the resurfacing mix requirements shown in Table 1-34 of Section 34, "Asphalt Concrete Pavement," with the exception of the liquid asphalt. Slow curing liquid asphalt, SC-4, shall be used and shall meet the specifications under AASHTO Designation M 141.

11.4 CONSTRUCTION DETAILS

A. Excavation. Trenches in existing improved streets, sidewalks, driveways and paved areas shall not be opened for more than 150 feet in advance of the pipe laying unless specifically authorized by the Engineer. In other areas, the trenches shall not be opened for more than 200 feet. No jumping of excavation will be permitted unless authorized in writing by the Engineer.

The trench width shall be the specified width for the pipe size to permit proper laying and jointing of the pipes, and where concrete jacket is called for, the width shall be increased accordingly. If the Contractor excavates beyond the specified width and such action results in greater load of overburden than the pipe is designed for, the Contractor shall replace the pipe with one of higher strength or provide a higher class of bedding to withstand the extra load at his own expense.

The top edges of the trench shall be neatly cut along well-defined lines. In overbreaks, the Contractor shall back-fill and repave the overbreak areas at his own expense.

The trench width below the level two (2) feet above the top of the pipe shall not exceed six (6) inches beyond the payment trench width specified in the Standard Details. From a level two (2) feet above the top of the pipe to existing ground, the width of trench excavation shall extend as nearly vertical as practicable and/or be confined to the minimum work area required for construction and shall not extend beyond existing structures or utilities adjacent to the pipe alignment, unless otherwise authorized by the Engineer.

The placing of stockpiles of excavated materials, pipes and construction materials adjacent to the trench excavation shall be prohibited on roads and highways, and areas adjacent to roads and highways where stockpiling of material may create a hazardous condition. The Contractor shall haul and store the materials at a site approved by the Engineer and haul to the job site as required at no cost to the County. Access to existing driveways, fire hydrants and meters shall be provided at all times.

When unsuitable material is encountered at the excavation, the Contractor shall be responsible for hauling and disposing of the material. The hauling shall be considered as incidental to the excavation work and no direct payment will be made. The Engineer shall determine if the excavated material is unsuitable.

For installing pipe in new embankment, the embankment shall first be constructed to a height of two diameters (O.D.) above the established pipe invert or to a height as indicated on the plans, and for a distance each side of the pipe location of not less than five times the diameter of the pipe. The trench shall then be excavated with sides as nearly vertical as soil condition will permit and the pipe installed.

B. Additional Excavation. When the subgrade material below the established trench grade is unsuitable, such as, muck, buried debris, or adobe, the Contractor shall excavate below grade to such depth and width as directed by the Engineer. The excavated area below grade shall be filled with aggregate in 6-inch compacted layers and brought up to within 6 inches of the invert grade or to the bottom of the concrete jacket or cradle.

C. Overexcavation. Any part of the trench excavated below the established grade or beyond the maximum permitted width, other than work under "Additional Excavation," shall be refilled and compacted with select material by the Contractor at his own expense.

D. Sheeting and Bracing. Wherever necessary, the Contractor shall properly sheet and brace the open trench to render it safe and secure from possible slides, to protect existing improvements and properties, and shall remove same before completing the backfill.

E. Dewatering. Unless authorized in writing by the Engineer, trenches shall be kept free from water during the installation, testing, and backfilling of pipes. The Contractor shall be responsible for any damages to adjacent properties resulting from his dewatering operation.

Discharge from dewatering operations shall not be drained directly onto the street or gutter. In areas where a storm drainage system has been installed, the discharge shall be conveyed to the nearest storm drain, by the use of pipes or other suitable means acceptable to the Engineer. If necessary, the discharge shall be filtered or otherwise treated to comply with all applicable Federal, State and County regulations concerning water pollution prior to its release into waterways or drainage systems.

In areas where there are no storm drainage systems, arrangements satisfactory to the Engineer shall be made to dispose of the discharge onto private properties.

F. Placing and Compacting. Backfilling work shall not commence until approval is granted by the Engineer or his authorized representative.

1) The first lift shall be backfilled by hand shoveling and tamping or by power equipment supplemented by hand shoveling and tamping so that the backfill material is in contact with the entire periphery of the pipe. The power equipment shall be of the front loader type where unloading of backfill material into the trench can be controlled so that the pipe is not damaged nor moved from its installed position.

Compaction of the backfill from the bottom of the pipe to 12 inches above the pipe barrel by ponding and jetting will be permitted provided the backfill material is of such character that it will be self-draining and that foundation material will not soften or be otherwise damaged by the applied water. The material should generally be well graded, with not more than 9% passing the No. 200 sieve.

The work shall be performed without damage to the pipe and trench and in such a manner that water will not be impounded. Ponding and jetting shall be supplemented by the use of vibratory or other compaction equipment when necessary.

2) For the intermediate lift, the backfill material shall be placed in horizontal uniform layers and thoroughly compacted by mechanical tamping. In roadways, sidewalks, alleys, and paved areas, each layer shall not exceed 8 inches in thickness before compaction. In lawn and planting areas, each layer shall not exceed 12 inches in thickness before compaction. Compaction shall not be less than 90% of the material's maximum density.

The material shall be made slightly damp for compaction but the amount of moisture shall not exceed its optimum moisture content, unless approved by the Engineer. Mechanical or hand tamper, or vibratory compactor may be used in compacting each layer.

The Contractor shall be responsible for protecting the pipe or structure while placing and compacting the backfill material.

3) The surface 2-foot lift shall be placed and compacted in accordance with Section 30 "Select Borrow for Subbase Course," and Section 31, "Aggregate Base Course" except in lawn and planting areas.

4) Where the trench is across an existing bank or slope, a grouted riprap surface shall be constructed so as to prevent erosion of the backfill.

5) Backfill under existing structures or facilities shall be sandy or granular material completely placed as soon as the pipe is laid and tested. The backfill material shall be rammed with proper tools until compacted to a minimum of 90% of its maximum density. Where the specified compaction cannot be attained, the Contractor shall backfill with Class "C" concrete. The on-site materials are generally suitable as backfill material provided organic materials, debris, and other objectionable material are not included in the backfill. Rock greater than 12 inches in diameter shall not be allowed in the backfill.

G. Temporary Trench Patching. To accommodate traffic immediately after backfilling the trench and prior to the permanent restoration, a temporary patch of cold-mix asphalt concrete shall be constructed over the compacted backfill. The cold-mix asphalt shall be compacted to a minimum thickness of 1-1/2 inches and shall be slightly humped not to exceed 3/8 inch for trench width less than 2 feet, and 3/4 inch for trench width greater than 2 feet.

The Contractor shall maintain the temporary trench patches in good condition at all times until the permanent restoration is completed. Chuck holes and any depression greater than 1/2 inch shall be repaired immediately.

Permanent restoration work shall be done in conformance with and as specified under Section 38, "Restoring Pavements and Other Improvements."

11.5 MEASUREMENT

Trench excavation shall be considered as unclassified and shall be measured for payment by the cubic yard unless specified otherwise in the special provisions. The quantity shall be computed based on the specified payment trench width for the size of pipe installed and the actual depth required to obtain the proper grade.

Backfill shall not be measured and paid for directly, but shall be considered as incidental and included in the unit price bid for excavation.

A. The depth of the pipe trench for computing excavation quantity shall be measured from the established trench grade to the original ground, or to the subgrade of the proposed roadway, or to the finished grade whichever is less.

In new embankment, the depth shall be from the established trench grade to a height above the pipe as described herein above or as indicated on the drawings.

The horizontal limits for measuring payment for manholes, junction boxes and other similar structures shall be the vertical plane one foot outside the exterior faces of the structures.

B. Additional excavation and backfill shall be measured for payment by the cubic yard based on the trench width specified for the size of pipe installed and the depth and extent of excavation below the established trench grade, as directed by the Engineer. Imported aggregate for backfilling below the established trench grade shall be measured for payment by the cubic yard.

C. Sheeting and bracing, dewatering, and disposing of excess excavated materials, and other miscellaneous work shall not be measured and paid for directly but full compensation shall be considered as included in the unit bid price for trench excavation.

D. For the City and County of Honolulu only, temporary trench patch shall be measured for payment by the square yard of 1-1/2 inches compacted thickness based on the payment trench width specified or by the ton as provided for in the proposal.

E. Grouted riprap shall be measured for payment by the square yard in place.

11.6 PAYMENT

Payment for trench excavation and backfill as measured above shall be made at the unit price bid per cubic yard and shall be full compensation for completing the excavation to the specified depth and backfilling the trench.

Payment for additional excavation below the established trench grade shall be made at the unit price bid for excavation above the trench grade and shall be full compensation for hauling and disposing of the unsuitable material. Payment for imported aggregate shall be made at the unit price bid per cubic yard.

For the City and County of Honolulu only, payment for temporary trench patch as measured above shall be made at the unit price bid per square yard or per ton.

For the Counties of Kauai and Hawaii only, temporary trench patch shall not be paid for directly but shall be considered as included in the unit price bid for trench excavation and backfill or other applicable items, unless otherwise specified in the special provisions and/or proposal.

Payment for grouted riprap as measured above shall be made at the unit price bid per square yard.

Payment may be made for the various items by other methods as specified in the special provisions and/or proposal.

SECTION 12 - ROADWAY EXCAVATION

12.1 DESCRIPTION

This work shall consist of excavating and grading the roadway prism, constructing embankments and slopes, and all necessary grading for the installation of curbs, gutters, and sidewalks. It shall include the disposing of all excess material, and excavating and disposing of unsuitable material.

12.2 CLASSIFICATION

Roadway excavation, comprising all materials within the roadway prism, embankments, and slopes, but excluding trench excavation shall be unclassified. Other types of classification shall be specified in the special provisions and shall be measured and paid for under the separate classifications.

12.3 PROTECTION OF EXISTING IMPROVEMENTS

A. Surface Improvements. The Contractor shall be responsible for the protection of existing surface improvements abutting the roadway prism and slopes and of those improvements within the right-of-way which are specified in the special provisions or indicated on the plans to remain. Any damage resulting from his operations shall be his responsibility.

B. Subsurface Improvements. The Contractor shall be responsible for the protection of existing subsurface improvements as specified under the applicable section of the General Provisions for the respective Counties.

Any underground utility discovered during the excavation work which is not shown on the plans and which is not to be abandoned, shall be protected, relocated, or adjusted as directed by the owner of the utility with the approval of the Engineer. Payment for relocation or adjustment work will be made in accordance with the unit contract price for similar work, or by force account as the Engineer may determine. When the owner of the utility decides to abandon and plug, relocate, or adjust the line with his own work force, the Contractor shall cooperate and assist wherever possible in expediting the work.

C. Private Utilities. Owners of utilities other than those owned and operated by the County, which are in the County streets pursuant to franchises or to rights claimed under the laws of the United States of America, are responsible for all adjustments and relocations of their facilities. The owners will assist the Contractor in locating and in protecting their facilities.

The Contractor shall coordinate his work with that of the affected owners and shall protect their facilities at all times. He shall be liable for all damages to private utility facilities resulting from his operations, and shall hold the County harmless.

12.4 CONSTRUCTION DETAILS

A. General. All suitable materials removed from the excavation shall be used as far as practicable in the construction of embankments, shoulders, sidewalk areas, slopes, in backfill for structures, and at such other places as may be directed by the Engineer. Suitable excavated material shall not be wasted or removed from the site without permission of the Engineer. The surface material from excavation which is suitable as topping or finishing soil shall be stockpiled at a convenient location approved by the Engineer and shall be kept free from erosion by wind and rain. This material shall then be used as top soil on sidewalk areas, roadway embankments, shoulder, planting areas, or as directed by the Engineer.

All unsuitable material, such as adobe, muck, expansive clay and materials with debris or organic matter, encountered above the road subgrade, shall be removed and hauled away from the project site. Unless a specific site is designated in the special provisions for disposal of unsuitable material, the Contractor is responsible to find a convenient site. The hauling and disposing of the unsuitable material shall be considered as incidental to the excavation work. The Engineer shall determine if the material is unsuitable.

B. Excavation Below Grade. Subgrade material that is unsuitable or unsatisfactory for the intended use shall be excavated to such depth and width deemed adequate by the Engineer. The excavated area shall then be brought up to grade with suitable backfill material placed in 6-inch compacted layers. Excavation below grade shall be of the same classification as that above it.

All boulders, ledge rock or other material exposed above the subgrade shall be removed or broken to the full roadbed width. No solid projections or ribs shall be within 6 inches below the subgrade surface.

If excavation below grade is required because of negligence on the part of the Contractor, it shall be remedied by the Contractor at his own expense.

C. Slopes. Excavation shall be finished with all slopes cut true and straight, in conformity with the grading ordinances, as shown on the plans, or as recommended by the consulting engineer or geologist. All slopes, whether old or new, shall be maintained with true and smooth surface. Overbreaks from overshooting or overexcavating shall be trimmed smoothly and neatly. The tops of excavation slopes shall be rounded and the ends of excavation slopes shall be flared and rounded.

D. Overbreaks. Any material which is excavated, displaced, or loosened outside and beyond the slopes, lines, or grades as staked or re-established, shall be removed and disposed of by the Contractor at his own expense. This applies to material from overbreaks due to blasting, to the inherent character of any formation encountered, or to any other cause but not to material which occurs as slides as described below.

Excessive blasting or "overshooting" will not be permitted. The Engineer shall have the authority to require the Contractor to discontinue any method of blasting which leads to overshooting or is dangerous to the public or destructive to property or to natural features.

E. Slides. All materials that have slid from the finished cut slopes or the finished embankments before final acceptance of the work shall be removed by the Contractor. Natural ground or cut slope outside of the planned roadway prism which, in the opinion of the Engineer, is unsafe and subject to slides, shall be excavated and benched. All such materials excavated shall be used in constructing roadway prism, reconstructing embankment with the approval of the Engineer, or shall be disposed of.

The Contractor shall be compensated for this work based on force account.

F. Disposal of Surplus Material. The site for the disposal of surplus material shall be designated on the plans or specified in the special provisions. When a disposal area is not specified or designated, the Contractor shall be responsible for finding a suitable location approved by the Engineer.

Surplus material shall be deposited and graded in such a manner so as to prevent unnecessary dust or silting problem or hazard to life, limb, or property.

Any material not disposed of within the project or hauled to designated locations, shall become the property of the Contractor and shall be removed from the site of work.

12.5 MEASUREMENT

Excavation shall be measured for payment by the cubic yard unless specified otherwise in the proposal. The quantity shall be computed based on the average-end-area method and center line distance. Where it is impractical to measure quantities of excavation by the average-end-area method, the Engineer shall use the best method to obtain an accurate estimate.

Excavation for unsuitable material below the established grade shall be measured by the cubic yard by cross-sectioning.

The original position of the ground surfaces shall be as shown on the plans unless either the Engineer or the Contractor demonstrates that the profiles or cross sections are erroneous before the original ground is disturbed.

The measurement shall include the volume of material involved in excavating and grading the roadway prism, embankments, slopes, rounding the tops and ends of cut slopes, widening of cuts as directed, excavating and removing slides and potential slide areas, and loosening and breaking of boulders or ledge rock within 6 inches below the roadway prism in cut sections whether the material is removed or not.

No measurement shall be made for the volume of material involved in overshooting or excessive blasting, excavating beyond the designated lines and grades, and incidental work necessary to complete the roadway prism.

Unless a bid item is included in the proposal, hauling shall not be measured for payment, but compensation shall be considered as included in the bid price for roadway excavation.

12.6 PAYMENT

Unless specified otherwise in the special provisions and/or proposal, payment shall be made at the unit price bid per cubic yard for the quantity of roadway excavation as measured above. Payment shall be full compensation for furnishing the necessary equipment, tools, labor and materials to complete the roadway excavation.

SECTION 13 - STRUCTURE EXCAVATION AND BACKFILL

13.1 DESCRIPTION

Structure excavation shall consist of the excavation, removal and disposal of all materials necessary for the construction of foundations for sewage treatment plants, pumping stations, bridges, retaining walls, box drains, headwalls, and similar structures, or for the placement of riprap, slope protection, and cribbing. It shall include all other excavation specified in the special provisions. Backfill or fill shall consist of furnishing, placing, and compacting of backfill or fill material.

This item of work includes the design, construction and subsequent removal of all shoring, sheeting, cribs, cofferdams, dewatering facilities and incidentals which may be necessary for excavation and compaction of backfill.

13.2 CONSTRUCTION DETAILS

The Contractor shall exercise caution in performing the work so as not to cause any slide or slip beyond the limits of the structure excavation. He shall be responsible and liable for damages to abutting improvements and properties resulting from any slide or slip caused by his negligence or by the operation of his equipment. He shall also at his own expense remove the loose material and backfill or repair the slide or slip area with granular material, lean concrete, or by any other method approved by the Engineer.

All unsuitable material, debris, and materials declared surplus, as identified by the Engineer, shall be removed from the project site by the Contractor. Unless a site is designated in the special provisions, the Contractor is responsible for finding a disposal site.

A. Preparation for Placing Foundation. Unsuitable material on which the permanent structure or member rests and which is below the established invert of structure foundation shall be excavated and removed as directed by the Engineer. The excavated area shall then be backfilled with granular material in compacted layers or concrete as directed by the Engineer. The work of excavation, removal and replacement of material not required for the permanent support of the structure foundation or member shall be considered the incidental responsibility of the Contractor and shall not be measured or paid for.

The bottom of the excavation for the foundation of structures shall be undisturbed and free of loose material, debris, and other unsuitable material. When disturbed, the loose material shall be compacted to 95% of its maximum density or, when specified, shall be removed and replaced with a bedding of granular material. When ledge rock or the excavation shall be carried into the ledge rock or coral to form a key for the concrete footing or structure, or to such additional depth as specified in the special provisions or directed by the Engineer.

B. Shoring, Cribs, and Cofferdams. When specified in the special provisions, shown on the plans, or when during the course of excavation the Contractor and/or the Engineer deem necessary, the Contractor shall construct shoring, cribs, or cofferdams to protect abutting properties and improvements and to prevent possible slide or slip of the earth walls and the immediate ground area. No excavation or further excavation shall be permitted until the above work is completed.

Cribs and cofferdams shall be carried well below the footing and shall be braced and watertight.

Upon completion of the work, all shoring, sheeting, cribs, and cofferdams shall be removed without disturbing the structures or other improvements.

C. Dewatering. Unless authorized in writing by the engineer, the structural excavation shall be kept free from water during the construction and/or installation of the structure and during backfilling. The Contractor shall be responsible for any damages to adjacent properties resulting from his dewatering operation.

Discharge from dewatering operations shall not be drained directly onto the street or gutter. In areas where a storm drainage system has been installed, the discharge shall be conveyed to the nearest storm drain, by the use of pipes or other suitable means acceptable to the Engineer. If necessary, the discharge shall be filtered or otherwise treated to comply with all applicable Federal, State and County regulations concerning water pollution prior to its release into waterways or drainage systems.

In areas where there are not storm drainage systems, arrangements satisfactory to the Engineer shall be made to dispose of the discharge onto private properties.

D. Inspection. During the course of excavation, the Engineer may stop the work and make bearing tests or test borings. The Contractor shall give any assistance the Engineer may need in making such tests. For the City and County of Honolulu only, materials and labor furnished by the Contractor for such tests shall be paid for on a force account basis or on a previously agreed price. For the Counties of Kauai, Maui and Hawaii, the Contractor shall conduct all tests at no expense to the County.

When the foundation excavation is completed, the Contractor shall notify the Engineer who will make an inspection and approve the work before any additional work or structure is placed thereon.

E. Backfilling. All materials for backfill shall be approved by the Engineer and shall be free from large clumps of soil, organic debris, adobe, or other deleterious matter. Suitable material from the excavation may be used for backfill with the approval of the Engineer. The word backfill as used herein shall be defined as including either fill or backfill.

The backfill shall be placed in horizontal layers not more than 6 inches thick after compaction. Each layer shall be compacted to 95% of its maximum density. Mechanical or power tampers may be used in compacting the backfill material. However, no equipment or tamper may be used which by its weight or movement will damage, move or tilt out of alignment any part of the structure above or below the ground surface. The Contractor shall be responsible for such damages and shall make necessary repairs at his expense.

13.3 MEASUREMENT

Structure excavation shall be measured for payment by the cubic yard unless specified otherwise. The quantities of material excavated shall be computed based on the dimensions shown on the plans or within the limits defined hereinafter. Any additional excavation outside of these limits shall not be paid for.

The horizontal limits for measuring the structure excavation for payment shall be the vertical planes one foot outside of the footings or structure walls.

The bottom limit for measurement shall be the bottom of the footings or the structure as shown on the plans or as otherwise established by the Engineer.

The upper limit for measurement shall be the existing ground or the finished grade whichever is lower.

No measurement shall be made of the materials used in shoring, sheeting, cribs, or cofferdams.

Excavation for unsuitable material below the established invert of structure excavation shall be measured by the cubic yard by cross-sectioning.

13.4 PAYMENT

Unless specified otherwise in the special provisions and/or proposal, structure excavation shall be paid for as measured above at the unit price bid per cubic yard. The unit contract price shall be full compensation for (1) construction and subsequent removal of shoring, sheeting, cribs, or cofferdams, except when such work is paid for under separate items listed in the proposal; (2) disposal of debris and surplus material; (3) furnishing the necessary equipment, tools, materials and labor; and (4) all other miscellaneous work and appurtenances.

Additional excavation shall be paid for under the bid price for excavation. Granular material or concrete used to backfill the area of additional excavation shall be paid for under the respective items in the proposal.

Backfill shall not be measured for payment directly, but full compensation shall be considered as included in the bid price for excavation.

Granular material used in the bedding or cushion shall be measured and paid for under a separate item in the proposal.

Unless specified otherwise in the special provisions, payment for dewatering shall be considered as included in the unit price bid for structure excavation.

SECTION 14 - ROCK FOR FILL

14.1 DESCRIPTION

This item shall include furnishing and placing clean rock or crusher run rock in areas indicated on the drawings as fill, as replacement for unsuitable foundation material, as a blanket over soft or spongy subgrade, or wherever directed by the Engineer.

14.2 MATERIALS

A. Rock for fill shall be sound unweathered rock, the maximum size of which shall be consistent with the depth and width of the fill area.

B. Crusher run rock for fill shall be graded granular particles, free from vegetable matter and other deleterious substances. The percentage composition by weight shall meet the following requirements:

Sieve Size	Percentage Passing
2"	100
1-1/2"	90-100
3/4"	50-90
#4	25-50
#200	3-9

When tested under AASHTO Test Method T 96, the wear shall not exceed 50 percent at 500 revolutions.

C. Binder materials may be either black sand, crushed limestone, fine aggregate or crushed rock, or other equal binder materials.

14.3 CONSTRUCTION DETAILS

A. Rock Fill. In placing rocks for fill, the spaces between larger rocks shall be filled with smaller rocks and binder material. The fill shall be then compacted in layers with approved power equipment until there is no visible evidence of further consolidation of the material being compacted.

The Contractor shall place and compact the material with care and in such manner as to prevent formation of voids and hollow spaces.

B. Crusher Run Rock Fill. The fill shall be placed in equal layers until the required grade is reached. Each layer shall be thoroughly compacted with approved power equipment and the maximum thickness shall not exceed 6 inches after compaction, unless permitted otherwise by the Engineer.

Water shall be added when necessary to obtain the necessary bond and compaction.

14.4 MEASUREMENT

Rock for fill shall be measured for payment by the cubic yard or by the ton as shown in the proposal. Where the measurement is by the cubic yard and unless specified otherwise, the volume shall be computed based on the dimensions of the material compacted in place. When the measurement is by the ton, the quantity of material shall be the weight as measured on platform scales, less the weight of all water in excess of 5% based on dry weight.

14.5 PAYMENT

Unless specified otherwise in the special provisions and/or proposal, payment as measured above shall be made at the unit price bid per cubic yard or per ton, and shall be full compensation for furnishing the labor, material and equipment necessary to complete the work in place.

SECTION 15 - CRUSHED ROCK

15.1 DESCRIPTION

This item shall include furnishing, spreading and compacting crushed rock for beddings, bases, or foundations as indicated on the plans, as specified in the special provisions, or as directed by the Engineer.

15.2 MATERIAL

Crushed rock shall be manufactured from sound durable lava rock and shall be free from vegetable matter and other deleterious substances. The wear when tested under AASHTO Test Method T 96 shall not exceed 50 percent at 500 revolutions.

Crushed rock shall be designated by numbers and the percentage composition by weight shall fall within the limits indicated in Table 1-15 below.

TABLE 1-15

CRUSHED ROCK GRADATIONS - ASTM DESIGNATIONS
Percentage Passing by Weight

Sieve Size	No. 1	No. 2	No. 4	No. 67	No. 10
3-1/2"	90-100				
3"	---	100			
2-1/2"	25-60	90-100			
2"	---	35-70	100		
1-1/2"	0-15	0-15	90-100		
1"	---	---	20-55	100	
3/4"	0-5	0-5	0-15	90-100	
1/2"	---	---	---	---	
3/8"	---	---	0-5	20-55	100
#4	---	---	---	0-10	85-100
#8	---	---	---	0-5	---
#16	---	---	---	---	---
#50	---	---	---	---	---
#100	---	---	---	---	10-30

15.3 DETAILS

The spreading and compacting of crushed rock shall comply with the requirements for the particular use specified under the various sections in these specifications.

15.4 MEASUREMENT AND PAYMENT

Unless specified otherwise in the special provisions, crushed rock shall be measured for payment by the cubic yard. The quantity shall be computed based on the compacted volume of the crushed rock in the final position, the dimensions of which shall be as indicated on the plans or as determined by the Engineer.

Unless specified otherwise in the special provisions and/or proposal, payment shall be made at the unit price bid and shall be full compensation for furnishing the necessary material, labor and equipment to complete the work in place.

SECTION 16 - BORROW

16.1 DESCRIPTION

Borrow shall include excavating, hauling, placing and compacting suitable and satisfactory material obtained from borrow pits or from designated sites approved by the Engineer.

A. On-Site Borrow. Materials excavated from within the project rights-of-way but outside of the planned cross sections shall be considered as on-site borrow. The material shall be excavated from areas specified in the special provisions or designated by the Engineer, and shall be used in the construction of embankments, subgrade, shoulders, or other designated uses.

B. Imported Borrow. Materials obtained from borrow pits outside of the project rights-of-way shall be considered as imported borrow. Unless designated otherwise in the special provisions, the Contractor may secure imported borrow from any source if approved in writing by the Engineer. No excavation will be permitted at locations where resulting scars will present an unsightly appearance from any travelway.

16.2 MATERIAL

Borrow material shall meet the requirements for the particular use intended. Coarse-grained soil with clay binders and fine-grained soils with expansion value less than 3% are acceptable borrow material. The CBR value shall be 8 or greater. In addition, for the Counties of Kauai and Hawaii, the sand equivalent value as determined by AASHTO T 176 shall not be less than 10.

If requested, the Contractor shall notify the Engineer of the location of the borrow site in sufficient time to permit the County to make tests to determine the suitability of the material. In case the material is rejected, the Contractor shall designate another site. All borrow shall be inspected and approved by the Engineer.

For the Counties of Kauai and Hawaii only, the Contractor shall notify the Engineer of the location of the borrow site. If requested by the Engineer, the Contractor shall employ an independent soils testing laboratory to determine the suitability of the borrow material, the results of which shall be submitted to

the Engineer. All costs associated with this testing will be borne by the Contractor. In case the material is found to be unsuitable, the Contractor shall designate another site, all borrow sites shall be approved by the Engineer.

16.3 DETAILS

Borrow shall be placed and compacted in accordance with the applicable sections.

16.4 MEASUREMENT AND PAYMENT

Unless specified otherwise in the special provisions, imported borrow shall be measured for payment by the cubic yard as computed by the average-end-area method and center-line distances. When it is not practicable to determine the volume by the end-area method, the Engineer shall use the best method to obtain an accurate estimate. Unless specified otherwise in the special provisions and/or proposal, payment shall be made at unit price bid per cubic yard.

On-site borrow shall not be measured for direct payment unless indicated otherwise in the proposal. Full compensation shall be considered as included in the unit price bid for the various items in the proposal.

SECTION 17 - EMBANKMENT

17.1 DESCRIPTION

This work shall include the preparation of embankment site; the construction of roadway embankments, berms and fill; and the placing and compacting of embankment materials in holes, pits and other depressions within the roadway area.

17.2 MATERIALS

Suitable borrow or excavation material shall be used in constructing embankments. The better material shall be used in the surface or upper layers. No vegetation, debris, junk, or other extraneous matter shall be mixed with the embankment material nor placed within the embankment.

Soil with expansion value greater than 3% shall not be placed in the top 2 feet of the embankment but may be used below this layer.

17.3 DETAILS

A. Site Preparation. The natural ground surface shall be cleared and grubbed of vegetation, junk and other organic matter and shall be inspected by the Engineer before placing the embankment material. Wherever the natural ground is of such nature as will impair the stability or usefulness of the embankment, the natural ground shall be stabilized or excavated and the unsuitable material disposed of.

When embankment is to be constructed on a slope greater than five horizontal to one vertical, the natural ground shall be terraced or stepped by plowing deeply into it in a horizontal plane. The excavated material shall be recompacted along with the new embankment material at the Contractor's expense. Ground with flatter slopes shall be terraced when directed by the Engineer or when specified in the special provisions.

B. Placing. Embankment material shall be placed in successive layers of uniform thickness. Each layer shall be approximately level with the center constructed slightly higher than the sides for storm water runoff, and shall be constructed to the full width of the cross section.

The top 2-foot layer of the embankment shall be constructed in horizontal lifts not to exceed 6 inches in compacted thickness. The percent compaction shall be as required by the Engineer.

In placing soil material 2 feet below finished subgrade, the compacted thickness of each layer shall not exceed 10 inches. If approved by the Engineer in writing or specified in the special provisions, successive horizontal layers with a compacted thickness exceeding 10 inches but not exceeding 12 inches may be placed, provided the required density is obtained throughout the full width and depth of each layer.

When embankment material contains by volume over 25% of rock larger than 6 inches in greatest dimension, the fill 3 feet below the finished subgrade may be constructed in layers of a loose thickness before compaction not exceeding 3 feet in thickness. When the embankment material contains less than 25% rock by volume, it shall be placed in layers not exceeding 12 inches in loose thickness.

C. Compacting. Embankments shall be compacted with compacting equipment satisfactory to the Engineer. The use of hauling equipment to obtain partial compaction will be allowed, but the Contractor will be required to compact the full width and depth of each layer to the required density before placing the next lift.

In locations where it would be impractical to use rollers or heavy compacting equipment, the material shall be compacted in 6-inch lifts with any method that will produce the required density.

At the time of compaction, the moisture in the material shall not vary by more than 3% from the optimum moisture. Material that is too wet shall be dried before compacting.

D. Density. The top 2-foot layer of the embankment shall be compacted to at least 95% of the maximum density of the material. Below this 2-foot plane, the embankment shall be compacted to at least 90% of the maximum density.

E. Rocks and Boulders. Rocks and boulders may be placed in deep fills provided they are well embedded, and the interstices filled with smaller pieces and filler materials to

give a density satisfactory to the Engineer. The rocks or boulders shall be well distributed throughout the embankment with the larger pieces on the outside, preferably starting at the toe of the slopes.

Rocks and boulders shall not be used in fill over existing ground with slopes greater than four horizontal to one vertical without the written approval of the Engineer.

F. Swampy Ground. Where embankments are to be constructed across swampy ground which will not support the weight of hauling equipment, the lower part of the embankment may be constructed by dumping successive loads of non-cohesive or sandy material in a uniformly distributed layer. The layer thickness should not be greater than that necessary to support the equipment while placing subsequent layers. The remainder of the embankment shall be constructed in layers and compacted under these specifications.

G. Maintenance. The Contractor shall be responsible for the stability of all embankments constructed under this contract and shall make repairs to any portion damaged or displaced at his own expense. Traffic shall be distributed over the work during construction so as to cover the entire surface.

17.4 PAYMENT

Unless shown in the proposal, embankment shall not be paid for directly but shall be considered as included in the unit price bid for roadway excavation, borrow, or other applicable items.

SECTION 18 - VITRIFIED CLAY SEWER PIPE AND APPURTENANCES

18.1 DESCRIPTION

This work shall consist of furnishing and laying vitrified clay sewer pipe and appurtenances in accordance with these specifications, the special provisions, and as directed by the Engineer, to the lines and grades shown on the plans.

18.2 MATERIALS

A. Vitrified Clay Pipe and Fittings.

1) General. Vitrified clay pipes and fittings may be either glazed or unglazed but shall be extra strength, first quality, durable, sound, and well burned throughout their entire thickness.

2) Manufacturing Requirements.

a) Identification Marks. All pipes and fittings shall be clearly marked with the name or trademark of the manufacturer, the batch number, the location of plant and extra strength designation.

b) Glazing. If salt-glazed pipes are furnished or required, the pipes must be smooth and their interior surfaces must be thoroughly glazed and be free from chips, crazes, blisters, hair cracks or other imperfections.

c) Shape. Pipe ends shall be square with the longitudinal axis, and sockets shall be true, circular and concentric with the barrel of the pipe.

The ends of the pipe shall be so formed that when the pipes are laid together and the joints made, they shall constitute a continuous and uniform line of pipe and shall have a smooth and regular interior surface.

Pipes shall be scored, according to the following table, on the inside of the socket and on the outside of the spigot. Scoring shall be approximately at right

angles to the axis of the pipe. Scoring may be omitted on pipes with flexible compression joints. Plain end pipe, acceptable to the Engineer, shall not be scored on the ends, but every length shall be clearly marked to indicate the depth of insertion into the coupling.

TABLE OF SCORING

Pipe Diameters	Minimum Number of Scorings
6"	1
8" through 15"	2
18" and up	3

d) Lengths. The length of straight pipes and Y's (of all sizes), exclusive of socket depth, shall be not less than 2-1/2 feet; except that for sizes less than 8 inches in diameter, the length may be 2 feet; and except that for special purposes, shorter lengths may be furnished.

e) Dimensions and Tolerances. The dimensions and permissible tolerances for vitrified clay pipe shall be as provided in Table 1-18.

The minimum annular space measured 1/2 inch from the base of the socket is defined as the "caulking space."

The tolerances shown in the table of dimensions for nominal size (I.D.) and the inside diameter of the socket shall be limited so as to comply with the provisions of the following paragraph (f) Imperfections.

f) Imperfections. All pipes and fittings must be free from injurious cracks, checks, blisters, broken extremities, or other imperfections. The following imperfections in a pipe or fitting will be considered injurious and cause for rejection:

TABLE 1-18

DIMENSIONS AND PERMISSIBLE TOLERANCES FOR VITRIFIED CLAY PIPE

(All dimensions expressed in inches)

Nominal Size (I.D.)		Wall Thickness		Socket Depth		Socket Thickness (Min.)	Difference in Length	
							Two opposite sides	Overall (per ft.)
	*		*		*	**		*
6	±3/16	7/8	-1/16	2-7/16	-1/4	1/2	3/8	-1/8
8	±1/4	15/16	-1/16	2-5/8	-1/4	5/8	7/16	-1/8
10	±1/4	1-1/16	-1/16	2-5/8	-1/4	3/4	7/16	-1/8
12	±5/16	1-1/8	-1/16	2-7/8	-1/4	7/8	7/16	-1/8
15	±5/16	1-1/2	-1/8	2-7/8	-1/4	1-1/8	1/2	-1/8
18	±3/8	2	-1/8	3-1/8	-1/4	1-3/8	1/2	-1/8
21	±7/16	2-3/16	-1/8	3-5/8	-1/4	1-3/8	9/16	-1/4
24	±1/2	2-1/2	-1/8	3-7/8	-1/4	1-5/8	9/16	-1/4
27	±5/8	2-7/8	-1/8	3-7/8	-1/4	1-7/8	5/8	-1/4
30	±5/8	3	-1/8	4	-1/4	2	5/8	-1/4
33	±3/4	3-1/4	-3/16	4	-1/4	2-1/4	11/16	-1/4
36	±3/4	3-1/4	-3/16	4-1/8	-1/4	2-7/16	11/16	-1/4
39	±3/4	3-3/4	-3/16	4-1/8	-1/4	2-3/4	3/4	-1/4
42	±1	4	-1/4	4-1/8	-1/4	2-3/4	7/8	-3/8

* The minus sign (-) alone indicates that the plus tolerance is not limited; the plus and minus sign (±) indicates the tolerance in both excess and deficiency.

** Socket thickness is measured 1/2 inch from mouth of socket.

Note: The minimum depth of the socket and the minimum socket inside diameter may be waived where such changes in dimensions are conducive to the proper application of the type of joint to be used.

1. There shall be no fractures or cracks passing through the barrel or socket, except that a single crack at the spigot end of the pipe not exceeding 75% of the depth of the socket, or a single fracture in the socket not exceeding 3 inches (76 mm) around the circumference nor 2 inches (50 mm) lengthwise may be permitted.

   Chips or fractures on the interior of the pipe shall not exceed 2 inches (50 mm) in length, one inch (25 mm) in width, and a depth of one fourth of the thickness of the barrel.

2. Lumps, blisters, pits, or flakes on the interior surface.

   Pipe of nominal sizes from 3 to 18 inches shall have no blister with a dimension exceeding 3 inches (76 mm), and no blister or pimple shall project more than 1/8 inch (3 mm) above the surface of the pipe.

   Pipe of nominal sizes over 18 inches shall have no blister exceeding 2 in./ft. (166 mm/m) of internal diameter, and no blister or pimple shall project above the surface of the pipe more than 1/8 in./ft. (10 mm/m) of internal diameter.

   Pipe shall have no broken blisters.

3. When the spigot or socket of the pipe varies from a true circle more than three percent of its nominal diameter.

4. When a pipe or fitting, designated to be straight, exhibits a deviation from a straight line of more than 1/16 inch per linear foot. The deviation shall be measured from a straight-edge on the concave side of the pipe.

5. Any piece broken from the socket or spigot end of the pipe or fitting.

6. When the dimensions exceed the permissible variations shown in the table.

7. Tramp clay, grog, or other foreign matter that has fused permanently to the exterior or interior surface of the pipe or fitting.

g) Caps and Branches. Caps shall be furnished with all branch pipes and stubs that are to be left unconnected. Caps shall be polyethylene, polypropylene, polyurethane, A.B.S., PVC, ozone resistant synthetic rubber, clay discs or of other material approved by the Engineer.

Branches shall be furnished with the spurs of the sizes specified, securely and completely fastened by the manufacturer to the barrel of the pipe. This shall be accomplished by fusion during vitrification in the case of glazed vitrified clay pipe of any size. In the case of unglazed vitrified clay pipe, fusion during vitrification or fastening material such as epoxy resin or other approved material of strength equal to the strength of the material of the pipe may be used. Y-branches shall have their axes approximately 45 degrees (unless otherwise specified on the plan) from the longitudinal axis of the pipe measured from the socket end. All branches shall terminate in sockets and the barrel of the branch shall be of sufficient length to permit making a proper joint when the connecting pipe is inserted in the branch socket.

h) Hydrostatic Pressure and Loading Test.

1. General. At the discretion of the Engineer, before being used in any work under these specifications, pipe shall be subjected to and shall meet the requirements of the hydrostatic pressure test and the loading test. These tests shall be made by an approved testing laboratory. All tests shall be conducted in conformance to the requirements of ASTM C 301.

4. Hydrostatic Test. The hydrostatic pressure test shall be applied to all pipes selected for testing in each size and class of pipe. The ends of the pipe shall be sealed by wood, metal, or rubber bulkheads in such a manner that there shall be no leakage in these areas at test pressures. When subjected to an internal hydrostatic pressure of 10 pounds per square inch for the times shown in the following table, the accumulated moisture on the exterior surface of the pipe shall not run down the sides in such quantity that it will exceed 10 milliliters. Each 10 square inches of moisture appearing on the exterior surface shall be considered to be one milliliter of runoff.

Thickness of Barrel (Inches)	Testing Time (Minutes)
Up to and including 1	7
Over 1, and including 1-1/2	9
Over 1-1/2, including 2	12
Over 2, and including 2-1/2	15
Over 2-1/2, and including 3	18
Over 3	21

5. Loading Tests. The loading test shall be a Three-Edge Bearing test, which shall conform to and meet the requirements under ASTM C 301 and shall be applied to all the specimens selected for testing.

Pipe shall withstand the following loads, each for its respective size and class and for the type of test imposed.

EXTRA STRENGTH PIPE - MINIMUM TEST LOADS

(Pounds per Linear Foot)

Size Inches	3-Edge Bearing Test Strength
6	2000
8	2200
10	2400
12	2600
15	2900
18	3300
21	3850
24	4400
27	4700
30	5000
33	5500
36	6000
39	6600
42	7000

B. Vitrified Clay Sewer Pipe Joints. Mechanical compression joints of the types listed in the following paragraphs shall be used. Poured or formed joints utilizing cement, sulfur compounds, bituminous materials, or other materials forming a rigid joint are not permitted except when approved by the Engineer. The use of Atlas JC-60 Sewer Joint Compound or equal is acceptable for joining the 6"x4" extra heavy cast iron reducer to a 6-inch vitrified clay sewer pipe to receive a 4-inch house sewer.

1) Type "A" joints (Polyvinyl Chloride). Type "A" joints shall contain two sealing components, one bonded to the outside of the spigot and the other bonded to the inside of the bell. Sealing components shall be plasticized polyvinyl chloride compound, shall be bonded to pipes and fittings at the pipe factory, and shall be cured to a uniform hardness and compressibility. The sealing components shall be shaped, sized, bonded, and cured in such a manner as to form a tight, dense, and homogeneous compression coupling when the joint is assembled. Any imperfection in the sealing components shall be cause for rejection.

   Type "A" joints shall conform in all respects to ASTM C 425, Type I.

2) Type "B" joints (Polyurethane). Type "B" joints shall contain two sealing components, one bonded to the outside of the spigot and the other bonded to the inside of the bell. Sealing components shall be polyurethane elastomer, shall be bonded to pipes and fittings at the pipe factory and shall be cured to a uniform hardness and compressibility. The sealing components shall be shaped, sized, bonded, and cured in such a manner as to form a tight, dense, and homogeneous compression coupling when the joint is assembled. Any imperfection in the sealing components shall be cause for rejection.

   Type "B" joints shall conform in all respects to ASTM C 425, Type I.

3) Compression couplings for plain-end pipe. Couplings for plain-end pipes shall consist of a rubber sleeve coupling with stainless steel shear ring attached to the ends of plain-end pipe and clamped with stainless steel compression bands. Stainless steel shear rings shall be AISI 304 or 316. Compression couplings for plain-end pipe shall comply in every respect with the requirements in ASTM C 425.

18.3 CONSTRUCTION DETAILS

A. Rock Cradle for Pipes. Unless otherwise specified in the special provisions, a rock cradle shall be provided. The rock cradle thickness shall be as shown on the standard details unless otherwise shown on the construction plans. Material shall be composed of crushed rock as specified in Section 15 of these specifications. Crushed rock gradation shall be No. 67.

B. Installation of Sewer Pipe.

1) Pipe shall be laid to the line and grade shown on the plans and shall commence at the lowest point, with the spigots facing in the direction of flow.

2) Pipe shall be fitted together and matched so that when laid, it will form a sewer with a smooth and uniform invert.

3) Before work is left for the night, exposed ends of sewers shall be closed with approved temporary covers to prevent earth and debris from entering the pipe.

4) Pipes which become submerged in water during the night shall be carefully checked each morning and pipes found "floated" from their proper position shall be re-laid by the Contractor at his own expense.

5) Prior to final inspection, all lines shall be visually inspected and all mud and/or any other material within the line shall be removed.

C. Compression Joint. The lubricant or adhesive furnished by the pipe manufacturer shall be wiped or brushed on the contact surfaces of the joint. The spigot shall be pushed into the bell until the joint snaps into position.

D. Testing Gravity Sewers for Leakage.

1) General. All sewers and sewer manholes shall be tested for leakage. All leakage tests shall be completed and approved prior to placing of permanent resurfacing. Where the difference in elevation between inverts of adjacent structures (manholes) exceeds 10 feet, no exfiltration leakage test will be required.

2) Exfiltration Test.

a) The maximum amount of leakage in any whole, continuous portion of sewer under test shall not exceed the rate of 200 gallons per day per inch of diameter of pipe per mile of pipe.

b) Each section of sewer shall be tested between successive manholes by closing the lower end of the sewer to be tested and the inlet sewer of the upper manhole with stoppers. The pipe and manhole shall be filled with water to a point at least 4 feet above the invert of the sewer at the center of the manhole; or in any case, not less than 1 foot above the high end of the highest house connection on the line being tested.

c) Should the Contractor desire to delay the building of the manhole, he may, at his option, use a barrel in the bank to provide the necessary pressure required for testing.

d) Water present in the trench shall be kept below the level of the subgrade of the sewer during the test and during any patching or repairs necessitated by the test.

3) If excessive ground water is encountered in the construction of a section of the sewer, the exfiltration test for leakage shall not be used. The end of the sewer at the upper structure shall be closed sufficiently to prevent the entrance of water and pumping of ground water shall be discontinued for at least 3 days, after which the section shall be tested for infiltration. The maximum amount of infiltration shall not exceed 200 gallons per day per inch of inside diameter per mile of pipe. Infiltration in excess of this amount shall be reduced to a quantity within the specified amount before the sewer will be accepted. In any case, the Contractor shall stop any individual leaks that may be observed.

4) Low Pressure Air Test.

a) Clean pipe to be tested by propelling snug fitting inflated rubber ball through the pipe with water.

b) Plug all pipe outlets with suitable test plugs. Brace each plug securely.

c) If the pipe to be tested is submerged in ground water, insert a pipe probe by boring or jetting, into the backfill material adjacent to the center of the pipe, and determine the pressure in the probe when air passes slowly through it. This is the back pressure due to ground water submergence over the end of the probe. All gauge pressures in the test should be increased by this amount.

d) Add air slowly to the portion of the pipe installation under test until the internal air pressure is raised to 4.0 psig.

e) After an internal pressure of 4.0 psig is obtained, allow at least two minutes for air temperature to stabilize, adding only the amount of air required to maintain pressure.

f) When pressure decreases to 3.5 psig, start stopwatch. Determine the time in seconds that is required for the internal air pressure to reach 2.5 psig. Minimum permissible pressure holding times for runs of single pipe diameter and for systems of 4", 6" or 8" laterals in combination with trunk lines are indicated in the following tables in seconds.

g) Safety. The air test may be dangerous if, because of ignorance or carelessness, a line is improperly prepared. It is extremely important that the various plugs be installed and braced in such a way as to prevent blowouts. Inasmuch as a force of 250 lbs. is exerted on an 8" plug by an internal pipe pressure of 5 psi, it should be realized that sudden expulsion of a poorly installed plug or of a plug that is partially deflated before the pipe pressure is released can be dangerous.

As a safety precaution, pressurizing equipment should include a regulator set at perhaps 10 psi to avoid over-pressurizing and damaging an otherwise acceptable line. No one shall be allowed in the manholes during testing.

5) If the leakage, as shown by the test, exceeds the allowable amount, the Contractor shall make the necessary corrections at his expense to reduce the exfiltration to within permissible limits. The Contractor shall repair all visible leaks, regardless of the limits of the leakage tests.

6) No backfilling shall be done between any adjacent manholes and no concrete cradle or jackets shall be placed until the pipe between such adjacent manholes shall have passed the leakage test, unless approved by the Engineer in writing.

7) The Contractor shall, at his expense, furnish all water, materials and labor for making the required test. All tests shall be made in the presence of the Engineer.

8) Payment for testing of gravity sewers for leakage shall be incidental to all the bid items in the bid proposal.

E. Wyes and Bends. Wyes and bends shall be installed where shown on the plans or as ordered by the Engineer.

F. House Laterals. House laterals shall end with a 6"x4" reducer, made of rubber ("Band-Seal" type or equal), and a vitrified clay cap. A 2"x2" redwood stake or 1-1/2" diameter PVC pipe shall be set at the end of the house connection reducer as shown on the Standard Details.

G. Chimneys. Chimneys shall be constructed where called for on the drawings or as ordered by the Engineer. See the Standard Details for the chimney details.

18.4 MEASUREMENT

A. Sewer Mains. The lengths of sewers measured for payment shall be the actual number of linear feet of pipe of the several sizes, installed in place, as determined by horizontal measurement. Where the grades exceed 10 percent, the actual length of pipe installed will be measured. However, at drop manholes, measurement for sewer mains shall be made to the outside face of the drop as shown in the Standard Details.

B. Sewer Laterals. Laterals shall be measured for payment in linear feet from the end of the reducer to the center line of the main less one-half the specified trench width for sewer main at that point.

C. Fittings. Wyes, bends and reducers with caps measured for payment shall be the actual number installed as ordered and accepted.

AIR TEST TABLES

MINIMUM HOLDING TIME IN SECONDS REQUIRED FOR PRESSURE TO DROP FROM 3-1/2 TO 2-1/2 PSIG

LENGTH OF LINE IN FEET	PIPE DIAMETER 4"	6"	8"	10"	12"	15"	18"	21"	24"	27"	30"	33"	36"	39"
25	4	10	18	28	40	62	89	121	158	200	248	299	356	418
50	9	20	35	55	79	124	178	243	317	401	495	599	713	837
75	13	30	53	83	119	186	267	364	475	601	743	898	1020	1105
100	18	40	70	110	158	248	356	485	634	765	851	935		
125	22	50	88	138	198	309	446	595	680					
150	26	59	106	165	238	371	510							
175	31	69	123	193	277	425								
200	35	79	141	220	317									
225	40	89	158	248	340									
250	44	99	176	275										
275	48	109	194	283										
300	53	119	211											
350	62	139	227											
400	70	158												
450	79	170												
500	88													
550	97													
600	106													
650	113	170	227	283	340	425	510	595	680	765	851	935	1020	1105

NOTE: TO BE USED WHEN TESTING ONE DIAMETER ONLY

D. Markers. Redwood or 1-1/2" diameter PVC pipe markers measured for payment shall be the actual number installed as ordered and accepted.

E. Chimneys. Chimneys shall be measured for payment in linear feet from the crown of sewer to the top of the uppermost chimney wye or to the top of the double wye.

18.5 PAYMENT

A. Mains and Laterals. Payment for vitrified clay sewer pipe as measured above shall be made at the respective unit prices bid per linear foot of the various sizes and shall be full compensation for all sewer pipe in place complete.

B. Fittings. Unless specified otherwise in the special provisions and/or proposal, payment for wyes, bends, and reducers with caps, as measured above shall be made at the respective unit price bid, which price shall be for the furnishing and delivering only. The installation and all other necessary labor, material and equipment shall be included in the price for pipe laying.

C. Markers. Unless specified otherwise in the special provisions and/or proposal, payment for redwood markers as measured shall be made at the unit price bid and shall be full compensation for each marker in place complete.

D. Chimneys. Payment for chimneys as measured above shall be made at the unit price bid per linear foot and shall be full compensation for the work in place complete.

SECTION 19 - REINFORCED CONCRETE SEWER PIPE AND APPURTENANCES

19.1 DESCRIPTION

This work shall consist of furnishing and laying reinforced concrete sewer pipe and appurtenances in accordance with these specifications, the special provisions, and as directed by the Engineer, to the lines and grades shown on the plans.

19.2 MATERIALS

A. Reinforced Concrete Sewer Pipe

1) General.

a) Pipe shall conform to the current requirements of ASTM Designation C76, except as modified and supplemented below. Design requirements and D-loads shall be as shown on the construction plans.

b) Pipes shall be furnished in nominal lengths of 8 feet or 12 feet except where other lengths are required by the Engineer to meet special conditions. All pipes entering or leaving manholes or structures shall have a maximum length of 24 inches.

c) Concrete shall be Class "AA-S" as specified under Section 39, "Portland Cement Concrete." Maximum size of coarse aggregate shall not be more than one-half of the wall thickness nor more than one-half the theoretical clear distance between adjacent coils of circular steel reinforcement.

d) Minimum concrete cover over circular or elliptical reinforcement shall be nominal 1".

e) Forms for molding the walls of the pipe shall be circular throughout their full length and sufficiently rigid to prevent distortion during subsequent operations. Forms may be of seamless or jointed construction designed so that they may be removed without damage to the surface of the pipe. Abutting edges shall be sufficiently tight to prevent leakage.

Pipe ends shall be formed by rigid rings which mold the pipe within the tolerances required. Forms may be wetted, oiled or waxed to prevent bonding of the concrete to the form and to assist in the formation of smooth surfaces.

f) Pipes may be either cast vertically or centrifugally.

1) Vertically cast pipes shall be cast in vertical steel or metallic forms so constructed that the inner and outer forms will be held in a circular and concentric position. The concrete shall be compacted with the aid of high frequency external vibrations and shall be continuously vibrated during placing of each batch. The concrete shall be placed in such a manner that the consolidated mixture is dense and interior surface even, smooth and hard.

2) Centrifugally cast pipe shall be spun in a mold and during the spinning operation, compaction and distribution of concrete shall be facilitated by the application of high frequency vibration at several points along the mold. The pipe shall be centrifugally cast in one operation without cement mortar lining.

Concrete shall be placed in the mold in a continuous and uniform rate. The pipe form shall be revolved at speeds that will insure thorough compaction of the concrete. A thin layer of mortar shall be brought up to form an even, smooth, hard finish on the interior surface of the pipe.

g) Pipe shall be cured by steam, water or a combination of steam and water unless otherwise specifically permitted. The curing shall be continued for a sufficient length of time until the specified 28-day strength of the concrete is obtained. Adequate space and facilities shall be provided for proper curing.

1. For the centrifugal pipe, after spinning, the mold containing the pipe shall be suitably enclosed and subject to the action of saturated steam. Forms shall not be removed until the pipe has been steam cured for at least 6 hours or water cured for 32 hours. Thereafter, the curing shall be continued in any manner until a companionate test cylinder reaches the design strength.

2. For the vertically cast pipes, within three (3) hours after the forms have been filled with concrete, stream shall be applied to the space within the inner form. The forms shall not be removed until the pipe has been steam cured for at least six (6) hours. After removal of the forms, the pipe shall be suitably enclosed and again subjected to the action of saturated steam. The steam curing shall be continued until thirty-six (36) hours after completion of the casting, at which time the pipe may be tipped and stored in a horizontal position. After completion of the thirty-six (36) hour steam cure, the curing shall be continued in any manner until a companionate test cylinder reaches the design strength.

h) Longitudinal Steel. Each pipe shall have a minimum of six longitudinal bars. The required area of the longitudinal bars shall be computed as follows:

1. Each pipe shall have a minimum longitudinal steel reinforcement equivalent in area to 1/2-inch round bars spaced at 30 inches center to center measured along the circumference of the pipe; or

2. Nominal length pipe of 8 feet shall have a minimum of six 1/4-inch round bars or their equivalent steel area; or

3. Nominal length pipe of 12 feet shall have a minimum of six 3/8-inch round bars or their equivalent steel area.

The more stringent steel area requirement of the preceding shall govern. Longitudinal reinforcement shall be spaced approximately uniformly around the circumference.

i) The pipe bell and the spigot shall each contain circumferential and longitudinal reinforcement equal to that within the pipe barrel.

B. Joints

Joints shall be reinforced concrete bell and spigot design using round rubber gaskets for sealing. The concrete bell shall be enlarged and the spigot be of nominal wall thickness. Flush bell and spigot joints shall not be permitted for pipe sizes smaller than 60 inches in diameter.

The joint shall be so designed and fabricated that when the pipe is laid, it is self-centering and the gaskets do not support the weight of the pipe. When the joint is completed, the gaskets shall be enclosed on all four sides, and shall keep the joint tight under all normal conditions of service, including expansion, contraction and normal earth settlement.

The spigot surfaces of the pipe and the reinforced concrete bell shall be accurately formed to provide closely fitting joints. The tolerance between the theoretical diameters and actual diameters of the contact surfaces shall be such that the clearance shall not exceed 1/16 inch at any point. The inside surface of the reinforced concrete bell shall be ground if necessary.

The rubber gaskets shall be fully contained. The joints shall be designed and accurately located and formed on each pipe section so that when the joint is completed, the gasket is restrained on four sides and effects a water-tight seal.

The joint shall be sealed with a continuous ring gasket made of a special composition neoprene rubber of such size and cross section as to completely fill the recess provided for it.

The rubber compound shall contain not less than 50 percent by volume of neoprene and shall contain no Factice, reclaimed rubber or any deleterious substances. All rubber gaskets shall be extruded or molded and cured in such a manner that any cross section will be dense, homogeneous, and free from porosity, blisters, pitting, and other imperfections. The gaskets shall be extruded or molded with smooth surfaces to the specified diameter within a tolerance of plus or minus 1/64 of an inch.

The rubber compound shall meet the following physical requirements when tested in accordance with the applicable sections of Federal Test Standard No. 601 and appropriate ASTM Methods of Test as indicated.

1) Tensile strength, psi, min 2100

2) Elongation at rupture, percentage, min 425

3) Shore Durometer, Type A (ASTM D 2240) ..... 40 to 55

4) Compression Set, percentage of original deflection, max. Method B (constant deflection; 22 hours at 158°F) (ASTM D 395) 32

5) Accelerated aging in air (70 hours at 212°F) Tensile strength, percentage or original strength, min 85
Hardness change, percentage, max ..... +15

6) Water absorption, percent volume change, max 10

7) Ozone 6 ppm, 25 percent elongation 2 hours at 100°F max ..... No Cracking

The Contractor shall submit a certified copy of the laboratory test results for the gasket showing that the above requirements are complied with.

All rubber shall be stored in a cool, well ventilated place and shall not be exposed to the direct rays of the sun.

If required by the Engineer, the Contractor shall submit test results showing the physical properties of the materials used in the manufacture of the gaskets.

C. Precast Pipe Fittings and Non-Standard Lengths of Pipe.

1) Fittings shall be fabricated from specially cast concrete pipe sections. A minimum of twelve 5/8" longitudinal bars, or their equivalent, shall be provided in pipes cast for fittings. Longitudinal steel shall be lap welded to a minimum of 4 inches when spliced.

2) Bends shall be miter bends. The maximum angle of bevel shall be 22-1/2°. Unless otherwise shown on the drawings, the radius as measured to the centerline of the bend shall be four times the diameter of the pipe.

3) Fittings shall conform to all applicable portions of the pipe specifications.

4) Non-standard lengths of pipe fabricated by splicing two or more pieces of concrete pipe shall conform to all of the requirements for precast pipe fittings.

5) Non-standard lengths of pipe consisting of a single piece of pipe shall conform to the requirements of reinforced concrete pipe.

6) All stub outs shall be cast or saw cut from standard length of pipe.

19.3 DETAILS

A. Pipelaying

It shall be the Contractor's responsibility to maintain a stable trench bottom at all times during excavation, dewatering and pipelaying.

Pipelaying in the prepared trench shall commence from the lowest point with the spigot end of the pipe pointing in the direction of flow.

Pipe shall be laid to the line and grade shown on the drawings and shall form a continuous sewer with a smooth uniform invert. The use of concrete blocks and wood wedges to adjust the pipe to proper line and grade is prohibited. Pipe shall be uniformly supported for its entire length.

B. Jointing

The inside surface of the concrete bell and the concrete spigot end including the groove shall be thoroughly cleaned before the joint is made. The rubber gasket shall be lubricated before it is uniformly stretched and placed in the annular groove in the spigot. The inside bell surface shall be lubricated to a distance of 2 inches from the end of the pipe. The lubricant shall be a soft vegetable soap compound.

Before assembling the joint, metal or wooden spacers shall be placed against the shoulder of the bell to provide the proper space between abutting ends of the pipe.

The spigot shall be telescoped into the bell and brought home. No mortaring of joints, inside or outside, shall be permitted.

After the joint is assembled, a thin metal feeler gauge shall be inserted between the bell and the spigot and the position of the rubber gasket checked around the complete circumference of the pipe. If the gasket is not in the proper position, the pipe shall be withdrawn, the gasket checked to see that it is not cut or damaged, the pipe relaid, and the gasket position checked again.

Joint openings shall be within the tolerance recommended by the manufacturer and shall be consistent with the design of the pipe but shall not exceed 1/2 inch. Any pipe laid with joint opening exceeding this requirement shall be withdrawn, defects corrected and the pipe relaid.

C. Leakage Tests

All leakage tests shall be conducted as specified in sub-section D. Testing Gravity Sewers for Leakage, under section 18.3 CONSTRUCTION DETAILS of Section 18 - Vitrified Clay Sewer Pipe and Appurtenances.

D. Shop drawings

The Contractor shall submit shop drawings showing the details of the pipe and fittings, dimensions, cross sections, quantity and placement of reinforcing, joint details, and any other pertinent information. The Contractor shall also submit pipeline layout drawings.

E. Manufacturing

The Contractor shall inform the Engineer in writing, prior to manufacturing the pipe or fittings, of the manufacturing schedule to coordinate inspection.

SECTION 20 - CAST IRON AND DUCTILE IRON SEWER PIPE AND APPURTENANCES

20.1 DESCRIPTION

This work shall consist of furnishing and installing cast iron and ductile iron sewer pipe and appurtenances in accordance with these specifications to the lines and grades shown on the plans or furnished by the Engineer.

20.2 MATERIALS

A. Cast Iron and Ductile Iron Pipe. Cast iron and ductile iron pipe shall be made with bell and spigot or flanged ends. Bell and spigot pipe shall have the type of joint as specified, being caulked joint, slip or push on joint, or mechanical joint. Pipe shall be furnished in lengths not less than 16 feet nor more than 20 feet unless otherwise specified or approved by the Engineer.

Cast iron and ductile iron pipe shall be cast centrifugally in metal or sand-lined molds in compliance with Federal Specification WW-P421, and American National Standards Institute (ANSI) Specifications A 21.6, A 21.8 or A 21.51.

B. Cast Iron and Ductile Iron Fittings and Special Castings. Cast iron and ductile iron fittings shall comply with ANSI Specification A 21.10.

C. Joints.

1) Caulked Joints. Lead shall conform to Federal Specification QQ-L-156, Type I, Pig Lead, and shall be furnished in linked ingots or notched bar ingots consisting of three to six pounds each, linked together by small segments which can be easily severed, or in pigs weighing approximately 100 pounds each. All such ingots shall have the manufacturer's or trade name stamped thereon.

Asbestos rope shall be 3/4 inch in diameter, twisted pure-felted asbestos rope, Style 4200 manufactured by John's Manville, containing not less than 98 percent asbestos as determined and computed by ASTM D 299, and shall not contain any organic material other than one single cotton thread per strand and lubricant. No tarred oakum or jute shall be used in

yarning and caulking bell and spigot pipe and fitting joints.

2) Mechanical Joints shall be in accordance with all applicable provisions of ANSI A 21.11.

3) Slip or Push-On Joint shall be in accordance with all applicable provisions of ANSI A 21.11. The plain end of the pipe shall have a slight taper to ease its sliding-fit with the gasket when the joint is made up.

4) Flanged Joint. Flanges shall be faced and drilled in accordance with all provisions of ANSI B 16.1 Class 125.

Gaskets shall be "full face" 1/16 inch thick cloth-inserted rubber packing, Garlock No. 19, Crane No. 997, or approved equal.

All bolts and nuts shall be electro-plated (zinc or cadmium) or pickled and hot dip galvanized.

Where bolts and nuts are in contact with sewage or sludge, bolts and nuts shall be stainless steel or CORTEN alloy, or approved equal.

D. Interior Lining. All pipes, fittings and special castings except sleeves and plugs, shall be cement-mortar lined in accordance with ANSI A 21.4.

Pipes and fittings used for gravity sewers need not be cement-mortar lined.

E. Exterior Coating. If required by the special provisions, all pipes, fittings and special casting shall be coated on the exterior surfaces with a coal-tar base paint which will dry to a hard, tough, durable film which will effectively resist abrasion and peeling due to handling, transportation and installation of the pipe, and which will not crack or check due to loss or evaporation of its ingredients. The paint shall be processed with a permanently elastic and non-volatile flux, with no tendency to further shrinkage from loss or evaporation of such flux after the paint film has become thoroughly dry and hard.

Surfaces shall be clean and dry, free from all grease, oil, sand and other foreign materials when painted.

20.3 DETAILS

A. Installation of Pipes and Appurtenances. The Contractor shall thoroughly inspect and test all pipes and appurtenances prior to installation and shall assume full responsibility for the soundness of the pipes and appurtenances installed.

Any pipe or appurtenance which has been installed and proven defective shall be removed and replaced by the Contractor at no additional cost to the County.

After the trench bottom has been prepared, each pipe shall be laid so that the barrel of the pipe shall have a bearing along its entire laying length with the bell end properly set to grade and alignment. Laying of pipe shall commence at the lowest point, the spigots facing in the direction of flow. The spigot end of the pipe shall then be properly centered and firmly embedded against the bell end of the pipe previously laid with uniform clearance around the spigot. The pipe then shall be firmly held in place by proper blocking on each side of the pipe.

In order to insure proper embedding of the spigot end of the pipe against the bell, the Contractor shall, after the installation of not more than twelve pieces of pipe, "jack" the pipe "home". Whenever valves are installed, the valves and pipes shall be "jacked home".

All "jacking" of pipe shall be completed prior to yarning of the joints.

No pipe "springing" or "buckling" into place between installed pipe or special casting will be allowed.

All pipes and appurtenances thereto shall be thoroughly cleaned and scraped of all foreign matter and protuberances and shall be kept cleaned until the yarning and leading of the joint have been completed.

Whenever it is necessary to cut a pipe, the cut edges shall be trimmed even, free from all projections.

Whenever it is necessary to install sleeves in the respective pipelines, the space between the end of the adjoining pipes shall be contacted by welding in place with

metal of the same material as the pipe not less than four filler pieces, four inches wide, length variable, equally spaced around the circumference of the pipe.

All pipes, 16 inches and larger, shall be "machine cut".

No "cold cutting", use of cold chisel and hammer, shall be permitted for cutting 16 inches and larger pipe.

All other sizes of pipe may be cut by the "cold-cutting" method.

1) Lead Joint. After the pipes or appurtenances thereto have been properly centered and brought to proper grade, aligned and thoroughly embedded against each other, each joint or opening shall be thoroughly cleaned and tightly caulked in such a manner as to leave 2 inches for lead.

   Molten lead shall be run in sufficient quantity to fill each joint at one pouring and to provide for a completely filled joint after final caulking.

   After the lead has cooled, each lead joint shall be carefully caulked by experienced men. The caulking shall be done in such a manner that the joints will be tight when the lead is driven up flush with the face of the bell, and at the same time the bell shall not be overstressed.

   Lead gates shall be caulked in the same manner at the pipe joint and shall not be "cut-off".

2) Mechanical Joint. In making the joint, the bell and the spigot end of the pipe as well as the rubber gasket shall be thoroughly cleaned before assembly. The gland, followed by the gasket is placed over the spigot end of the pipe which is inserted into the bell. The small side of the gasket and the lip side of the gland shall face the bell. The gasket is then pushed into position so that it is evenly seated in the bell and the gland is moved against the face of the gasket.

Bolts are inserted with threaded ends on the gland side. Nuts are screwed on by hand and made hand-tight in pairs (180 degrees apart). Bolts are then alternately tightened (180 degrees apart) to the desired tension with an ordinary ratchet wrench, beginning at the bottom, then the top and so on. The normal ranges of bolt torques to be applied to standard cast iron bolts in the joint are shown in ANSI Specification A 21.11.

When the joint is properly assembled, the distance between the face of the bell and the face of the gland shall be uniform all around the pipe.

Before assembly, threaded ends of the bolts shall be dipped in fuel oil for lubrication.

After completion of the joint, bolts shall be given one coat of Inertol Standard or a high-grade asphaltum.

3) Slip or Push-On Joint. The gasket seat in the socket on the pipe and gasket should be wiped with a cloth. The gasket should be placed in the socket with the large round end entering first. It can then be sprung into the gasket seat so that the groove fits over the head in the seat.

A thin film of non-toxic lubricant, supplied by the manufacturer, should then be applied to the inside surface of the gasket that will come in contact with the pipe. In some cases, it might be desirable to apply a thin film of lubricant to the outside of the plain end of the pipe for about one inch back from the end.

The joint is made by exerting sufficient force on the entering pipe so that its plain end is moved past the gasket until it makes contact with the base of the socket.

When pipes are cut in the field, the outside of the cut end should be tapered back about 1/8 inch at an angle of about 30 degrees with the center line of the pipe with a coarse file or portable grinder.

4) Flanged Ends. All flanged pipes, fittings and valves shall be installed to the lines and grade shown on the drawings.

Face of flanges shall be true and free of projections and shall be cleaned of all rust and foreign matters.

Gaskets shall be "full face" carefully cut to fit flanges and bolt holes.

Flanges shall be brought up to true alignment and fit with uniform tension on all bolts. All bolt threads shall be coated with graphite compound.

B. Leakage Tests.

1) Force Mains. Pipes and appurtenances shall be subjected to a pressure test in the presence of the Engineer.

A separate test shall be made on each section of the pipeline with its appurtenances whenever any section of the work is installed in such manner as to permit its segregation as a unit. If valves are available at each end of the section, the test shall be made between valves. If valves are not available, the Contractor shall install the additional plug or cap, properly braced to withstand the required test pressure. When a section of the work is ready for testing, suitable test holes shall be tapped into the main one foot on each side of the gate valves, or as directed by the Engineer and connected by suitable piping to the test pump. Between the tap and pump, a stopcock shall be installed; and between the stopcock and tap, a pressure gauge, furnished by the Engineer, shall be installed.

The section of pipe to be tested shall be completely filled with water and care shall be taken to insure that no air pockets exist. The stopcock shall be opened, and the hydrostatic pressure raised to the required pressure.

All pipe and appurtenances shall be tested from 125 to 250 pounds per square inch test pressure as ordered by the Engineer.

The stopcock shall then be shut, and the gauge observed for 30 minutes. During this period, the pressure shall not drop more than ten pounds.

The Engineer may require tests to cover any section or a combination of sections and may require additional tests made at any time.

The Contractor shall furnish and install all equipment and material necessary for tests and shall, after all visible leaks have been stopped and the test completed, install brass plugs or corporation cocks in the holes made for testing purposes.

2) Gravity Line. Gravity sewer lines shall be tested as specified in Section 18, "Vitrified Clay Sewer Pipe and Appurtenances".

20.4 PAYMENT

Payment for the furnishing and installation of pipes and appurtenances shall include full compensation for all materials, labor and equipment for handling, hauling, placing, unloading, cutting, jointing, testing, painting, lead, glands, bolts, nuts and all other incidental material and work required to install in place complete. Unless otherwise mentioned, payment shall be as follows:

A. Pipes. Payment for the furnishing and installation of the various sizes of pipes including all necessary joint accessories shall be made at the unit price bid per linear foot based on the actual linear feet of pipes installed and tested in the trenches or as approved by the Engineer.

B. Fittings. Payment for cast iron fittings shall be made on either the actual number or the total weight of the various sizes and types of fittings furnished and installed based on the unit price bid, unless otherwise specified. The total weights of the various types and sizes of fittings shall be the sum of the weights of fittings furnished and installed based on the unit weight listed in the "Handbook of Cast Iron Pipes", edited by the Cast Iron Pipe Research Association.

Payment for all necessary joint accessories shall not be made directly but shall be included in the bid items.

C. Leakage Test. Payment for pipe leakage test shall not be made directly but shall be included in the unit price bid for the various sizes of pipes.

SECTION 21 - PVC SEWER PIPE AND APPURTENANCES

21.1 DESCRIPTION

This work shall consist of furnishing and laying PVC (poly-vinyl chloride) sewer pipe and appurtenances in accordance with these specifications to the lines and grades shown on the plans or as ordered by the Engineer.

21.2 MATERIALS

A. General. PVC gravity sewer pipe and fittings shall conform to the requirements of ASTM D 3034. Minimum wall thicknesses shall be as determined by Standard Dimension Ratio (SDR) 35.

B. Cell Classification. Pipe shall be made of PVC plastic having a cell classification of 12454-B, 13364-A, or 13364-B as defined in ASTM D 1784. The fittings shall be made of PVC plastic having a cell classification of 12454-B, 12454-C, or 13343-C. PVC compounds of other cell classifications shall be pre-qualified by the manufacturer.

C. Selection of Test Pipe. When testing is required by the Engineer, one test pipe shall be selected at random by the Engineer from each 1200 linear feet or fraction thereof of each size of pipe delivered to the job site but no less than one test pipe per lot. A lot shall be defined as pipe having the same identification marking. The length of specimen for each selected pipe shall be a minimum of 8 feet.

D. Acceptance. The basis for acceptance shall be the inspection of pipe, fittings and couplings, the tests specified herein, and compliance with the specifications. At the time of manufacture, each lot of pipe and fittings shall be inspected for defects and tested for impact, stiffness and flattening in accordance with ASTM D3034. The Engineer may require certification by the manufacturer that the test results comply with specification requirements. When the pipe is delivered to the job site, the Engineer may require the Contractor to provide additional testing to insure the quality of the pipe at no expense to the County. Pipe which is not installed within 120 days of the latest factory test shall not be used without prior approval of the Engineer.

E. Joints. Pipe joints shall be bell and spigot type with an elastomeric gasket. The gasketed joints shall be manufactured with a socket configuration which will

preclude improper installation of the gasket and will insure the gasket remains in place during the joining operation. All pipe shall have a home mark on the spigot end to indicate proper penetration when the joint is made.

F. Shape. Pipe ends shall be square with the longitudinal axis; and sockets shall be true, circular and concentric with the barrel of the pipe.

The ends of the pipe shall be so formed that when the pipes are laid together and the joints made, they shall constitute a continuous and uniform line of pipe and shall have a smooth and regular interior surface.

G. Length. The length of straight pipes shall be not less than 20 feet, except that for special purposes, shorter lengths may be furnished.

H. Imperfections. All pipes and fittings must be free from injurious cracks, checks, blisters, broken extremities, or other imperfections. The following imperfections in a pipe or fitting will be considered injurious and cause for rejection.

1) Any crack in the barrel or ball of the pipe, extending through the entire thickness, regardless of the length of such crack. Any crack which extends through 1/5 or more of the barrel or bell thickness and is over 3 inches long. Any crack which is more than 1/32 inch wide at its widest point.

2) Lumps, blisters, pits, or flakes on the interior surface.

3) When the spigot or bell of the pipe varies from a true circle more than three percent of its nominal diameter.

4) When a pipe or fitting, designated to be straight, exhibits a deviation from a straight line of more than 1/16 inch per linear foot. The deviation shall be measured from a straightedge on the concave side of the pipe.

5) Any piece broken from the socket or bell end of the pipe or fitting.

6) When the dimensions exceed the permissible variations shown in the table below.

7) Foreign matter that has fused permanently to the exterior or interior surface of the pipe or fitting.

I. Identification Marks. All pipe fittings and couplings shall be clearly marked at an interval not to exceed 5 feet as follows:

1) Nominal pipe diameter.

2) PVC cell classification.

3) Company, plant, shift, ASTM, SDR, and date designations.

4) Service designation and legend.

The SDR designation is not required for fittings and couplings.

J. Dimensions and Tolerances:

Table 1 - Pipe Dimension (inches)

Nominal Size	Average O.D.	Tolerance On Average	Minimum Wall Thickness	Approx. Wt./20' Length (lbs.)
6	6.275	±0.011	0.180	49.4
8	8.400	±0.012	0.240	88.5
10	10.500	±0.015	0.300	138.6
12	12.500	±0.018	0.360	198.1

K. Pipe Flattening. There shall be no evidence of splitting, cracking or breaking when the pipe is tested as follows:

Flatten specimen of pipe, equal in length to the nominal outside but not less than six (6) inches long, between parallel plates in a suitable press until the distance between the plates is forty percent (40%) of the outside diameter of the pipe. The rate of loading shall be uniform and such that the compression is completed within two to five minutes. Test shall be conducted at standard laboratory atmosphere of 73.4° ± 3.6°F and 50 ± 5 percent relative humidity.

L. Impact Resistance. Pipe (6" long section) shall be subjected to impact from a free falling tup (20 lb. Tup A) in accordance with ASTM D 2444. No shattering or splitting shall be evident when the following energy is impacted:

Nominal Size	Ft. - Lb. of Energy
6"	210
8"	210
10"	220
12"	220

Test shall be conducted at standard laboratory atmosphere of 73.4¼ ± 3.6¼F and 50 ± 5 percent relative humidity.

M. Pipe Stiffness. Minimum pipe stiffness (F/AY) at 5% deflection shall be 46 for all sizes when calculated in accordance with ASTM D 2412. Test shall be conducted at standard laboratory atmosphere of 73.4¼ ± 3.6¼F and 50 ± 5 percent relative humidity.

N. Joint Tightness. Two (2) section of pipe shall be joined together in accordance with the manufacturer's recommendations. Upon subjection to an internal hydrostatic pressure of 25 psi for one (1) hour, the joint shall show no evidence of leakage. Test shall be conducted at standard laboratory atmosphere of 73.4¼ ± 3.6¼F and 50 ± 5 percent relative humidity.

O. Acetone Immersion Test. After two (2) hours immersion in a sealed container of anhydrous (99.5% pure) acetone, a one-inch (1") long sample ring shall show no visible spalling or cracking when tested in accordance with ASTM D 2152.

P. Chemical Resistance. The PVC compound for cell classifications not specifically identified in item 4 above shall be prequalified by the pipe manufacturer by meeting the chemical resistance tests which follow. Compound samples and molded test specimens shall be prepared in accordance with ASTM D 543.

Tensile and Izod impact exposure specimens shall be immersed in the solutions specified in Table 2 for a period of 112 days. Test specimens shall be conditioned to constant weight at 110¼F (43.3¼C) before and after submersion. The solutions shall be kept at a temperature of 77¼F ± 5¼F (25¼C ± 3¼C). At 28-day intervals, selected specimens shall be removed, washed, surface dried and tested.

TABLE 2 - Test Solutions

Chemical Solution	Concentration (%)
Sulfuric acid	20*
Sodium hydroxide	5
Ammonium hydroxide	5*
Nitric acid	1*
Ferric chloride	1
Soap	0.1
Detergent (Linear alkyl benzly sulfonate or LAS)	0.1
Bacteriological	BOD not less than 700 ppm.

*Volumetric percentages of concentrated reagents of C.P. grade

Weight change specimens shall be 2 inches in diameter and may be molded discs or discs cut from the pipe wall. Specimens shall be conditioned for seven days at 43° ± 2°C, cooled in a desiccator for three hours at 23° ± 2°C, weighed, and then immersed in the solutions. At 4-week intervals, selected specimens shall be removed, washed, surface dried and weighed. These same specimens shall be reconditioned for seven days at 43° + 2°C, cooled in a desiccator for the three hours at 23° ± 2°C and again weighed.

Initial and post exposure specimens shall meet the following requirements when tested at 23° ± 2°C:

Property	ASTM Test Method	Cell Class Minimum Values		
		12454	13343	13364
Tensile Strength (Yield), psi	D 638	7000	6000	6000
Impact Strength, ft-lbs/in.	D 256 Method A	0.65	1.5	1.5
Weight Change, %	D 543	1.5	1.5	1.5

If any specimen fails to meet the requirements at any time during the 112-day exposure period, the material will be subject to rejection.

Q. Certification. A copy of the manufacturer's test report or a statement by the seller, accompanied by a copy of the test results, that the material has been sampled, tested and inspected in accordance with the specifications shall be submitted to the Engineer. Each certification so furnished shall be signed by an authorized agent of the seller or manufacturer.

21.3 CONSTRUCTION

A. Trench Excavation. Trenches for PVC sewer pipe shall be excavated and prepared in accordance with the requirements of Section 11, "Trench Excavation and Backfill", and ASTM D 2321 except as modified herein.

1) Overexcavation. The maximum allowable trench width shall be equal to the outside diameter of the pipe plus 18 inches for pipe up to 12 inches (I.D.). If the trench excavation exceeds the computed maximum allowable trench width whether by excavation, cave-in, or by ground movement, the Contractor shall provide at his own expense additional bedding, another type of bedding, and/or a higher strength of pipe designated by the Engineer. Where shoring is required, the allowable width of the trench shall be increased only by the thickness of the sheathing.

B. Trench Backfill. Trench shall be properly backfilled and compacted as shown on the plans and as specified under Section 11, "Trench Excavation and Backfill", except as follows:

1) Pipe Bedding. Where unsuitable material is encountered at the subgrade and additional excavation is required, the void created by the additional excavation shall be filled and compacted with bedding material specified on the plans or special provisions. Where concrete is specified to bed the pipe, the top of the concrete shall be considered as the top of the bedding.

Bedding material shall consist of one of the following:

1) Beach sand.

2) No. 8 or No. 67 aggregate conforming to the gradation requirements of ASTM C33.

3) 3/8" filter aggregate.

a) Classes A and C bedding shall be in accordance with the Standard Details unless otherwise specified.

b) Class B bedding shall be 12-inches above the top of the pipes and shall be in accordance with the Standard Details unless otherwise specified.

4) Native free-draining granular material having a minimum sand equivalent of 30 or having a coefficient of permeability greater than 0.001 centimeter per second.

5) Other material approved by the Engineer.

Bedding material shall first be placed so that the pipe is supported for the full length of the barrel with full bearing on the bottom segment of the pipe equal to a minimum of 0.4 times the outside diameter of the barrel. If the pipe is to be laid in a rock excavation, the rock shall be removed such that no ribs, rocks, or solid projections will be within 6 inches of the sewer pipe horizontally; and there shall be at least 4 inches of bedding below the pipe.

Compaction of the bedding from the bottom of the pipe to 12 inches above the pipe barrel by jetting will be permitted provided that the foundation material will not soften or be otherwise damaged by the applied water. Flooding or ponding methods of achieving the required relative density will not be permitted. The size and length of jet pipe, quantities and pressure of water, and jetting locations shall be sufficient to compact the bedding to 87% minimum relative density. Compaction of the backfill from 12 inches above the pipe barrel to the finish surface shall conform to the requirements of Section 11.4

C. Installation of Sewer Pipe. Laying of pipe shall commence at the lowest point, the bell end facing upstream. Pipe shall be fitted together and matched so that when laid in the work, it will form a sewer with a uniform and smooth invert. The interior of the sewer pipe shall be cleared of all dirt, joint compound, and superfluous or foreign material as the work progresses. Exposed ends of sewers shall be closed with approved temporary covers to prevent earth and debris from entering the pipe before leaving the work for the night. Should water, mud and/or any other material enter any joint after the pipe has been laid in the trench, the joints thus affected shall be opened up either by removal of the pipes or by pulling the joints apart, and the joint thoroughly cleaned and replaced. Pipes which become submerged in water during the night shall be carefully checked each morning, and pipes found "floated" from their proper positions shall be relaid by the Contractor at his own expense.

Compression joints shall be wiped clean and thoroughly lubricated with lubricant provided by the manufacturer and used as directed, before the spigot end of the pipe is inserted into the bell end.

Because of the nature of plastic pipe and fittings, the Contractor is cautioned to exercise care in handling, loading, unloading, and storing to avoid damage. The pipe and fittings shall be stored under cover before using and shall be transported in a vehicle with a bed long enough to allow the length of pipe to lay flat. Defective pipe will not be accepted. All plastic pipes shall be covered with minimum of 3" of approved backfill material within 24 hours after being placed in the trench.

Center load pipe with sufficient backfill to prevent arching and whipping under pressure. Joints shall be left exposed for inspection by the Engineer during pressure test.

The Contractor shall arrange with the pipe manufacturer or his authorized representative for the service of a qualified pipe instructor, who shall be on hand at the start of installation to instruct in the proper assembly and installation of the pipe.

D. Leakage Test for Sewers. All PVC sewers shall be tested for leakage by either the air test method or the water test method. Testing of sewers shall be considered as incidental to the various sizes of pipes called for in the proposal.

1) Air Test. When an air test is used in lieu of exfiltration test to check for leakage in the sewer pipe, the Engineer shall give explicit instructions to be followed in carrying out the test. The minimum time requirements for air testing for the 0.5 psig pressure drop allowed under the test for 3.5 psig to 3.0 psig shall not be less than that shown in the following table, from manhole to manhole:

Pipe Size Inches	Time Minutes
6	4
8	6
10	9
12	13

2) Exfiltration Test. Each section of sewer pipe shall be tested between successive manholes by closing the lower end of the sewer to be tested with a suitable plug and then filling the pipe and upper manhole with water to an elevation that will create an average internal pressure of 5 psig within the section of pipe to be tested.

Water in the trench shall be kept below the level of the subgrade of the sewer during the test and during any patching or repairs necessitated by the tests.

The maximum amount of leakage in any whole, continuous portion of sewer under test shall not exceed the rate of 100 gallons per inch of diameter of pipe per mile of sewer in 24 hours. The sewer shall remain under test for two hours after all visible leaks have been repaired.

If the leakage, as shown by the test, exceeds the allowable amount, the Contractor shall make the necessary corrections at his expense to reduce the exfiltration to within the permissible limits. The Contractor shall repair all visible leaks, regardless of the leakage test.

No backfilling shall be done between any two adjacent manholes until the pipe between such adjacent manholes shall have passed the leakage test, unless otherwise approved by the Engineer.

3) Infiltration Test. If excessive ground water is encountered in the construction of a section of the sewer, the exfiltration test for leakage shall not be used. The end of the sewer at the upper structure shall be closed sufficiently to prevent the entrance of water and pumping of ground water shall be discontinued for at least 3 days, after which the section shall be tested for infiltration. The maximum amount of infiltration shall not exceed 100 gallons per day per inch of inside diameter per mile of pipe. Infiltration in excess of this amount shall be reduced to a

quantity within the specified amount before the sewer will be accepted. In any case, the Contractor shall stop any individual leaks that may be observed.

E. Mandrel Test for Deflection. A mandrel test shall be performed no sooner than 30 days after the trench backfill is completed. In roadway areas, the 30-day period shall begin after installation and compaction of bedding, backfill and subbase to within 2 feet of the finished pavement grade. A rigid nine-sled (9) mandrel shall be pulled through the pipe by hand between adjacent manholes to measure for obstructions (deflections, joint offsets and lateral pipe intrusions). The mandrel shall have a cross section equivalent to a circle having a diameter at least 95 percent of the specified base inside diameter of the pipe. The minimum length of the circular portion of the mandrel shall be equal to the nominal diameter of the pipe. This test shall be performed by the Contractor in the presence of the Engineer. All material, equipment and labor required to perform the test shall be provided by the Contractor at no cost to the County. Any section of pipe that fails to permit passage of the mandrel will not be accepted until properly repaired or replaced and retested.

Nominal Pipe Size (Inches)	Base Inside Diameter (Inches)
6	5.92
8	7.92
10	9.90
12	11.78

F. Special watertight manhole couplings will be required for all manhole connections. Couplings may be cast directly into cast-in-place manholes or grouted into precast concrete manholes with non-shrink or expansion-type grout, as shown on the Standard Details.

G. For connections of PVC lateral sewers to mains of different materials, an approved saddle wye fitting constructed of the same material as the main line shall be installed. Connection to the saddle fitting shall be made by means of an approved flexible rubber coupling in accordance with the coupling manufacturer's installation recommendations or by other means acceptable to the Engineer.

H. House lateral shall end with 6"x4" reducer with cap. A 2"x2" redwood stake or 1-1/2" diameter PVC pipe shall be set at the end of the house connection reducer as shown on the Standard Details.

I. Chimneys shall be constructed where called for on the drawings or as ordered by the Engineer in accordance with the Standard Details.

21.4 MEASUREMENT AND PAYMENT

The lengths of various sizes of PVC sewer pipe to be paid for by the linear foot shall be the actual length of pipe placed according to the plans and these specifications. Pipe bends, wyes, and other fittings shall not be measured separately but shall be included in the measurement of the actual linear foot of pipe placed.

The contract unit price paid per linear foot for the various sizes of PVC sewer pipe shall be the full compensation for work required to install, complete in place, the PVC sewer pipe as shown on the plans and specified in these specifications. Trench excavation, trench backfill, concrete cradles and jackets, pavement restoration, fittings, sewer leakage tests and mandrel tests shall be considered as included in the contract unit price paid. The above contract price shall include full compensation for furnishing all labor, materials, tools, equipment and incidentals.

Chimneys shall be paid for as units from actual count of chimneys installed complete in place and accepted by the Engineer. The unit price paid for each chimney shall be full compensation for installing the chimney complete in place, as shown on the plans and as specified in these specifications. The unit price paid shall include all labor, materials, tools, equipment, and incidentals for doing the work, including excavation and backfilling.

SECTION 22 - CONNECTION TO EXISTING SEWER AND CONNECTING CESSPOOL IN DIRECT LINE OF SEWER (FOR CITY AND COUNTY OF HONOLULU ONLY)

22.1 DESCRIPTION

A. Connection to Existing Sewer

This work shall consist of breaking into existing manhole, cutting of existing sewer, and connecting to existing sewer as described herein.

B. Cesspool in Direct Line of Sewer

This item of work includes the backfill of cesspool in direct path of new sewer main and the connection of building sewers utilizing such cesspool.

22.2 CONSTRUCTION DETAIL

A. Connection to Existing Sewer

The Contractor shall arrange in advance with the Engineer the exact time for making connections to existing sewers.

1) Breaking into Existing Manhole. Connection into an existing sewer manhole shall be performed by the Contractor in the presence of the Engineer. A tight fitted false form shall be placed on the inside of the manhole when making the connections. The Contractor shall be responsible for the removal of any material falling inside the existing sewer and for all damages to the existing manhole and sewer due to his performance of the work. After the Contractor completes the connection, the City Division of Wastewater Management will perform the required channelizing within the existing manhole after receipt of a work order from the Engineer.

2) Sewer Enclosed Within a New Manhole. After the Contractor has constructed a new manhole over an existing sewer line, the City Division of Wastewater Management will perform the required cutting of the existing sewer line after receipt of a work order from the Engineer. No cutting shall be done until the Contractor has cleared the new manhole of all mud, debris, and standing water.

3) Saddle Wye. Where a new lateral is required from an existing sewer line, the Division of Wastewater Management will perform the saddle wye tap-in after receipt of a work order from the Engineer. The Contractor shall leave the pipe exposed and the trench dewatered below the invert of the pipe to permit the tap-in. The Contractor shall furnish the saddle wye.

B. Cesspool in Direct Line of Sewer

Upon completion of the sewer main to a point just downstream of the cesspool, the Contractor shall, unless otherwise shown on the construction plans, connect the building sewers utilizing such cesspool to the "Y" branches provided under the provisions of the sewer ordinances and the plumbing code of the City and County of Honolulu. Necessary permits for sewer connections must be obtained prior to starting the work.

After the building sewers have been connected at the "Y" branches, the Contractor shall arrange with the Division of Wastewater Management to have the cesspool pumped out and shall then install the new sewer through or under the cesspool as indicated on the drawings. When the new sewer main has been installed and accepted, he shall then backfill the cesspool and shall restore the ground surface to its original condition.

22.3 MEASUREMENT

A. Connection to Existing Sewer

The number of connections to be paid for shall be the actual number completed and accepted.

B. Cesspool in Direct Line of Sewer

The actual number of cesspools so treated and accepted shall constitute the number for which payment shall be made.

22.4 PAYMENT

A. Connection to Existing Sewer

Payment for breaking into existing manholes, cutting of existing sewers, and connections to existing sewer as measured above shall be made at the respective unit prices bid.

B. Cesspool in Direct Line of Sewer

Payment for work performed for cesspools in direct path of sewer lines will be made at the unit price bid each. This price shall be full compensation for connecting the building sewers to the sewer main "Y" branches, C.I. soil pipe and appurtenances, plumbing inspection fees, trench excavation, extra excavation over the normal trench excavation, filling the cesspool with excavated trench material, tamping of backfill, labor, equipment, tools and all necessary incidental work. The City Division of Wastewater Management will perform the required cesspool pumping at no cost to the Contractor.

SECTION 23 - SEWER MANHOLES

23.1 DESCRIPTION

This work shall consist of constructing sewer manholes in accordance with these Specifications and the details shown on the Plans. Manholes shall be brick or cast-in-place concrete.

Precast concrete manholes conforming to these Specifications may be approved for installation in lieu of brick manholes.

23.2 MATERIALS

A. Concrete. Concrete for precast reinforced concrete riser sections and tapered sections shall be Class "AAA-S" conforming to the requirements under Section 39, "Portland Cement Concrete." Concrete for cast-in-place concrete manhole walls shall be Class "A-S." All other concrete shall be Class "B-S."

B. Reinforcing Steel. Reinforcing steel shall conform to the requirements of Section 48, "Reinforcing Steel."

C. Bricks. Bricks shall be red brick conforming to requirements of ASTM C 32, Grade MA or locally manufactured lava, or cinder brick conforming to ASTM C 55.

D. Precast Reinforced Concrete Manhole Riser Sections and Tapered Sections. Precast reinforced concrete manhole riser sections and tapered sections shall conform to ASTM C 478. Concrete shall be Class "AAA-S." Tapered sections shall be truncated concentric cones. Minimum wall thickness shall be 5 inches. Eccentric cones and precast base sections may be allowed if authorized in writing by the Engineer.

E. Mortar. Mortar shall conform to the requirements of Section 39, "Portland Cement Concrete."

F. Frames and Covers. Cast iron frames and covers shall conform to the requirements for Gray Iron Casting, ASTM A 48, Class No. 30, and shall be cast to pattern with appropriate markings as shown on the Standard Details, free from blowholes and other imperfections. The bearing faces of the frames and covers shall be machined and fitted together to prevent rocking. All casting shall be thoroughly cleaned and painted with one coat of Inertol Standard or approved equal before leaving the shop.

G. Manhole Rungs.

1) Cast iron rungs shall be fabricated as detailed, conforming to ASTM A 48. Rungs shall be thoroughly cleaned and painted with one coat of Inertol Standard or approved equal before leaving the shop.

2) Stainless steel rungs, Type 302, 304 or 316, shall be fabricated as detailed.

3) Wrought iron rungs shall be fabricated as detailed, conforming to ASTM A 207 and shall be hot-dip galvanized after fabrication.

23.3 CONSTRUCTION DETAILS

A. Excavation and Backfill. Excavation and backfill shall be in accordance with Section 11, "Trench Excavation and Backfill."

B. Concrete Work. Concrete base of the manhole shall be constructed as detailed and allowed to set for at least 24 hours before additional work is constructed on this base.

Concrete walls shall then be constructed and cured in accordance with the provisions of Section 39, "Portland Cement Concrete."

C. Brick Work. Clean, sound bricks shall be dipped in water or otherwise thoroughly soaked before being laid in a full bed and joint of mortar. The joints on the inside of the brick manholes shall be neatly struck.

The inside of the brick manhole shall be bagged or plastered to present a smooth interior surface.

The outside of the brick portion of sewer manholes shall be plastered with 1-inch thickness of cement mortar.

Manholes which are 10 feet deep or less from the invert to the top of the frame may be made entirely of brick from the concrete base upwards, provided that the invert is not below the ground water table and the manhole is located in a relatively dry area.

D. Precast Concrete Manholes. Precast concrete manholes shall be constructed as shown on the drawings. The details of the riser and tapered sections and the joints shall be submitted for approval by the Engineer.

Precast concrete manholes may be used in locations below the ground water level after conducting leakage tests to demonstrate the watertightness of the manhole to the satisfaction of the Engineer and receiving his approval.

Precast concrete manholes may be used in sidehill locations after demonstrating the stability of the manhole at the particular location and receiving the approval of the Engineer.

E. Cleanup. Upon completion, manholes shall be thoroughly cleaned of all debris.

Cast iron frames, covers and steps shall be painted with one coat of coal tar paint.

23.4 MEASUREMENT

Sewer Manholes shall be measured for payment based either on the number of manhole structures constructed in place complete, with or without drop connections and manhole chimneys, or on the number of manhole bases, the linear feet of manhole walls, the number of manhole frames and covers, the linear feet of drop connections, and the linear feet of manhole chimneys, constructed in place complete.

A. Sewer Manhole. When shown in the proposal, sewer manholes, with or without drop connections and manhole chimneys, shall be measured for payment by depth in multiples of one foot as measured from the invert to the cover frame.

B. Bases. The number of manhole bases to be paid for shall be the actual number constructed and accepted.

C. Walls. Walls for all types of manholes shall be measured for payment in linear feet of wall constructed and accepted as measured from the top of the manhole base to the bottom of the manhole frame.

D. Frames and Covers. Manhole frames and covers measured for payment shall be the actual number installed and accepted.

E. Drop Connections. Drop connections shall be measured for payment in linear feet of drop installed and accepted as measured from invert to invert.

F. Manhole Chimneys. Manhole chimneys shall be measured for payment in linear feet as measured from the bottom face of the top slab of the open drop to the bottom of the chimney cast iron frame.

23.5 PAYMENT

Payment shall be made only for manholes fully completed, including excavation and backfill, and ready for use, at the unit price bid as measured above and shall be full compensation for furnishing the material, equipment and labor necessary to construct the work.

A. Sewer Manhole. Payment for sewer manholes as measured above shall be made at the unit price bid each and shall be full compensation for the manhole fully completed, including rungs, excavation and backfill, and ready for use.

B. Bases. Payment for manhole base as measured above shall be made at the unit price bid each and shall be full compensation for the work in place complete.

C. Walls. Payment for manhole walls as measured above shall be made at the unit price bid per linear foot and shall be full compensation for all walls in place complete, including rungs, excavation and backfill.

D. Frames and Covers. Payment for cast iron sewer manhole frames and covers as measured above shall be made at the unit price bid each and shall be full compensation for all work in place complete.

E. Drop Connections. Payment for drop connections as measured above shall be made at the unit price bid per linear foot and shall be full compensation for all work in place complete.

F. Manhole Chimneys. Payment for manhole chimney as measured above shall be made at the unit price bid per linear foot and shall be full compensation for all work in place complete.

SECTION 24 - DRAIN PIPES

24.1 DESCRIPTION

This work shall consist of furnishing, laying, and jointing pipes for storm drains and culverts to the established lines and grades, and including all connections and finishing.

24.2 MATERIALS

Drain pipe shall be of the type and class indicated on the plans.

A. Reinforced Concrete Pipe. Reinforced concrete pipe shall conform to ASTM C 76. Unless specified otherwise, Class III pipe shall be used.

B. Non-Reinforced Concrete Pipe. Non-reinforced concrete pipe shall conform to ASTM C 14.

C. Galvanized Corrugated Metal Pipe. Only when specified in the special provisions or indicated on the plans shall galvanized corrugated metal pipe be used for drain pipe and culvert construction. The corrugated metal pipe shall conform to AASHTO M 36 and the bituminous coating and lining shall conform to the provisions of AASHTO M 190.

D. Mortar and Grout for Concrete Pipe Joints. Mortar shall be composed of one part portland cement and two parts sand or fine aggregate by volume. Fine aggregate and sand shall conform to AASHTO M 45.

For pipes 54 inches or greater in diameter, the joints may be constructed with either mortar or with a 1:2:2 concrete mix using No. 4 commercial aggregate as coarse aggregate.

Grout shall be composed of one part portland cement and one and one-half parts sand by volume.

E. Rubber-Type Gasket for Concrete Pipe. Rubber gasketed joint for drain pipe shall conform to ASTM C 443.

When requested, the Contractor shall furnish a certified statement from the manufacturer of the test results and specifications of the rubber gasket furnished.

F. Pre-formed Plastic Sealing Compound for Reinforced Concrete Pipe. The sealing compound shall be produced from blends of refined hydrocarbon resins and plasticizing compounds reinforced with inert mineral filler, and shall contain no solvents, irritating fumes or obnoxious odors. The compound shall not depend on oxidizing, evaporating, or chemical action for its adhesive or cohesive strength. It shall be supplied in extruded tapered-form. The gasket shall be protected by a suitable removable two-piece wrapper. The two-piece wrapper shall be so designed that one-half may be removed longitudinally without disturbing the other half to facilitate application of the gasket.

1) Chemical Composition. The chemical composition of the sealing compound shall meet the following requirements.

Components	Min.	Max.
Bitumen (Hydrocarbon plastic content) % by weight	50	70
Ash-Inert Mineral Matter % by weight	30	50
Volatile Matter % by weight	-	2.0

2) Physical Properties. The physical properties of the sealing compound shall meet the following requirements.

Property	Analysis
Specific Gravity @ 77°F. (25°C.)	1.20 to 1.35
Ductility @ 77°F. (85°C.) Min.	5.0 cm
Softening Point @ 77°F. Min.	320°F.
Flash Point, C.O.C. Min.	600°F.
Fire Point, C.O.C. Min.	625°F.
Penetration 77°F. (25°C.) (150 gms.) 5 sec.	50 to 120

3) Tests

a) When tested for chemical composition and physical properties, the material shall be tested in accordance with the following methods:

Bitumen	ASTM D 4-52
Volatile Matter	ASTM D 6-64
Specific Gravity	ASTM D 71-52
Ductility	ASTM D 113-44
Softening Point	ASTM D 36-64T
Flash Point	ASTM D 92-57
Fire Point	ASTM D 92-57
Cone Penetration	ASTM D 217-60T

b) Adhesion and hydrostatic pressure. The sealing compound shall not leak at the joints for a period of 24 hours when tested in the following manner.

Adhesion and hydrostatic pressure test. Mount a vertical column using 2-1/2 sections of 3-foot 6-inch bell and spigot or tongue and groove pipe. Seal the 1/2 section to a concrete slab with the sealing compound and follow with the other two sections. Immediately fill the pipe sections with water to obtain an approximate 6 feet head pressure. Mount a horizontal column using 3 sections of 12-inch to 36-inch tongue and groove pipe and apply the sealing compound to seal the tongue and groove joints, the metal end plates, bolts and washers. Draw multiple pipe section together until a 1/8" to 3/16" squeeze-out is observed at all joints. Immediately fill pipes with water, slowly applying hydrostatic pressure in increments of 2 pounds per square inch every minute until 10 psi is reached.

c) Chemical Resistance. The sealing compound when immersed separately in a 5% solution of caustic potash, a 5% solution of hydrocloric acid, a 5% solution of sulfuric acid and a saturated hydrogen sulfide solution for 30 days at ambient room temperature shall show no visible deterioration.

d) When tested in the following manner, the material shall not sag or flow.

Sag or flow resistance (vertical or overhead joints) test. Fill a wooden form 1" deep, 1" wide and 6" long flush with the sealing compound and place in an oven 135°F, in a vertical position for 5 days.

G. Connections for Corrugated Metal Pipe. The type of joint used shall be at the option of the Contractor but subject to the approval of the Engineer.

H. Pipe Cushion Material. Material for pipe cushion may be sand, crushed limestone, graded crushed aggregate, or other select granular material approved by the Engineer.

All material shall pass the 1-inch sieve and not more than 5% by weight shall pass the No. 100 sieve.

I. The use of any other type of drain pipe and joint shall be only with the written approval of the Engineer.

J. Test. When requested, the Contractor shall furnish to the Engineer for testing one pipe length for each size of pipe used in the project. The pipe shall be selected at random by the Engineer.

K. Rejection. If the test specimen does not meet the required specifications, the Engineer may reject part or the entire order of pipe. Only pipes approved and marked by the Engineer shall be used for the job. The Contractor shall promptly remove all rejected pipes from the job site.

24.3 CONSTRUCTION DETAILS

A. Trench Preparation. The trench shall be properly prepared as specified under Section 11, "Trench Excavation and Backfill," and as shown on the plans.

After the trench has been excavated to a depth 6 inches below the pipe barrel, except where the 6-inch depth is deemed not necessary by the Engineer, the trench bottom shall be brought up to grade by backfilling with cushion material.

B. Pipe Laying. The pipe shall be laid upgrade, unless otherwise permitted by the Engineer, and shall rest firmly on the prepared bedding or cushion material so that its entire length will have full bearing.

No blocking of any kind is permitted for adjusting the pipe to grade except when used in embedment of concrete.

No pipe shall be laid directly on solid rock bed. Ledge rock or boulders shall be removed or excavated to provide a minimum clearance of 6 inches under the pipe. The excavation shall then be backfilled with cushion material and the pipe placed thereon.

Corrugated metal pipe shall be laid in accordance with the recommendations of the manufacturer.

In new embankment where pipes are to be installed, the embankment shall be constructed to a height of two diameters above the pipe invert or to a height as indicated in the detail drawing. The trench shall then be excavated and the pipe installed.

C. Pipe Jointing. Immediately after jointing the pipe sections, the joints shall be protected from the air and sun to prevent quick drying or deterioration.

1) Mortar Joints. When mortar joints are specified, the ends of each pipe section shall be wiped clean and dampened, and the lower one-third shall be well covered with cement mortar before inserting the adjoining pipe end. After the pipes are centered and the invert aligned, the joints shall then be hand mortared.

2) Grouted Joints. The grouting material shall be mixed with enough clean water to obtain a workable mix that will readily and completely fill the annular space. The grout shall be placed within 30 minutes after mixing. A flexible wire may be used to vibrate and settle the grout. The joint may be refilled with grout as required.

3) Gasket Type Joints. When rubber-type gasket joint is specified, the gasket shall be properly inserted on the pipe as recommended by the manufacturer. The pipe section shall be carefully handled and controlled to avoid disturbing the gasket and knocking it out of position, or loading it with dirt or other foreign material.

When inserting the tongue or spigot, the pipe section shall be properly aligned and supported to minimize unequal lateral pressure on the gasket. Concentricity shall be maintained at all times until the gasket is properly positioned.

Once the joint is positioned, the pipe section shall be held firm until the fill material under and alongside the pipe is compacted.

4) Pre-formed Plastic Sealing Compound Joints. The application and laying procedures shall be as follows:

a) Remove loose material from the joint surfaces, then apply a brush coat of primer approved by the manufacturer. Allow primer to dry completely.

b) Remove paper from the flat side only of gasket strips and firmly press the adhesive strip in contact with the dry primed surface. Press strips end-to-end to form a continuous gasket on the leading edge of tongue (also groove for double bead application). Allow sufficient conditioning or adhesive strengthening time before lowering the pipe section into the trench. The outside wrapper shall remain for protection.

c) The outside wrapper shall be removed when the pipe is in the trench exposing the clean adhesive gasket surfaces.

d) Use sufficient pushing or pulling force applied in a straight line, to bring the opposing joint surfaces together. Apply sufficient force until the joint is tightly closed, and the plastic gasket flows to solidly pack and take the shape of the joint space. Joints pulled up tightly shall show a slight squeeze-out.

Only whole pieces and one-cut piece shall be allowed. Short, fragmented pieces shall not be used to complete the circumference. The gasket size shall be determined by pipe size and elevation of the pipeline as follows:

A) Single bead application for dry trench conditions (above Water table).

Pipe Size	Extruded Rope Size		
	Rope Diam.	Cross Sec. Area	Min. Deliv. Length
18" & below	1"	.80 sq. in.	2' - 5"
24" - 42"	1-1/2"	1.75 sq. in.	3' - 5"
48" - 66"	1-3/4"	2.50 sq. in.	3' - 5"
72" - 96"	2"	3.25 sq. in.	3' - 5"

B) Double bead application for wet trench conditions (at or below Water table).

Pipe Size	Extruded Rope Size		
	Rope Diam.	Cross Sec. Area of Each Bead	Min. Deliv. Length
30" & below	1"	.80 sq. in.	2' - 5"
36" - 48"	1-1/2"	1.75 sq. in.	3' - 5"
54" - 72"	1-3/4"	2.50 sq. in.	3' - 5"
78" - 96"	2"	3.25 sq. in.	3' - 5"

D. Backfilling. Backfill work shall comply with Section 11, "Trench Excavation and Backfill." For mortared or grouted joints, the backfill work may not begin until 16 hours after jointing; however, backfilling may begin if the work can be completed while the mortar or grout is still plastic. The conduit shall be inspected before any backfill is placed. Any pipe found to be out of alignment, unduly settled, or damaged, shall be taken apart and relaid or replaced.

The Contractor shall exercise care not to cause any movement of the pipe sections.

E. Finishing. The interior of the pipe shall be free from foreign material, mortar and dirt. The interior joints shall be finished smooth.

The lips of the pipe inlet and the outlet shall be rounded with stiff mortar with a minimum radius of 3 inches or 0.15 times the pipe diameter.

Any pipe, after laying, which is not in true alignment or grade, or shows undue settlement, or is damaged, shall be replaced by the Contractor at his own expense.

Every precaution should be taken to prevent flooding of the trench before the backfill operation. Floatation of the pipe by water shall be sufficient reason for rejecting the pipes affected.

24.4 MEASUREMENT

A. Pipe. The length of pipe to be paid for shall be the horizontal measurement in linear feet. Where the slope of the pipe exceeds 10 percent, the measurement shall be the actual length of pipe installed.

No payment will be made for pipe placed in excess of the length approved by the Engineer.

B. Cut-Off. Where pipes are cut-off flush with the outside face of the headwall or the interior face of the manhole or catch basin, no payment will be made for the cut-off portion.

C. Other Items of Work. Concrete jacket shall be measured and paid for as specified under Section 43, "Concrete Blocks, Cradles and Jackets."

Excavation and backfill shall be measured and paid for as specified under Sections 11 and 15, "Trench Excavation and Backfill" and "Crushed Rock," respectively.

D. Incidental Work. Compensation for all incidental work, such as furnishing and compacting the pipe cushion material, connections, jointing and patching shall be considered as included in the prices bid for drain pipes.

24.5 PAYMENT

Reinforced concrete pipe, non-reinforced concrete pipe, and corrugated metal pipe shall be paid for as measured above at the unit price bid per linear foot for the different sizes and classes and shall be full compensation for furnishing material, labor, tools and equipment to construct the work in place complete.

SECTION 25 - DRAIN MANHOLES

25.1 DESCRIPTION

This work shall consist of constructing storm drain manholes in accordance with the Standard Details and as shown on the plans.

25.2 MATERIAL

A. Concrete. Unless specified otherwise, Class "B" concrete shall be used in the construction of cast-in-place concrete manhole walls, top slab and bases. Class "B" concrete shall be used in the manufacture of precast reinforced concrete units, unless specified otherwise.

For the County of Hawaii only, Class "A" concrete shall be used unless otherwise specified on the plans.

B. Reinforcing. Reinforcing steel shall meet the requirements under Section 48, "Reinforcing Steel."

C. Precast Reinforced Concrete Manhole Units. Precast reinforced concrete riser units and tops shall conform to ASTM C 478 and as specified herein. The precast tops shall be either of the concentric cone type or of the flat slab type. Eccentric cones may be allowed if authorized in writing by the Engineer.

The riser units shall be cylindrical in shape with a minimum inside diameter of 48 inches. The height of the riser units shall be at the option of the manufacturer. The minimum wall thickness shall be 5 inches or 1/12 the diameter of the manhole, whichever is greater.

The reinforcement for the 48-inch units shall consist of a single cage of steel, placed approximately at the center of the wall section. Each linear foot of section shall have a minimum of 0.15 square inch of circumferential steel.

D. Concrete Brick. Concrete bricks shall conform to the specifications for concrete building brick, ASTM C 55.

E. Casting and Rungs. Manhole frames, covers and rungs shall meet the requirements specified under Section 23, "Sewer Manholes."

25.3 CONSTRUCTION DETAILS

A. Excavation and Backfill. Excavation and backfill shall be in accordance with Section 11, "Trench Excavation and Backfill" where applicable. The backfill around the manhole from the bottom of the base slab to the surface 2-foot lift shall be placed and compacted according to Section 11.4F2. The surface 2-foot lift shall be placed and compacted according to Section 11.4F3.

B. Subbase Preparation. Unsuitable material below the established manhole base shall be removed to a depth sufficient to provide a stable foundation when backfilled with granular material. This item of work shall be measured and paid for as specified under Subsection 11.4B "Additional Excavation."

C. Manhole Base. Manhole base shall be that portion measured from the bottom of the base slab to a height 6 inches above the highest pipe barrel. All manhole bases shall be reinforced as shown in the Standard Details and shall be cast in place. Precast base may be allowed if authorized in writing by the Engineer.

Newly poured concrete base shall be allowed to set for at least 24 hours before additional work is constructed thereon.

The minimum thickness of the bottom slab shall be 8 inches and of the wall section, 9 inches.

D. Brick Manhole Wall. Concrete brick wall shall be constructed in horizontal courses with a running bond using a header course every sixth course, or any standard bond of equivalent strength. The interior brick joints shall be neatly struck and finished smooth.

No brick wall shall be constructed below the ground water table or in manholes with walls greater than 7 feet in height as measured from the top of the base to the cover frame. The top 4-foot cone section, however, may be constructed of brick regardless of depth of manhole.

E. Cast-In-Place Concrete Wall. Cast-in-place concrete wall shall have a minimum thickness of 6 inches with minimum reinforcing of #4 horizontal bars spaced 12 inches on centers and #4 vertical bars equally spaced at 1/8 the length of the perimeter.

For manholes greater than 10 feet in depth, as measured from the invert to the cover frame, the wall section shall be designed for the particular location and soil condition.

F. Precast Concrete Wall. The precast concrete riser units shall be laid in horizontal courses, each on a full bed of mortar. The tongue and groove shall be locked in place and the annular space filled with mortar. Excess mortar at the interior joints shall be struck off smooth.

Manhole rungs or steps may be attached to the interior walls at the manufacturing plant or they may be set in place after the manhole is erected at the site.

G. Special design manholes shall be constructed as shown on the plans. Standard shallow manholes shall be constructed in accordance with the Standard Details.

H. Cleanup. After the manhole has been constructed, it shall be cleaned of all debris and loose mortar.

25.4 MEASUREMENT

Drain manholes shall be measured for payment based either on the number of manhole structures constructed in place complete, or on the number of manhole bases, the linear feet of manhole walls, and the number of manhole frames and covers constructed in place complete.

A. Drain Manhole. When shown in the proposal, standard drain manholes shall be measured for payment by depth in multiples of one foot as measured from the invert to the cover frame.

B. Manhole Base. Manhole bases, including reinforcement, to be paid for shall be the actual number constructed in place complete.

C. Manhole Frame and Cover. Manhole frame and cover to be paid for shall be the actual number installed.

D. Manhole Wall. Manhole walls, including the rungs and reinforcement, shall be measured for payment by the linear foot. The quantity shall be based on measurement from the top of the manhole base to the bottom of the cover frame for standard manholes less than 10 feet in depth.

E. Others. Special manholes, shallow manholes, and manholes greater than 10 feet in depth shall be measured for payment by depth in multiples of one foot as measured from the invert to the cover frame.

25.5 PAYMENT

Payment for manhole bases, walls, frames and covers shall be made at the unit price bid as measured above and shall be full compensation for furnishing the material, equipment and labor necessary to construct the work.

Special manholes, manholes greater than 10 feet in depth, shallow manholes, and standard drain manholes when provided in the proposal, shall be paid for at the unit price bid in the proposal. The price shall be full compensation for furnishing the labor, tools, equipment and material necessary to construct the work in place complete.

Payment for excavation and backfill shall be considered as included in the prices bid for the above items.

SECTION 26 - CATCH BASINS AND STORM WATER INLETS

26.1 DESCRIPTION

This work shall consist of constructing catch basins and storm water inlets, including excavation and backfill, as shown on the plans and in accordance with the Standard Details. Special catch basins and inlets shall be constructed as shown on the plans.

26.2 MATERIALS

Materials for catch basins and inlets shall conform to the applicable provisions under Section 23, "Sewer Manholes"; Section 39, "Portland Cement Concrete"; Section 40, "Concrete Structures"; and as specified herein.

When the class of concrete is not specified or shown on the plans, Class "B" concrete shall be used.

For the Counties of Kauai and Hawaii only, Class "A" concrete shall be used unless otherwise specified on the plans.

Cast iron frames and covers, and manhole rungs shall meet the requirements specified under Section 23, "Sewer Manholes."

Materials for the manufacture of inlet frames and grates shall conform to the applicable requirements of ASTM A 48, Class 30 for cast iron; ASTM A 536 for nodular cast iron; and American Iron and Steel Institute C 1021 for special quality, hot rolled steel bars.

All steel items shall be galvanized after fabrication and all cast iron items unless otherwise specified shall be painted with or dipped in a commercial quality asphaltum paint.

The bearing surfaces of the frames and covers or gratings shall be machined and the cover shall seat firmly into the frame without rocking.

26.3 CONSTRUCTION DETAILS

Catch basins and inlet structures shall rest on stable foundations. Excavation and backfill shall be in accordance with Section 11, "Trench Excavation and Backfill" where

applicable. The backfill around the catch basin or inlet from the bottom of the structure to the surface 2-foot lift shall be placed and compacted according to Section 11.4F2. The surface 2-foot lift shall be placed and compacted according to Section 11.4F3. Any unsuitable materials encountered at or below the established base of the structure shall be excavated to sufficient depth and refilled with granular aggregates as specified under Subsection 11.4B, "Additional Excavation."

26.4 MEASUREMENT

Catch basins and storm water inlets to be paid for shall be the actual number constructed, or when shown in the Proposal, shall be measured for payment by depth in multiples of one foot as measured from the invert to the top of the manhole frame or grating, whichever is higher.

Concrete gutters fronting the catch basins, including deflector inlets, shall be paid for under the item of catch basin.

26.5 PAYMENT

Catch basins and storm water inlets shall be paid for as measured above at the respective unit price bid each for the different types. Payment shall be full compensation for furnishing and installing gratings, rungs, frames and covers, concrete gutters, excavation, backfill and other appurtenances.

SECTION 27 - CONCRETE CHANNELS

27.1 DESCRIPTION

This work shall consist of constructing concrete channels for streams and waterways to the lines and grades shown on the plans. The work includes preparation of channel foundation and walls, grading, furnishing and placing the various items which are to constitute the finished structure.

27.2 MATERIALS

A. Concrete. Class "A" concrete shall be used.

B. Weep Holes. Pipe for weep holes may be asbestos-cement pipe having a minimum crushing strength of 1000 pounds per linear foot when tested in accordance with AASHTO T 33, clay drain tile meeting ASTM C 700, concrete pipe meeting ASTM C 412, or plastic pipe meeting ASTM D 2997. The pipe diameter shall be 3 inches and the pipes shall be spaced 8 feet on centers unless otherwise indicated on the plans.

C. Reinforcement. Reinforcing steel bars or mesh shall be of the size and spacing indicated on the plans. The steel shall conform to the requirements under Section 48, "Reinforcing Steel."

27.3 CONSTRUCTION DETAILS

A. Channel Excavation. The channel section shall be excavated to the lines and grades as shown on the plans.

When the Engineer determines that the material found at or below the grade to which excavation would normally be carried in accordance with the plans and/or specifications is unsuitable for foundation, the Contractor shall remove such material to the required width and depth and replace it with compacted crushed rock material or concrete as directed by the Engineer.

If the Contractor, due to his operations, excavates the bottom beyond the limits indicated on the plans or as directed by the Engineer, he shall backfill the void with compacted crushed rock material or concrete as directed by the Engineer. This work shall be at the Contractor's expense.

All foundations shall be inspected and approved by the Engineer before starting the concrete work.

B. Dewatering. The channel section shall be free from water when pouring the concrete and for a period of 6 hours after the completion of the pour.

C. Concrete Work. All concrete work shall conform to Section 39, "Portland Cement Concrete." No concrete shall be placed in structures except in the presence of an inspector.

The exposed concrete walls shall be finished smooth. Shiplap or tongue and groove ridges are not acceptable.

D. Weep Holes. Weep holes shall be constructed along the channel walls and invert as shown on the plans. A minimum of 2 cubic feet of filter material shall be placed at each weep hole unless otherwise indicated on the plans.

27.4 MEASUREMENT

The volume of excavation shall be measured for payment by the cubic yard and the quantity shall be computed based on the cross sections shown on the plans or on the existing grades determined prior to commencing the excavation work.

The volume of excavation of unsuitable material below the established channel grade and backfill to grade shall be measured for payment by the cubic yard and the quantity shall be computed based on the dimensions of additional excavation ordered by the Engineer.

The quantities of reinforced concrete in the channel section shall be measured for payment by the cubic yard and the quantity shall be computed based on the dimensions shown on the plans or such other dimensions as may be ordered in writing by the Engineer.

27.5 PAYMENT

The various items of work shall be paid for as measured above and shall be full compensation for furnishing the necessary labor, materials, tools and equipment to complete the work in place.

The price paid per cubic yard of excavation shall be full compensation for preparing and compacting the foundation, dewatering, and disposing of the excavated material.

Payment for additional excavation below the established foundation grade shall be made at the same unit price bid for excavation above the foundation grade as specified above. Payment for imported aggregate or concrete shall be made at the unit price bid per cubic yard.

The price paid per cubic yard of concrete shall be full compensation for furnishing the necessary materials and constructing the reinforced concrete lining and weep holes, including furnishing and placing filter rock material.

SECTION 28 - SUBSURFACE DRAINS

28.1 DESCRIPTION

This item of work shall consist of constructing subsurface drainage system for the collection and control of subsurface water. The work includes trench excavation and backfill, furnishing and placing of the drain pipes and permeable materials, and other pertinent fixtures or fittings.

28.2 MATERIALS

A. Perforated Metal Pipe. Perforated corrugated metal pipe shall be bituminous coated. The bituminous material used for coating shall meet the requirements under AASHTO M 190. The pipe and coupling bands shall meet the requirements under AASHTO M 136.

B. Perforated Concrete Pipe. Perforated concrete pipe and fittings shall meet the requirements of AASHTO M 175. The pipe may be either bell and spigot or tongue and groove pattern.

C. Perforated Asbestos Cement Pipe. Perforated asbestos cement pipe shall meet the requirements of AASHTO M 189.

Couplings may be manufactured of the same material as the pipe or of plastic. Couplings shall be the sleeve type, suitable for holding the pipe in alignment without the use of sealing compound or gaskets.

D. Concrete Pipe. Reinforced concrete pipe and non-reinforced concrete pipe shall meet the requirements under C 76 and C 412 respectively.

E. Plastic Pipe. Plastic pipe shall meet the requirements of ASTM D 2997.

F. Other Types of Drain Pipes. The use of any other type or make of subdrain pipe shall be with the written approval of the Engineer.

G. Filter Material. Filter material for use under, around, and over the pipe shall be crushed aggregates with gradation as follows:

FILTER MATERIAL

Sieve Sizes	Percentage Passing By Weight
3/8"	100
#4	70-100
#16	35-85
#50	10-45
#100	0-10

28.3 CONSTRUCTION DETAILS

The trench shall be excavated to the line and grade shown on the plans or as directed by the Engineer. The Contractor shall sheet the trench where necessary in order to install the subsurface drain.

Extreme care shall be exercised in placing the filter material, laying the pipe, and backfilling so that there will be no mixing of the excavated material with the filter material.

Concrete pipes shall be laid without mortar in joints and the lengths shall be firmly pressed together. Asbestos-cement pipe, metal pipe and plastic pipe shall be joined by couplers.

All perforated pipes shall be laid with the perforations down.

28.4 MEASUREMENT

A. Method No. 1

The subsurface drain shall be measured for payment by the linear foot for the various types and sizes of pipes installed and shall be based on the slope length. Pipes placed in excess of the length designated will not be paid for.

Excavation and backfill shall be measured and paid for as specified under Section 11, "Trench Excavation and Backfill."

Filter aggregates shall be measured for payment by the cubic yard or by the ton as indicated on the proposal.

B. Method No. 2

Where it will be difficult to make an accurate estimate of excavation quantity and/or of filter material quantity, the measurement for payment for the subsurface

drainage system shall be by the linear foot of pipe installed and shall be full compensation for excavation and backfill, and furnishing all material, equipment and labor to construct the work in place complete.

28.5 PAYMENT

Payment shall be made at the unit price bid in the proposal and shall be full compensation for furnishing the materials, labor and equipment necessary to construct the subsurface drain, including connecting accessories, all fittings, and connections to drain manholes or catch basins.

SECTION 29 - SUBGRADE

29.1 DESCRIPTION

This work shall include grading and compacting the existing ground to the designated elevation before placing the layer of specified material thereon. The finishing and compacting work shall not begin until all underground utilities indicated on the plans are completed and the trenches backfilled in accordance with the requirements under Section 11, "Trench Excavation and Backfill."

29.2 DETAILS

A. Preparation. In advance of setting line and grade stakes, the subgrade area shall be cleared of brush, weeds, vegetation, and debris, all of which shall be satisfactorily disposed of to the satisfaction of the Engineer. All depressions and ruts which contain water shall be drained.

Unsuitable materials and boulders encountered at and below the subgrade surface shall be removed and replaced as specified under Subsection 12.4B "Excavation Below Grade."

B. Finished Subgrade. The finished subgrade shall have a density of at least 95% of its maximum density for a depth of 6 inches or more. The surface shall be rolled until the material does not creep under the roller and finished smooth to the required grade and cross section.

C. Protection of Subgrade. The subgrade shall be shaped and sloped to drain.

D. Surface Tolerance. The finished subgrade upon which subbase or base course is placed shall not vary more than 0.10 foot above or below the theoretical grade.

For the County of Kauai, the finished subgrade shall not be higher than the theoretical subgrade.

All unnecessary traffic shall be kept off the prepared subgrade. Should it become necessary to haul materials and aggregate over the prepared subgrade, the Contractor shall drag and roll the traveled way as frequently as may be necessary to remove ruts, cuts and breaks in the

surface. The surface shall be brought up to grade, compacted and rolled smooth before placing the subsequent layer of specified material.

Should the prepared subgrade become soft, spongy, or yielding due to the weather or excessive sprinkling, the Contractor shall at his own expense remove and replace the soft material or let it dry out sufficiently, then recompact the material to the required density and grade.

29.3 PAYMENT

Preparation of subgrade will not be paid for separately. It shall be included in the unit bid price paid for the material to be placed on the subgrade.

SECTION 30 - SELECT BORROW FOR SUBBASE COURSE

30.1 DESCRIPTION

This item of work shall consist of furnishing, placing, and compacting the select borrow on a prepared subgrade.

The subbase course is intended to serve as a foundation or stabilizing course for the subsequent base and surfacing.

30.2 MATERIAL

Select borrow for subbase course shall consist of crusher run waste, mud-rock, coral, sand, or cinders. The material shall be free of organic matter and other deleterious substances and shall have a minimum California Bearing Ratio value of 25 percent.

The maximum size of any particle in its greatest dimensions shall not exceed 3 inches. The material shall be well graded from coarse to fine so as to form a dense compacted layer. The amount of material passing the 200 mesh sieve shall be less than 15 percent. Filler shall be added to the select borrow if required to obtain a well graded mixture.

30.3 DETAILS

A. Spreading. The select borrow shall be delivered to the site and spread on the approved prepared subgrade in a manner that will avoid segregation of the particles. The material shall be spread in layers. Each compacted layer shall not exceed 6 inches in thickness.

B. Rolling. Each layer of material shall be rolled until the material does not creep under the roller before a succeeding course of surfacing material is applied. Water shall be added prior to or during the rolling and only in such quantity as to insure a dense compaction and not to damage the subgrade.

All rolling shall commence at the outer edges of the surfacing and continue toward the center. Under no circumstances shall the center of the roadbed be rolled first. The material shall be compacted to not less than 95% of its maximum density.

C. Finished Subbase. The finished surface shall be rolled smooth to the grade and cross section shown on the plans. Any irregularities developed in any surface during or after rolling shall be remedied by loosening the surface and correcting the defects. The entire area, including the surrounding surface, shall then be re-rolled until thoroughly compacted.

When directed by the Engineer, the Contractor shall spread filler material over the surface of the subbase course. The spreading shall be broomed, sprinkled with water, and rolled until the entire surface is filled and bonded.

D. Surface Tolerance. The finished subgrade upon which base course is placed shall not vary more than 0.05 foot above or below the theoretical grade.

For the County of Kauai, the finished subgrade shall not be higher than the theoretical subgrade.

30.4 MEASUREMENT

Select borrow for subbase course shall be measured for payment by the cubic yard. The volume shall be computed based on the completed subbase as constructed in its final position. The thickness, width, and length shall be as shown on the plans or as determined by the Engineer.

Filler material and water when required shall be considered as incidental and included in the price bid for select borrow.

30.5 PAYMENT

Select borrow shall be paid for at the unit price bid per cubic yard as measured above and shall be full compensation for furnishing labor, material, equipment, and all incidental work necessary to construct the subbase course.

SECTION 31 - AGGREGATE BASE COURSE

31.1 DESCRIPTION

This work shall consist of furnishing, spreading and compacting untreated aggregate base course on the prepared subbase or subgrade, or on existing improved surfaces in conformity with these specifications.

31.2 MATERIAL

Aggregate for untreated base shall consist of a crushed product of stone or coral. It shall be free of vegetable matter and other deleterious substances and shall be of such nature that it can be compacted readily under watering and rolling to form a firm, stable base.

Where the mineral aggregate does not contain sufficient natural cementing material to be readily compacted, a binder material consisting of rock screenings or other approved cementitious material shall be uniformly added to and mixed into the aggregate before compaction.

The crushing shall be so regulated that at least 80 percent by weight of the material retained on the No. 4 sieve is crushed particle. A crushed particle is defined as one having at least one mechanically fractured face.

When tested in accordance with the designated methods, the aggregate base in combination with the binder material, if used, shall meet the requirements as set forth.

TEST	METHOD	REQUIREMENT
Los Angeles Abrasion	AASHTO T 96 (Grading A)	50% Maximum
Sand Equivalent	AASHTO T 176	35% Minimum
Plasticity Index	AASHTO T 90	6 Maximum
Flat or elongated pieces (Length to width or width to thickness ratio of 3)		25% Maximum
Grading	AASHTO T 27	Refer to Table 1-31

If the portion passing the No. 4 sieve is composed entirely of crushed coralline limestone, the sand equivalent requirement shall be not less than 20% and the grading requirement on the No. 200 sieve shall be 3 to 12 percent in lieu of that specified in Table 1-31.

Unless otherwise specified, 1-1/2 inch maximum size aggregate shall be furnished.

TABLE 1-31 GRADING REQUIREMENTS

Screen Size	Percent Passing by Weight 2-1/2" Maximum	1-1/2" Maximum	3/4" Maximum
3"	100	-	-
2-1/2"	90 - 100	-	-
2"	-	100	-
1-1/2"	65 - 90	90 - 100	-
1"	-	-	100
3/4"	45 - 70	50 - 90	90 - 100
No. 4	25 - 45	25 - 50	35 - 55
No. 200	3 - 9	3 - 9	3 - 9

31.3 DETAILS

A. Preparation of Foundation. The new subbase, compacted subgrade, or re-shaped road surface upon which the aggregate base is to be placed shall be prepared as specified under other applicable sections of these specifications.

B. Placing and Compacting Aggregate Base. The base material shall be delivered to the site and spread on the approved prepared foundation by means of vehicles equipped with spreading devices. The material when spread shall be uniform in gradation and free from large pockets of segregated particles. Segregated material shall be remixed until uniform.

Material shall not be stockpiled nor dumped in piles on the roadbed but shall be spread longitudinally and only in such quantity to obtain the required thickness. After watering and compacting, the completed base shall conform to the required grade and cross section within the tolerances specified hereinbelow.

When the specified thickness of the base is 6 inches, the base shall be constructed in one lift. When the specified thickness is greater than 6 inches, the base shall be constructed in two or more equal lifts. The maximum thickness of each lift shall not exceed 6 inches.

The base course shall be compacted until it does not creep or weave in front of the roller or compacting vehicle. When tested, the base course shall have a field CBR value of at least 85% for the City and County of Honolulu. For the Counties of Kauai, Maui and Hawaii, the base course shall be compacted to not less than 95% of its maximum density.

Wherever necessary, filler material shall be added to the surface. It shall be spread in one or more uniform thin layers. Each layer shall be rolled dry until additional filler cannot be forced into the voids. The surface shall then be sprinkled with water and again thoroughly rolled. All excess filler shall be removed. The sprinkling and rolling shall be continued to secure a thoroughly bonded surface.

Where the aggregate base course is constructed in more than one layer, each layer shall be constructed as specified above except that sprinkling will be required only in the top layer. Each layer shall be compacted to a field CBR value of not less than 85% for the City and County of Honolulu only. For the Counties of Kauai, Maui and Hawaii, each layer shall be compacted to not less than 95% of its maximum density.

C. Rolling. After spreading and blading, the aggregate shall be rolled lightly to obtain initial compaction to bring out any irregularities. The surface of the base shall then be carefully shaped and all high and low spots eliminated. When smooth and true, the material shall be rolled until it does not creep or move under the weight of the roller.

All rolling shall be longitudinal and shall commence at the outer edges. Rolling shall progress from each side toward the center of the road with an overlap of at least one-half of the rear wheel tracks on successive trips. Under no circumstances shall the center of the road be rolled first.

D. Tolerances. The finished surface shall be checked for accuracy with a 10-foot straightedge. If the surface at any point varies more than 1/4 inch from the lower edge of the straightedge laid in any direction, it shall again be shaped and re-rolled. This process shall be repeated until the surface meets the required tolerance.

The finished subgrade upon which the final wearing surface is placed shall not vary more than 0.04 foot above or below the theoretical grade.

For the County of Kauai, the finished surface of the base course where not controlled by structures shall not vary more than 0.04 foot above or below the theoretical grade. The thickness of the finished base section shall not be less than 0.02 foot of the planned thickness of any point of the cross-section.

31.4 MEASUREMENT AND PAYMENT

All base course shall be measured for payment by the square yard. Payment shall be made at the unit price bid per square yard and shall be full compensation for furnishing the necessary material, equipment and labor to complete the base course in place.

SECTION 32 TREATED BASES

32.1 CEMENT TREATED BASE

A. Description. This work shall consist of furnishing mineral aggregate, cement and water, and mixing, spreading, compacting, and curing the mixture in accordance with these specifications and the special provisions.

B. Materials

1) Cement. Portland cement shall comply with the specifications for portland cement, ASTM C 150, Type I.

2) Water shall be clean and free from harmful amounts of oil, alkali, acid, salt and organic matter.

3) Mineral Aggregate. Mineral aggregate shall be clean and free from vegetable matter and other deleterious substances. The percentage composition by weight of aggregate ranging from coarse to fine may vary depending on the source but shall meet the following requirements:

Sieve Size	Percentage Passing By Weight
1 in.	100
#4	35 to 75
#200	2 to 15

C. Design. The design mix shall be specified in the special provisions based on laboratory tests. Unless a minimum compressive strength is specified, the design mix when compacted at optimum moisture content shall attain the minimum compressive strength of 750 psi at 7 days.

D. Mixing. Cement treated base may be mixed at the site, designated as road-mix. Cement treated base mixed at a central plant shall be designated as plant mix.

1) Road-Mix. Cement, aggregate and water may be mixed directly on the approved prepared roadbed.

Cement may be furnished in sacks or in bulk. The cement shall be distributed uniformly and in such manner as to prevent any dust problem or loss by wind action. The rate of cement spread per linear foot of windrow or blanket shall not vary more than 10% from the designated rate.

After the cement has been applied, it shall be mixed with the aggregate by a road mixing machine designed to pick up both the cement and aggregate while mixing. The mixing shall continue until the cement has been sufficiently blended with the aggregate to prevent the formation of cement balls when water is applied.

Water shall be added either during or after mixing. Road-mixing machine with provision for introducing water at the time of mixing, through a metering device, may be used. Excessive concentrations of water on or near the surface shall be avoided. Mixing shall continue until a uniform mixture of aggregate, cement and water is obtained.

2) Plant-Mix. The aggregate, cement and water shall be mixed at a mixing plant of either the batch type or the continuous-flow type. The plant shall be equipped with feeding and metering devices which will add the aggregate, cement and water into the mixer in the specified quantities. Aggregate and cement shall be mixed sufficiently to prevent cement balls from forming when water is added. Mixing shall continue until a uniform mixture of aggregate, cement and water is obtained.

The mixture shall be delivered to the roadbed in trucks equipped with protective covers. It shall be placed on the approved moistened subgrade in a uniform layer by an approved self-propelled mechanical spreader ready for

compaction without further shaping. The layer of aggregate-cement shall be uniform in thickness and surface contour, and shall conform to the required grade and cross-section.

Dumping of the mixture in piles or windrows upon the subgrade will not be permitted.

E. Compacting and Finishing. The mixture shall be spread in one lift if the required thickness is 6 inches or less, and in two or more equal lifts if the required thickness is greater than 6 inches. The maximum compacted thickness of each lift shall be 6 inches.

Prior to the beginning of compaction, the mixture shall be in a loose condition for its full depth and width. The percentage of moisture shall not vary by more than two percentage points above or below its optimum moisture content.

Initial rolling of the cement treated base shall be performed with steel-wheel rollers or sheepsfoot rollers. The Contractor may then use whatever type of self-propelled compacting equipment he chooses that will produce the required density to complete the compaction to the designated grade and cross section. Not more than 1 hour shall elapse between the start of moist mixing and the start of initial compaction. Final compaction shall be completed within 2 hours. The density of the compacted cement treated base shall be not less than 95% of the maximum density obtained in the laboratory.

The finished surface of the cement treated base shall be uniform and shall not vary by more than 1/4 inch at any point measured from the bottom of a 10 foot straight edge laid in any direction. All high spots shall be trimmed off to within the specified tolerance and any excess material shall be removed and disposed. The area shall then be re-rolled.

F. Curing. The completed cement treated base shall be protected against drying with a bituminous curing seal for 7 days. The curing material shall be applied as soon as possible, but not later than 24 hours after final rolling. The finished surface shall be kept continuously moist until the curing seal is applied.

No vehicular traffic or equipment shall be permitted on the cement treated base during the first 3 days after applying the curing seal. Should the Contractor use his equipment over the bituminous-covered surface before the bituminous material has dried sufficiently to prevent pickup, he shall at his own expense apply sufficient granular cover over the surface before such use. He shall be responsible for the protection of the curing seal and the base.

Curing seal shall consist of liquid asphalt (MC-30) or asphaltic emulsions, and shall be applied at a rate between 0.15 to 0.25 gallon per square yard of surface. The exact rate will be determined by the Engineer.

G. Construction Joints. At the end of each day's construction a straight transverse construction joint shall be formed by cutting back into the completed work to form a true vertical face.

32.2 PLANT MIX ASPHALT TREATED BASE

A. Description. This work shall consist of constructing one or more courses of plant mixed asphalt treated base course on a prepared subbase and subgrade in accordance with the requirements of these specifications.

B. Materials

1) Asphalt Cement shall have a penetration of 85-100 and conform to the requirements of Section 34.2A of these specifications.

2) Aggregate shall conform to the requirements of Section 34.2B of these specifications, and shall meet the following grading requirements:

Sieve Size	Per Cent Passing by Weight
1-1/4"	100
1"	85 - 100
1/2"	60 - 85
#4	40 - 55
#8	30 - 40
#30	12 - 21
#100	7 - 14
#200	1 - 8

3) Blending Sand and Mineral Filler. The requirements of Section 34.2C shall be applicable.

4) Composition. The plant mixed asphalt treated base course shall be composed of a mixture of aggregate, filler or blending sand or both if approved, and bituminous material. The several aggregate fractions shall be sized, uniformly graded and combined in such proportions that the resulting mixture meets the grading requirements.

Bituminous binder in an amount between 4.0 to 5.0 per cent, based on the dry weight of the aggregate, shall be added to the mixture as directed by the Engineer.

C. Details. Except as modified below, the requirements of Section 34.3 of these specifications shall be applicable.

Where the required thickness of plant mixed material is 4 inches or less, the mixture may be spread and compacted in one layer. Where the required thickness is more than 4 inches, the mixture shall be spread and compacted in 2 or more layers of approximately equal thickness, and the maximum compacted thickness of any one layer shall not exceed 4 inches.

Immediately upon completion of spreading operations, the plant mixed material shall be thoroughly compacted to a relative specific gravity of not less than 95 percent of the specific gravity of the combined mixture without voids. Places not accessible to the roller shall be tamped with mechanical tampers.

The combined thickness of the asphalt treated base course and the asphaltic concrete pavement shall be within 0.02 foot of the planned thickness.

Before starting construction of the plant mix asphalt treated base course, a prime coat shall be applied to the approved surface upon which the plant mix asphalt treated base course is to be placed. The prime coat shall conform to the requirements of Section 33.2A of these specifications. If the plant mix asphalt treated base course is to be placed directly on the subgrade, a prime coat is not required.

A tack coat shall be applied to all layers of asphalt treated base course upon which a subsequent layer of asphalt treated base course or asphaltic concrete is to be placed. The tack coat shall conform to the requirements of Section 33.2B of these specifications.

32.3 MEASUREMENT AND PAYMENT

Cement treated base, road-mix and plant-mix, shall be measured for payment by the square yard unless an alternate basis of payment is provided in the proposal. Payment at the unit price bid shall be full compensation for furnishing, hauling, and spreading the aggregate, cement and water; mixing and compacting the mixture; and curing the finished base with asphalt curing seal.

Plant mix asphalt treated base shall be measured for payment by the ton or the square yard. Payment at the unit price bid shall be full compensation for furnishing the material, equipment, tools, labor, and any incidental work necessary to construct the work in place.

SECTION 33 ASPHALT SURFACE TREATMENT

33.1 DESCRIPTION

This work shall include furnishing and applying liquid asphalt on surface areas preparatory to the laying of an asphalt concrete pavement or other surface construction. A prime coat shall be applied to the approved prepared surface of new base course for road pavement or to other untreated surfaces. A tack coat shall be applied to the prepared surface of existing pavement or base to provide bond between the existing surface and the new construction.

33.2 MATERIAL

A. Prime Coat. Prime coat shall consist of liquid asphalt of low viscosity that will penetrate the prepared surface with asphalt to plug voids, coat and bond dust and loose material particles and thus harden or toughen the surface, and waterproof the base. When the grade is not specified in the special provisions, Type MC 30 conforming to AASHTO M 82 shall be used.

B. Tack Coat. Tack coat shall be either SS1 or SS-1H emulsified asphalt. The bituminous material shall meet the requirements under AASHTO M 140.

33.3 DETAILS

Immediately before applying the prime or tack coat, the surface to be treated shall be swept clean of all loose material, dirt, excess dust or other objectionable material. No application shall be permitted when the surface is wet or when weather conditions are unsuitable.

The liquid asphalt shall be uniformly distributed over the surface by means of sprayer type distributor, pressure operated, mounted on a truck.

Curbs, gutters, sidewalks and other improvements shall be protected from splashing of asphalt. Surfaces splashed with asphalt shall be immediately cleaned.

A. Prime Coat. The prime coat shall be spread at the rate of 0.25 gallon per square yard of surface covered. Any excess application of prime coat shall be removed

immediately. Traffic shall be kept off the prime coat until it has penetrated the surfaces. Unless directed otherwise, the prime coat shall be allowed to cure for a period of not less than 24 hours.

The material shall be heated and applied at a temperature between 50° to 120°F.

B. Tack Coat. Tack coat shall be spread at the approximate rate between 0.05 to 0.10 gallon per square yard of surface covered. Hand sprayers shall be used to apply the liquid asphalt around castings, areas inaccessible to distributor bars, and wherever cover is insufficient.

The material shall be heated and applied at a temperature between 75° to 130°F.

Tack coat shall be placed only so far in advance of the surface course placement as necessary for it to cure properly. The Contractor shall be responsible for the placement of the surface course and the protection of the tack coat.

A tack coat shall be applied to edges of existing pavement, manhole frames, gutters, or curbs against which asphalt concrete course is to be placed.

33.4 MEASUREMENT AND PAYMENT

Unless the proposal provides for separate payment for this item of work, furnishing and spreading prime coat or tack coat shall be considered as included in the bid prices for the items in the proposal for asphalt concrete pavement or other surface construction.

SECTION 34 ASPHALT CONCRETE PAVEMENT

34.1 DESCRIPTION

This work shall include furnishing and mixing mineral aggregate and asphalt binder at a central mixing plant, and hauling, spreading, and compacting the mixture on the approved prepared base course to the established grade and cross-section shown on the plans.

34.2 MATERIALS

A. Asphalt. The bituminous material shall be paving asphalt with a 85-100 penetration for locally refined product and shall meet the requirements under AASHTO M 20 for the specified grade or an aged residue graded paving asphalt, grade AR-4000 or AR-8000, conforming to AASHTO M 226-73I. The heptane-xylene equivalent shall be not more than 35% when tested in accordance with AASHTO T 102.

The use of other grades of asphalt shall be specified in the special provisions or approved in writing by the Engineer.

The Contractor shall furnish the Engineer with test reports covering the shipment of each lot of asphalt cement used for the project.

B. Aggregate. Mineral aggregate shall be obtained by crushing and screening hard, durable bluish-gray lava rock of uniform quality. The aggregate shall be free from decomposed materials, vegetable matter, and other deleterious substances. Elongated or flat pieces, where the ratio of length to width or width to thickness is greater than three, shall not exceed 25% by weight of the total aggregate in any batch. The percentage of wear shall not exceed 45% when tested under AASHTO T 96 after 500 revolutions.

Coarse aggregate shall be that portion of the mineral aggregated retained on a No. 4 sieve. Fine aggregate shall be that portion passing the No. 4 sieve.

C. Blending Sand and Mineral Filler. A nominal quantity of blending sand and mineral filler will be permitted with the Engineer's approval to obtain the required

gradation of the mineral aggregate. The quantity of blending sand and mineral filler used shall not exceed 5% of the total weight of the aggregate.

Natural sand shall be hard-grain, clean and free from loam, clay, organic matter or other deleterious substances. Mineral filler shall consist of thoroughly dry limestone dust or bluish-gray lava rock dust and shall be free of lumps or loosely bonded aggregations. The percentage composition by weight when tested under AASHTO M 29, shall meet the following requirements.

Percentage Passing by Weight

Sieve Size	Blending Sand	Mineral Filler
# 30	90-100	100
#100	5-50	Not less than 85
#200	0-10	Not less than 65

D. Gradation and Composition Requirements. The aggregate gradations for the various mixes of asphalt concrete are shown on Table 1-34. The grading limits specified are based on materials of uniform specific gravity. Correction of grading limits shall be made to compensate for any variations in specific gravity of the individual sizes.

The asphalt concrete are designated by mix numbers:

1) Mix #2 shall be used in constructing the first course for asphalt concrete wearing surface for road pavement.

2) Mix #3 shall be used in constructing the surface course for asphalt concrete wearing surface for road pavement.

3) Mix #4 shall be used in resurfacing existing pavements. For the County of Kauai only, this mix may also be used in constructing the surface course for asphalt concrete wearing surface for road pavement or constructing or resurfacing driveways.

4) Mix #5 shall be used in constructing driveways and repairing or resurfacing existing driveways. For the County of Kauai only, this mix shall not be used.

The amount of asphalt binder used in the particular mix shall be within the percentage range shown in Table 1-34 based on total dry weight of the mixture.

TABLE 1-34 ASPHALT CONCRETE COMPOSITION AND GRADATIONS

Sieve Size	Percentage Passing by Weight			
	Mix #2 (Coarse)	Mix #3 (Medium)	Mix #4 (Fine)	Mix #5 (Extra Fine)
1-1/4"	100			
1"	85-100	100		
3/4"	---	90-100		
1/2"	60-80	70-90	100	
3/8"	---	---	80-100	100
#4	36-50	40-57	55-75	70-90
#8	26-36	30-46	35-52	45-65
#30	16-25	18-31	13-25	22-38
#100	7-14	8-20	6-15	12-21
#200	1-8	4-10	4-10	6-12
Asphalt Binder (%)	4.5-6.5	4.5-7.0	5.5-7.5	6.0-8.0

E. Job Mix. The Contractor shall submit for approval, a job-mix formula for each asphalt concrete mixture to be supplied for the project. The job-mix formula for each mixture shall establish a single percentage of aggregate passing each required sieve size and a single percentage of bituminous material to be added to the aggregate.

After the job-mix formula is established, all mixtures furnished for the project shall conform thereto within the following ranges of tolerances:

Sieve Size	Tolerance
Passing No. 4 and larger sieves	± 7 per cent
Passing No. 8 to No. 100 sieves (inclusive)	± 4 per cent
Passing No. 200 sieve	± 2 per cent
Asphalt Binder	± 0.4 per cent

F. Tests. The combined mineral aggregates when tested shall conform to the following requirements:

K-Factor (obtained from Centrifuge Kerosene Equivalent Test)..... 1.7 maximum

Sand Equivalent..... 50 minimum

34.3 DETAILS

A. Mixing. Asphalt cement shall be heated in a kettle of approved type and maintained at a temperature between 275° and 325°F. The heat must be applied so that there is no burning of any portion of the asphalt concrete. Live steam shall not be injected into the asphalt.

The mineral aggregate shall be heated to a temperature between 275° to 325°F.

After heating to the required temperature, the required amount of asphalt cement shall be added to the heated aggregate in a mixer and the mixing commenced. The minimum mixing period shall be 30 seconds. Longer mixing may be necessary to produce a thoroughly blended mixture in which all the particles are coated uniformly. Any mixture which shows an excess or deficiency of asphalt, or any uneven distribution of cement due to insufficient mixing, shall be wasted.

B. Preparing of Surface. All surfaces on or against which asphalt concrete wearing surface course is to be placed shall first be given a prime or tack coat as specified under Section 33, except clean surfaces of any course of asphaltic materials laid within the preceding 24 hours.

The Contractor shall prepare the existing surface by power brooming to remove all loose particles, dust, sand, and other foreign materials.

C. Spreading and Finishing. If required by the Engineer, a leveling course mixture shall be spread to level irregularities, dips, depressions, sags, and to provide a smooth base of uniform grade and cross section. The leveling course shall not be placed more than one day in advance of placing the surface course. No additional compensation will be allowed for furnishing, placing, and compacting the leveling course.

The surface course shall be spread with a mechanical, self-propelled spreading and finishing machine equipped with a hopper or mixture compartment to receive the mixture from the haul trucks, and a screed or cutoff device that oscillates in a horizontal motion or vibrates vertically when striking off the course or lift under construction. The screed shall be capable of adjusting to the required crown and elevation, and capable of covering the full width of a traffic lane. Spreading of the mixture from hauling trucks will not be permitted.

The paving machine shall be operated in such a manner as to distribute the mixture to proper cross section, width and thickness without segregation of aggregates.

If the paving machine leaves ridges, indentations, or other marks in the surface that cannot be eliminated by rolling or prevented by adjustment in operation, its use shall be discontinued and another equipment, acceptable to the Engineer, shall be furnished by the Contractor.

If more than one course is to be constructed in any area, not more than 24 hours shall elapse between the spreading and finishing of any two successive courses in that area. No wearing surface mixture shall be spread during unsuitable weather or when the base is wet.

When asphalt concrete wearing surface is to abut an existing transverse construction joint. The joint shall be trimmed to a neat vertical line.

When asphalt concrete wearing surface is to abut a concrete gutter, the wearing surface shall be laid so that its surface, after compaction, will approximately be slightly higher than the surface of the concrete gutter. The edge of the wearing surface shall then be neatly cut along the gutter edge.

At locations where the width of asphalt concrete mixture to be spread is too narrow to permit the use of a self-propelled mechanical spreading and finishing machine, or where the surfacing is to extend to a featheredge, the mixture shall be finally shaped and smoothed by means of a wooden float 8 feet long.

The maximum depth of asphalt concrete which may be spread and rolled in any one course or lift shall not exceed a compacted thickness of 2½ inches. When a thicker surface pavement is specified or indicated, the pavement shall be constructed in two or more lifts and the minimum thickness of each lift shall be 1 inch unless specified otherwise. Longitudinal joints in any two successive lifts or courses shall be offset a minimum of 6 inches so that one joint shall not be directly over the other.

D. Compacting. All compacting vehicles shall be self-propelled and in first-class mechanical condition. All rollers shall be capable of reversing and changing direction smoothly. The rollers shall be kept in continuous motion while on the hot mat and operated so that all parts of the pavement received equal compression. Roller shall be operated by competent and experienced personnel.

All rolling shall be longitudinal with the drive wheel forward in the direction of the paving machine. Rolling shall start near the edge of the pavement and proceed toward the center of the roadway, overlapping on successive trips by not less than one-half the width of the roller. The initial rolling shall take place as closely behind the laying machine as the temperature and condition of the mat will allow. The mixture temperature shall range between 220°F. and 300°F.

The initial or "breakdown" rolling shall be accomplished with steel-wheeled roller weighing 10 tons. After the first pass of the roller, any low or grainy spots shall be broken up with a hot rake and more material worked in to insure a smooth surface of uniform texture and density. Immediately following, a pneumatic-tired roller weighing not less than 12 tons shall be used to continue the rolling. For productions not exceeding 150 tons per hour, at least one steel-wheeled roller shall be used for the initial rolling. For productions in excess of 150 tons per hour, one additional roller will be required for each additional 100 tons per hour or fraction thereof. With the approval of the Engineer, the Contractor may achieve the required compaction by the best means available at his disposal.

Rolling shall continue until the compressed pavement or surfacing has attained a relative specific gravity of not less than 91 percent of the specific gravity of the combined mixture without voids. Test to determine compaction shall be done in accordance with ASTM D 2041 commonly called the "Rice Method". The final rolling shall be performed with a steel-wheeled roller weighing not less than 10 tons.

E. Smoothness. The finished surface of the pavement shall be true to grade and cross section, free from depressions and grainy spots, and of uniform texture. It shall not vary more than 1/8 of an inch from any point along the bottom of a 10-foot straightedge laid in any direction except across the crown.

F. Surface Tolerance. For the County of Kauai only, the finished surface of the asphaltic concrete pavement shall be within 0.02 foot above or below the theoretical grade. The thickness of the finished pavement shall not be more than 0.02 foot of the planned thickness at any point of the cross-section.

G. Pavement Samples and Testing. For the County of Kauai only, upon the Engineer's request, the Contractor shall cut pavement samples 12-inches by 12-inches or 4-inch diameter cores, minimum. Samples of the mixture shall be taken for the full depth of the course at the location directed by the Engineer. Where samples have been taken, new material shall be placed and compacted to conform with the surrounding area. The entire cost of sampling and restoring the area shall be borne by the Contractor, and no additional compensation will be made.

For the County of Kauai only, upon the Engineer's request, the Contractor shall employ an independent testing laboratory to analyze the characteristics of the asphaltic concrete pavement samples to determine if the asphaltic concrete pavement meets the requirements as set forth in this section. The entire cost of testing and any costs associated with the testing shall be borne by the Contractor, and no additional compensation will be made.

34.4 MEASUREMENT AND PAYMENT

Asphalt concrete surfacing shall be measured for payment by the square yard or by the ton. The number of square yards shall be computed based on the horizontal dimensions of the completed surface.

Payment shall be made at the unit price bid as measured above, and shall be full compensation for furnishing the material, equipment, tools, labor, and any incidental work, necessary to construct the work in place.

SECTION 35 - ASPHALT CONCRETE RESURFACING

35.1 DESCRIPTION

This work shall consist of furnishing, spreading and compacting an asphalt concrete wearing surface over an existing pavement.

35.2 DETAILS

A. Preparation. The existing pavement to be resurfaced shall be cleaned of debris, dirt and dust prior to placing the tack coat. The tack coat shall be spread as described under Section 33, "Asphalt Surface Treatment."

B. Asphalt Concrete. The extent and the thickness of resurfacing shall be as shown on the plans and as specified in the special provisions. The asphalt concrete mix and the spreading, compacting and finishing of the mix shall meet the requirements under Section 34, "Asphalt Concrete Pavement."

If the mix is not specified, Mix #4 shall be used.

C. Existing Castings. The work under this item shall not include the adjustment of castings to the new finished surface, unless specified otherwise.

The resurfacing mixture shall be placed continuously over all castings. Location of casting shall be made after the resurfacing work has been completed.

After the resurfacing is completed, the Contractor shall reset the castings to the new finished surface as specified under Section 36, "Adjustment of Existing Utility Structures to Finished Grade".

35.3 MEASUREMENT AND PAYMENT

Asphalt concrete resurfacing shall be measured for payment by the ton. Payment shall be made at the unit price bid per ton and shall include full compensation for preparing the pavement surface, applying the tack coat and finishing the work.

SECTION 36 - ADJUSTMENT OF EXISTING UTILITY STRUCTURES TO FINISHED GRADE

36.1 DESCRIPTION

This work shall consist of adjusting existing manholes, street monuments, frames and covers, and other castings to the new pavement finished grade. The Contractor shall be responsible for the adjustment of utility structures in accordance with these specifications.

36.2 MATERIALS

All materials used in the adjustment shall meet the specifications under the respective sections herein for concrete and mortar, bricks, manholes, frames and covers, and other castings.

All frames and covers and castings shall be salvaged, cleaned, and re-used unless directed otherwise by the Engineer. Sound bricks recovered from existing manholes may be re-used after cleaning.

36.3 DETAILS

A. Adjusting. Unless specified otherwise in resurfacing of pavement, the existing structures within the pavement area shall not be adjusted until the resurfacing is completed. The newly resurfaced pavement shall be neatly cut in straight lines or circles. The frames and covers or other castings shall be carefully removed and cleaned. Underground structure walls shall be built up and cleaned. Underground structure walls shall be built up to the required elevations. The top of the structures shall be reconstructed to receive the cover frames or castings. Manhole cover frame shall be set in full mortar beds.

In lowering existing pavement, the existing manhole frames and covers or castings shall be removed. The walls shall be lowered to the required elevations. The manhole openings shall be temporarily covered by suitable means and the new pavement constructed over it. After the pavement has been completed, it shall be neatly cut and the temporary cover removed. The adjustment of the frames and covers or casting shall be as described above for newly resurfaced pavement.

B. Backfilling. Backfill shall be constructed with base course material placed in 6-inch layers and thoroughly compacted to not less than 95% of its maximum density.

C. Finishing. On asphalt concrete pavement, the finished surface over the compacted backfill shall be constructed with asphalt concrete. The minimum compacted thickness shall be 2 inches in residential zones and 2-1/2 inches in business and industrial zones. The specific gravity shall be not less than 91% of the specific gravity of the combined mixture without voids.

The finished asphaltic concrete surface shall be constructed within one week after manhole frames are adjusted.

The Contractor shall notify and coordinate his work with the affected agencies before adjusting any structure.

If authorized in writing by the Engineer, portland cement concrete may be used in place of asphalt concrete.

36.4 MEASUREMENT AND PAYMENT

The adjustments of existing structures shall be measured for payment by the actual number of units adjusted. Payment shall be made at the unit price bid and shall be full compensation for removing, cleaning, and adjusting the structures, backfilling and finishing the surface pavement.

The adjustments of existing structures shall be considered as incidental to the paving cost if specified in the special provisions and/or proposal.

SECTION 37 - PORTLAND CEMENT CONCRETE PAVEMENT

37.1 DESCRIPTION

This work shall consist of constructing portland cement concrete pavement for streets and other public rights-of-way. The pavement shall be constructed in accordance with the details shown on the plans and in conformance with the Standard Details and these specifications.

37.2 MATERIALS

A. Concrete. Portland cement concrete shall be Class "AA" and conform to the provisions in Section 39, "Portland Cement Concrete."

B. Joint Materials. Poured sealer for joints shall conform to the requirements of ASTM D 1190. Other types approved by the Engineer may be used.

Preformed fillers for joints shall conform to the requirements of ASTM D 994 or D 1751 as specified, and shall be punched to admit dowels where called for in the plans. The filler for each joint shall be furnished in a single piece for the full depth and width required for the joint unless otherwise authorized by the Engineer. When the use of more than one piece is authorized for a joint, the abutting ends shall be fastened securely and held accurately to shape by stapling or other positive fastening satisfactory to the Engineer.

C. Steel. Deformed bars for concrete reinforcement shall conform to the requirements of ASTM A 615, Grade 40.

Dowel bars shall be plain round bars conforming to ASTM A 615 and shall be free from deformations restricting slippage in the concrete. Before delivery to the worksite, one-half the length of each dowel bar shall be painted with one coat of lead or tar paint.

Sleeves for dowel bars to be used in expansion joints shall be metal of an approved design to cover 2 inches, plus or minus 1/4 inch, of the dowel, with a closed end and with a

suitable stop to hold the end of the sleeve at least 1 inch from the end of the dowel bar. Sleeves shall be designed so that they do not collapse during construction.

D. Curing Materials. Curing materials shall conform to the following specifications:

Type	Specification
Burlap cloth made from jute or kenaf	AASHTO M 182
White liquid membrane-forming compounds for curing concrete	AASHTO M 148, ASTM C 309
Sheet materials for curing concrete	AASHTO M 171, ASTM C 171

37.3 DETAILS

A. Subgrade. The subgrade or subbase upon which the concrete pavement is to be constructed shall be prepared in accordance with the applicable provisions in Sections 29, 30, 31 and 32.

Prior to placing the concrete, the prepared surface shall be wetted down to make it damp without the formation of puddles or mud pockets.

B. Side Forms. Forms shall be constructed of wood or metal. The use of other material shall be permitted with the approval of the Engineer. Side forms shall be placed to the required grade and alignment of the finished pavement. The forms shall be supported during the entire operation of placing, tamping, and finishing of the concrete pavement. The vertical deviation shall not exceed 1/8 inch and the horizontal deviation by more than 1/4 inch in any 10-foot section.

All forms shall be thoroughly cleaned and oiled before being placed.

C. Reinforcement. Concrete pavement shall be reinforced at structure approaches, construction joints and other locations as shown on the plans. The reinforcement steel shall meet the specifications under Section 48, "Reinforcement Steel."

D. Slipform Paving. Instead of using fixed forms, the Contractor may place concrete with a slipform paver designed to spread, consolidate, screed, and float-finish the freshly placed concrete in one complete pass of the machine. The slipform paver shall be operated with as nearly a continuous forward movement as possible and all the operations of mixing, delivering, and spreading concrete shall be so coordinated as to provide uniform progress with stopping and starting of the paver held to a minimum.

The subgrade and slipform paver track area shall be brought to proper grade and cross section by means of a properly designed and operated machine. Disturbed grade shall be properly recompacted. If any traffic is allowed to use the prepared grade, the grade shall be checked and corrected immediately ahead of placing the concrete.

E. Placing. Unless otherwise authorized by the Engineer, placing of concrete pavement shall commence at the lowest point of the work.

The concrete shall be deposited on a moist grade in such manner as to require as little rehandling as possible. Placing shall be continuous between transverse joints without the use of intermediate bulkheads. Necessary hand spreading shall be done with shovels, not rakes. Workmen shall not be allowed to walk in the freshly mixed concrete with boots or shoes coated with earth or foreign substances.

Concrete shall be thoroughly consolidated against and along the faces of all forms and along the full length and on both sides of all joint assemblies. Vibrators shall not be permitted to come in contact with a joint assembly, the grade, or a side form. The vibrator shall never be operated longer than 15 seconds in any one location.

Concrete shall be deposited as near to expansion and contraction joints as possible without disturbing them but shall not be dumped onto a joint assembly.

F. Strikeoff, Consolidation, and Finishing. The sequence of operations shall be the strikeoff and consolidation, floating if necessary, straightedging, and final surface finish. The pavement shall be struck off and consolidated with a mechanical finishing machine, vibrating screed, or by hand-finishing methods when approved by the Engineer. A slipform paver may be used.

In general, adding water to the surface of the concrete to assist in finishing operations shall not be permitted. If it is permitted, it shall be applied as a fog spray with approved spray equipment.

After the pavement has been struck off and consolidated, it shall be scraped with a straightedge 10 feet long equipped with a handle to permit operation from the edge of the pavement. Any excess water and laitance shall be removed from the surface of the pavement. The straightedge shall be operated parallel to the center line of the pavement and shall be moved forward one-half its length after each pass. Irregularities shall be corrected by adding or removing concrete. All disturbed places shall be again straightedged. The use of long-handled wood floats shall be confined to a minimum; they may be used only in emergencies and in areas not accessible to finishing equipment.

Before final finishing is completed and before the concrete has taken its initial set, the edges of the slab and curb shall be carefully finished with an edger of the radius shown in the plans.

A burlap drag or broom shall be used for final finishing. The burlap drag shall be at least 3 feet wide and long enough to cover the entire pavement width. It shall be kept clean and saturated while in use. It shall be laid on the pavement surface and dragged in the direction in which the pavement is being placed. For a broom finish, a stiff bristled broom shall be drawn from the center to the edge of the pavement with adjacent strokes slightly overlapping to produce surface corrugations of uniform appearance and about 1/16 inch in depth.

The surface of the concrete pavement shall be finished true to grade and cross section. The surface smoothness shall be tested with a 10-foot straightedge laid parallel to the road center line and the distance from the surface to the bottom of the straightedge shall not exceed 1/8 inch.

When fine cracks or hair checks appear in newly placed concrete before it is thoroughly set, immediate steps shall be taken by the Contractor to remedy the condition.

G. Curbs. Curbs shall be required along the edges of all streets where shown in the plans and shall be formed to the cross section in accordance with the plans. Curbs, and curbs and gutters, may be constructed integrally with the pavement using slipform or extrusion equipment or placed immediately after finishing operations by hand forming or using face forms. They may be constructed also as a separate operation before or after pavement construction using forms or slipform or extrusion equipment.

H. Pavement Protection. The Contractor shall have always available materials to protect the surface of the plastic

concrete against rain. These materials shall consist of burlap, curing paper, or plastic sheeting. When slipform construction is being used, materials such as wood planks or forms to protect the edges of the pavement shall also be required. The Contractor shall also protect the newly placed concrete pavement from mechanical injury, vehicular, and pedestrian traffic for the duration of the curing period.

The pavement shall not be opened to vehicular traffic for a period of 14 days or when design strength is achieved. Also, before opening to traffic, the pavement shall be cleaned.

I. Curing. Immediately after the concrete pavement is finished, the concrete shall be protected against excess loss of moisture. It shall be cured for a period of not less than 5 days.

The Contractor may use any method in curing the concrete pavement outlined in Section 39.5-E, "Curing."

J. Joints. Contraction joints, expansion joints, and all longitudinal joints shall be placed as indicated in the plans. Transverse construction joints shall be used as required. Transverse joints shall extend continuously through the pavement and curb.

K. Transverse Contraction Joints. Transverse contraction joints shall consist of planes of weakness created by forming or cutting grooves in the surface of the pavement. They shall be equal to at least one-fourth the depth of the slab.

1) Transverse strip contraction joints shall be formed by installing a parting strip to be left in place.

2) Formed grooves shall be made by depressing an approved tool or device into the plastic concrete. The tool or device shall remain in place until the concrete has attained its initial set and shall then be removed without disturbing adjacent concrete.

3) Sawed contraction joints shall be created by sawing grooves in the surface of the pavement with an approved concrete saw. After each joint is sawed, the saw cut and adjacent concrete surface shall be thoroughly cleaned.

Sawing of the joints shall begin as soon as the concrete has hardened sufficiently to permit sawing without excessive raveling, usually 4 to 24 hours. All joints shall be sawed before uncontrolled shrinkage cracking occurs. If necessary, the sawing operations shall be carried on both day and night, regardless of weather conditions. A standby saw shall be available in the event of breakdown.

The sawing of any joint shall be omitted if a crack occurs at or near the joint location before the time of sawing. Sawing shall be discontinued if a crack develops ahead of the saw. In general, all joints shall be sawed in sequence. All contraction joints in lanes adjacent to previously constructed lanes shall be sawed before uncontrolled cracking occurs. If extreme conditions make it impracticable to prevent erratic cracking by early sawing, the contraction joint groove shall be formed before initial set of concrete, as provided above.

4) Transverse formed contraction joints shall consist of a groove or cleft extending downward from and normal to the surface of the pavement. These joints shall be made while the concrete is plastic by an approved mechanically or manually operated device to the dimensions indicated in the plans.

Transverse construction joints of the type shown in the plans shall be placed whenever the placing of concrete is suspended for more than 30 minutes. A butt joint with dowels or a thickened-edge joint shall be used if the joint occurs at the location of a contraction joint. Keyed joints with tie bars shall be used if the joint occurs at any other location.

L. Transverse Expansion Joints. Transverse expansion joints shall consist of a vertical expansion joint filler placed in a butt-type joint with or without dowel bars as shown in the plans. The expansion joint filler shall be continuous from form to form, shaped to the subgrade, curb section, and to the keyway along the form. Preformed joint filler shall be furnished in lengths equal to the pavement width or equal to the width of one lane. Damaged or repaired joint filler shall not be used unless approved by the Engineer.

The expansion joint filler shall be held in a vertical position. An approved installing bar or other device shall be used if necessary to ensure proper grade and alignment during placing and finishing of the concrete. Finished joints shall not deviate in horizontal alignment more than 1/4 inch from a straight line. If joint fillers are assembled in sections, there shall be no offsets between adjacent units. No plugs of concrete shall be permitted anywhere within the expansion space.

M. Longitudinal Joints. Longitudinal joints shall consist of planes of weakness created by forming or cutting grooves in the surface of the pavement. They shall be equal to at least one-quarter the depth of the slab plus 1/2 inch.

1) Sawed longitudinal joints shall be sawed grooves made with a concrete saw after the concrete has hardened. The joint may be sawed at any time before use by construction traffic or before opening if construction traffic does not use the pavement.

2) Longitudinal groove joints are formed in the same manner as transverse formed groove joints.

3) Longitudinal strip joints are formed in the same manner as transverse strip joints.

4) Longitudinal construction joints shall be of the dimensions shown in the plans. Where a key is required, it shall be constructed by forming when the first lane adjacent to the joint is placed. These joints shall be finished with an edger of the radius shown in the plans. When placing the second slab, concrete must not be left overhanging the lip formed in the first slab by the edging tool.

5) The longitudinal joints shall be located as indicated below unless shown otherwise on the plans.

Road R/W Width	Curb to Curb Width	Joint Locations Longitudinal
Less than 50'	Less than 20'	None
	20' to 36'	Center line
56' to 60'	40'	Center line and 10 feet each side of center line
76' to 80'	60' to 64'	Center line and 10 and 20 feet each side of center line

N. Sealing Joints. Joints to be sealed shall be filled with joint-sealing material before the pavement is opened to traffic and as soon after completion of the curing period as is feasible. Just before sealing, each joint shall be thoroughly cleaned of all foreign material, including membrane curing compound, and joint faces shall be clean and surface-dry when seal is applied. Material for seal applied hot shall be stirred during heating to prevent localized overheating.

The sealing material shall be applied to each joint opening in accordance with the details shown in the plans or as directed by the Engineer. The joint filling shall be done without spilling material on the exposed surfaces of the concrete. Any excess material on the surface of the concrete pavement shall be removed immediately and the pavement surface cleaned. The use of sand or similar material to cover the seal shall not be permitted. Joint-sealing material shall not be placed when the air temperature in the shade is less than 50°F, unless approved by the Engineer.

O. Surface Tolerance. For the County of Kauai, the finished surface of the concrete pavement shall be within 0.07 foot above or below the theoretical grade. The thickness of the finished pavement shall not be less than 0.02 foot of the planned thickness of any point of the cross-section.

37.4 MEASUREMENT

Portland cement concrete pavement shall be measured for payment by the square yard based on horizontal dimensions of the finished surface of pavement.

Unless specified otherwise, reinforcement shall be measured as provided in Section 48, "Reinforcing Steel."

Subgrade and subbase preparation shall be measured as provided in Sections 29 and 30.

All joint construction, including expansion material and sealing compound, shall be included in the unit price bid for concrete pavement.

37.5 PAYMENT

Unless specified otherwise, payment shall be made at the unit price bid per square yard for the specified class and thickness of portland cement concrete pavement and per pound of steel reinforcing bars as measured above.

The unit price bid shall be full compensation for furnishing the labor, tools, equipment, materials except reinforcing steel; and for constructing, curing, and protecting the concrete pavement.

SECTION 38 - RESTORING PAVEMENTS AND OTHER IMPROVEMENTS

38.1 DESCRIPTION

All restoration work on pavements and other improvements such as driveways, sidewalks, curbs and gutters shall conform to the requirements under the Revised Ordinances of the respective Counties, as amended; under Hawaii Revised Statutes, as amended, relating to Federal-Aid Highways; and under these specifications.

38.2 MATERIALS

All materials used for restoration work shall be equal or better in quality than the materials being replaced. They shall match the existing improvements in texture and color wherever possible. Unless specified otherwise, asphalt concrete shall be Mix #4. Portland cement concrete shall be Class "AA" for concrete pavement and Class "B" for curb and gutter.

38.3 CONSTRUCTION DETAILS

Before proceeding with the restoration work, the pavement shall be power saw cut to provide clean, solid, vertical joints. Concrete sidewalk and concrete pavement shall be cut with a power saw along straight lines.

Whenever possible, cut lines shall be parallel to or at right angle to the street center line.

A. Asphalt Concrete Pavement. The asphalt concrete mixture shall be placed on the prepared base and compacted to 95% of its maximum density. The minimum compacted thickness shall be 2 inches in residential zones and 2-1/2 inches in business and industrial zones. The finished surface shall be slightly humped not to exceed 3/8 inch for pavement width of less than 2 feet and 3/4 inch for width greater than 2 feet.

B. Concrete Pavement. The edges of existing concrete pavement shall be wire brushed and washed with water before placement of the new concrete. The restored pavement shall have a minimum thickness of 6 inches. The finished surface shall be flush with the existing surface and shall be broomed lightly.

C. In replacing curbs, gutters, sidewalks and driveways, the junctions with the existing improvements shall be along straight lines, preferably along the scored lines or

joints. Breaking or cutting of precast curb blocks will not be permitted. The entire unit shall be removed and if in good condition, salvaged and re-used. Concrete gutter shall be reconstructed for the full width of the gutter with a minimum thickness of 6 inches.

Where more than one-half the width of the scored block of the sidewalk is to be restored, the entire scored block shall be removed and reconstructed with concrete 4 inches minimum thickness.

38.4 MEASUREMENT

Unless specified otherwise in the special provisions and/or proposal, restoration work other than trench repavement shall be considered as incidental to the various related items of work.

No measurement for payment shall be made for restoration work on any existing improvements damaged, undermined, or destroyed as a result of the Contractor's operations. The Contractor shall restore the improvements at his own expense.

Trench repavement shall be measured for payment by the square yard. Measurement shall be based upon the payment trench width. Where the Engineer determines that the trench requires trimming back 6 inches on both sides of the trench, measurement shall be based upon the payment trench width plus one foot. Any repavement required beyond this width shall be done by the Contractor at his own expense.

38.5 PAYMENT

Unless specified otherwise in the special provisions and/or proposal, payment for restoration work other than trench repavement shall not be paid for directly but shall be as included in the various related items of work.

Payment for trench repavement shall be made at the respective unit price bid per square yard for repaving State Highway pavement and for repaving City and County Road pavement as measured above.

SECTION 39 - PORTLAND CEMENT CONCRETE

39.1 DESCRIPTION

This section shall apply to portland cement concrete for use in the various types of concrete structures and concrete pavements, and to cement mortar. The furnishing and storing of portland cement and aggregates, mixing, transporting and placing the concrete of the various classes, and curing and finishing the concrete structures shall conform to the requirements specified herein.

39.2 MATERIALS

A. Portland Cement. Cement for all classes of concrete and mortar other than concrete and mortar for sewerage structures shall conform to the requirements under ASTM Designation C 150, Type I or Type II.

Cement for concrete and mortar for sewerage structures shall be Type II portland cement or shall be modified Type I portland cement except that the amount of tricalcium aluminate shall not exceed 8 percent. Mill certificates shall be furnished upon request of the Engineer.

Cement shall at all times be adequately protected from rain and dampness. Any cement which in the opinion of the Engineer has deteriorated shall be rejected.

B. Aggregates. Aggregates shall conform to the specifications of ASTM Designations:

C 33 for use in concrete,
C 330 for use in lightweight reinforced concrete, and
C 144 for use in masonry mortar.

When tested in accordance with AASHTO T 96, aggregates shall show a wear of not more than 50% at 500 revolutions.

The maximum aggregate size for use in concrete shall be 1 inch unless specified otherwise in the special provisions. When concrete is to be used in structures less than 6 inches in thickness, the maximum aggregate size shall be 3/4 inch.

All aggregates shall be clean, free from debris and other extraneous materials. They shall be stored in such a manner as to prevent intrusion of foreign matter.

1) Fine Aggregate. Fine aggregate shall consist of beach sand, manufactured fines, or a combination thereof. No coral beach sand shall be used in concrete for sewage structures.

Fine aggregate shall be graded within the following limits:

Sieve Size	Percentage Passing by Weight
3/8"	100
No. 4	95 to 100
No. 8	80 to 100
No. 16	50 to 85
No. 30	25 to 60
No. 50	10 to 30
No. 100	2 to 10

2) Coarse Aggregate. Coarse aggregate shall be graded for the maximum size specified within the following limits:

COARSE AGGREGATE - ASTM DESIGNATIONS

Sieve Size	Percentage Passing by Weight No. 67	No. 57
1-1/2"	--	100
1"	100	95 to 100
3/4"	90 to 100	--
1/2"	--	25 to 60
3/8"	20 to 55	--
No. 4	0 to 10	0 to 10
No. 8	0 to 5	0 to 5

C. Water. Water shall be clean and free of oil, acid, salt, alkali, organic matter, or other deleterious substances.

D. Admixture. All water reducing, set retarding admixtures shall meet the requirements of ASTM C 494, Type D; all air entraining admixtures shall meet the requirements of ASTM C 260; or as specified in the special provisions.

39.3 CONCRETE CLASSIFICATION AND QUALITY

A. Classification. All concrete mixtures shall conform to the requirements in the following Table 1-39.

TABLE 1-39	CONCRETE	CLASSIFICATION AND QUALITY
Classification	Water*	Compressive** Strength
AAA, AAA-S	5.0	4,000
AA, AA-S	5.4	3,500
A, A-S	6.6	3,000
B, B-S	7.3	2,500
C	8.0	2,000

*Gallons of water per bag of cement: maximum allowable.

**Pounds per square inch at 28 days: minimum strength (f'c). The above data are for normal weight aggregates without any admixtures.

The minimum strength requirements shall be satisfied if the following conditions are met:

The averages of all sets of three consecutive strength test results equal or exceed the required f'c and no individual strength test result falls below the required f'c by more than 500 psi, where each strength test result shall be the average of two cylinders from the same sample.

The Engineer shall have the option to request additional testing on the concrete represented by the questionable test cylinder results.

When by additional testing, the concrete still fails to meet the minimum strength requirements as set forth above, the Engineer may require the faulty concrete to be removed and replaced, or the structure reinforced to support the original design loads. All cost for the corrective work shall be borne by the Contractor.

Unless specified otherwise on the plans, special provisions, or in the proposals, all concrete shall be Class "A," using normal weight aggregates.

The Contractor shall submit to the Engineer the design mix he intends to use and secure approval before actual concrete pouring operations.

B. Job-Site Mixed Concrete. Any type of mixer may be used with the approval of the Engineer. All mixers shall be equipped with a suitable timing device.

Mixing equipment shall be kept in first-class condition at all times. The interior of the drum shall be kept free of incrustation of concrete.

The drum shall be completely emptied before receiving materials for the next batch. After the materials are added, it shall revolve at the rate of speed designated by the manufacturer of the particular mixer, but it shall make not less than 14 nor more than 20 revolutions per minute. The size of concrete batch shall not exceed the rated capacity of the mixer.

The mixing time shall be not less than the equipment manufacturer's minimum mixing time nor more than 5 minutes after all the solid materials are placed into the drum. Water shall be placed into the drum by the end of the first quarter of the required mixing time.

C. Ready-Mixed Concrete. Ready-mixed concrete may be used. The mixing, transporting, placing, and the quality of the concrete shall meet the requirements as specified under ASTM Designation C 94.

D. Concrete for Sewerage Structures. Where concrete in any structures is to come in direct contact with sewage or sewage gases, and where otherwise required by these specifications or called for on the drawings, the concrete shall satisfy the requirements of Class "AAA-S," Class "AA-S," Class "A-S," or Class "B-S." The concrete shall contain no limestone or coral aggregate. An approved admixture whose active ingredient is a metallic salt of hydroxylated carbonic acid and conforming to ASTM C 494, Type D, shall be added in strict accordance with the manufacturer's recommendation.

E. Concrete Slump. The consistency of the concrete shall be determined by the slump test made in accordance with the current "Standard Method of Slump Test for Consistency of Portland Cement Concrete," ASTM C 143, or by ASTM C 360 (Kelley Ball) when approved by the Engineer. Unless specified otherwise, the slump for the different types of concrete structures shall conform to the following requirements:

Types of Construction	Slump in Inches
Road Pavement	2 (max.)
Reinforced Concrete Structures:	
Heavy Section	3 (max.)
Thin Sections and Columns ..	4 (max.)
Concrete Placed Under Water	6 (min.)
	8 (max.)

39.4 CEMENT MORTAR

Cement mortar shall be composed of portland cement, fine aggregate, and water proportioned and mixed as specified in these specifications or in the special provisions for the particular use intended. The proportion varies from equal volume of cement to fine aggregate to one part cement to three parts fine aggregate.

Fine aggregates shall meet the requirements of the following limits:

FINE AGGREGATES FOR MORTAR

Sieve Size	Percentage Passing by Weight	
	Natural Sand	Man'f. Fine
3/8"	100	
No. 4	95 to 100	100
No. 8	- -	95 to 100
No. 16	- -	60 to 100
No. 30	- -	35 to 70
No. 50	- -	20 to 40
No. 100	0 to 5	10 to 25
No. 200	- -	0 to 10

Where the mortar is to come i direct contact with sewage or sewage gases, the fine aggregate shall contain no coral sand.

One pound of Master Builders Co. "O.M." or approved equal shall be added per sack of cement.

39.5 PLACING

A. Placing Concrete. Concrete shall be batched only in such quantities as are required for immediate use and placement. Any concrete having initial set before placing and finishing shall be discarded and shall not be used for the work. No remixing with water or with other materials shall be permitted once the initial set has taken place.

Concrete shall be placed as nearly as possible in its final position so as to avoid segregation of the materials and displacement of the reinforcement. The placement shall be completed within 30 minutes after water is first added to the mix. However, when the concrete is continually agitated, the time may be extended to 1-1/2 hours. Retempering shall not be permitted after the concrete has stiffened.

No concrete shall be poured in the absence of the inspector.

Open trough and chutes shall be of metal or metal lined and shall be kept clean and free from coatings of hardened concrete. Wood chutes treated with form oil may also be used.

Concrete shall not be dropped a distance of more than 5 feet unless approved in writing by the Engineer.

Concrete shall not be placed in horizontal members or sections until the concrete in the supporting vertical members or sections has been consolidated.

B. Compacting. With the exception listed herein, all concrete shall be compacted with high frequency internal vibrators immediately after placing. The use of internal vibrator shall not be required in thin sections, thin slabs on ground, sidewalks, or inaccessible locations where compaction by vibrator is not practicable. Approved spading tools shall be used wherever the use of vibrators is not practicable or suitable.

The use of external vibrators for compacting concrete shall be permitted where the concrete is inaccessible for adequate compaction by internal vibrators and provided the forms are constructed sufficiently rigid to resist displacement or damage from external vibration.

Sufficient number of vibrators shall be used to thoroughly work the concrete around the reinforcement and embedded fixtures and into corners and angles of the forms. The duration of the application of vibration shall be the minimum time required to compact the concrete in place and not cause separation of the materials.

Concrete shall be provided in sufficient quantities for continuous pour of the structure or unit section to avoid formation of cold joints. When work stoppage is required, a construction joint shall be made and constructed at locations shown on the drawings or approved by the Engineer. Before resuming concreting, the joint shall be thoroughly cleaned and wetted.

C. Curing. Newly placed concrete shall be maintained above 50°F and in a moist condition for at least the first 7 days after placing, except that high-early-strength concrete shall be so maintained for at least the first 3 days.

Sprinklers, saturated mats, waterproof paper, white polyethylene sheeting, liquid membrane, or a combination of these may be used to cure the concrete. The manner of application and the quantity used shall be as specified by the manufacturer or as approved by the Engineer.

39.6 MEASUREMENT

All portland cement concrete placed, finished, and cured shall be measured for payment as specified in the various items of work as provided for in the proposal.

When unit volume is specified, it shall be measured in cubic yards and shall be computed by using the dimensions of the concrete structures as shown on the plans.

Cement mortar shall not be measured and paid for separately, but shall be included in the bid prices of the various appropriate items of work.

39.7 PAYMENT

Payment for portland cement concrete as measured above or as provided for in the proposal, shall be full compensation for furnishing the necessary equipment, labor, and materials to complete the concrete structure in place.

SECTION 40 - CONCRETE STRUCTURES

40.1 DESCRIPTION

This work shall consist of constructing concrete structures as required herein, in the plans and in the special provisions.

The work shall comply with and conform to the standard practices and codes as set forth by the American Concrete Institute, the Concrete Reinforcing Steel Institute, and the "Uniform Building Code."

40.2 MATERIAL

Materials used in this work shall meet the requirements and specifications under the following applicable sections and test designations:

Section 39, "Portland Cement Concrete"
Section 48, "Reinforcing Steel"
ASTM D 1751, D 1752 and D 994
for expansion joint fillers

Class "A" concrete shall be used throughout the work, unless another class or strength is designated on the plans or in the special provisions.

40.3 DEWATERING

Pumping of water shall not be permitted from the interior of any structure foundation when such pumping will cause settlement of the adjacent ground or existing improvements. Pumping shall not be permitted during the placing of concrete, or for a period of at least 12 hours thereafter, unless it is done from a suitable sump separated from the concrete work by a tight wall. The dewatering operation must conform to the requirements of the State Department of Health.

40.4 FORMS

The finished forms shall be smooth and true to the required dimensions and grades, with mortar tight joints. Forms shall have sufficient strength to resist springing out of shape during the placing of concrete. The inside surfaces shall be thoroughly coated with form oil.

Forms may be of wood, metal, or any other material at the option of the Contractor, provided that the forms are

constructed to meet the requirements herein. Surfaces of metal forms shall be free from irregularities, dents, or sags. Knot holes and broken pieces in wood forms shall be covered with metal sheet.

Forms for girders and slabs shall be cambered unless otherwise noted. Bevel strips shall be provided in corners of columns and beam boxes for chamfering corners.

40.5 REMOVAL OF FORMS

Forms shall not be disturbed until the concrete has set. They shall not be removed until the concrete has hardened and has attained the necessary strength to support its own weight and any construction live loads. Forms and supports shall not be removed without the consent of the Engineer.

The listing below serves only as a guide in determining the minimum length of time required before removal of forms and is based on the use of Type I portland cement. When high early strength portland cement or high quality concrete is used, the length of time listed below may be reduced.

Walls in mass work	24 hours
Thin walls (12 inches or less) and sides of beams and girders ..	48 hours
Columns	7 days
Bottom forms of beams, girders, and slabs	7 to 14 days

Any method of form removal likely to cause over-stressing of the concrete shall not be permitted. Supports shall be removed in such a manner as to permit the concrete to uniformly and gradually take the stress due to its own weight. The Contractor shall be responsible for safe practice in removing and shoring and for placing adequate reshores.

After the forms are removed from any concrete work, the Contractor shall immediately cut all embedded wire and nails at a point at least 1/2 inch inside the concrete surface and fill the resulting void with mortar.

40.6 SURFACE FINISHES

All concrete surfaces of structures other than top surfaces as outlined in Section 40.7 herein below shall be finished with an ordinary finish either as a final finish or preparatory to a higher class finish. Surfaces exposed to public view from travelways shall have a higher class finish.

A. Class 1, Ordinary Finish. This finish shall apply to all concrete surfaces with the exceptions as noted herein.

1) All form metal ties shall be removed to a depth of at least 1/2 inch below the surface of the concrete and the resulting holes cleaned and filled with mortar. Metal ties projecting into the cells of box griders shall be removed flush with the concrete surface. Mortar shall consist of 1 part of cement to 2 parts of fine aggregate by volume.

2) All fins caused by form joints and other projections shall be removed except on surfaces which are to be buried or which are to be completely enclosed.

3) All honey combed areas shall be cleaned and filled with mortar. Extensive honey combed areas, which in the opinion of the Engineer, are of such an extent or character as to affect the strength of the structure materially shall be removed and replaced.

B. Class 2, Rubbed Finish. This finish shall be applied to concrete surfaces visible from travelways, interior of rooms, large culverts, pedestrian underpasses, exposed surfaces of bridges, abutments and walls, and to such other surfaces as specified in the special provisions.

After the completion of the ordinary finish, all irregularities and unsightly bulges shall be removed by the use of power carborundum stones or discs. The surface shall then be sanded with a power sander or other approved abrasive as required to obtain a uniform texture. Depressions due to form marks and other imperfections shall be repaired.

C. Class 3, Cement-Wash Finish. When a cement-wash finish is specified, the Contractor shall first complete the ordinary finish and the rubbed finish.

A thin coat of cement-water mixture, with additives as required, shall then be steel trowelled over the surface area. The finished surface shall be uniform in color and texture and free from air pockets. The cement wash shall not peel or rub off after curing and drying.

Unless specified otherwise, all surfaces of concrete rail posts, railings, and rail bases shall have a cement-wash finish.

40.7 FINISHING OF TOP SURFACE

Top surfaces shall include all floor slabs, suspended slabs, bridge decks, tops of culverts and other similar surfaces. After the concrete has been placed and compacted, the surface shall be struck off with a strike board. After striking off, the surface shall be floated, not less than 2 times with wood floats, until all excess water is removed. After the concrete has hardened sufficiently, a final finish with a steel trowel or other finish specified in the plans or special provisions shall be applied. The top surfaces of sidewalks and other pedestrian concrete surfaces shall receive a non-slip finish.

40.8 MISCELLANEOUS DETAILS AND REQUIREMENTS

A. Falsework. When requested, calculations, manufacturers brochures, and detailed plans of the falsework shall be furnished by the Contractor at least 2 weeks prior to the construction of the falsework. The Contractor shall be responsible for the safety and adequacy of all falsework.

B. Weep Holes. Weep holes, 3 inches in diameter and spaced at 8-foot intervals, shall be constructed in retaining walls, wing walls and abutment walls unless shown otherwise on the plans. A minimum of 2 cubic feet of filter material conforming to the requirements of Section 28.2G at each weep hole shall be provided.

C. Slots, Recesses, and Anchors. Unless noted otherwise, the Contractor shall furnish and set all inserts, anchors, ties, and hangers required to secure the work of other trades.

40.9 MEASUREMENT AND PAYMENT

The completed concrete structure shall be measured for payment based on unit prices or lump sum as set forth in the proposal. Where payment is provided for on the basis of unit prices, measurement shall be by the cubic yard of concrete based on the dimensions shown on the plans or ordered by the Engineer.

Payment shall be made at the unit price bid or lump sum bid and shall be full compensation for furnishing the materials, tools, equipment and labor necessary to complete the structure in place.

Unless indicated otherwise in the special provisions or proposal, no direct payment shall be made for reinforcing steel.

SECTION 41 - CONCRETE CURB AND GUTTER

41.1 DESCRIPTION

This work shall consist of constructing concrete curb and gutter to the established line and grade. The gutter shall be cast in place on a prepared subgrade, and the curb shall be of precast units or cast in place as an integral structure with the gutter.

41.2 MATERIALS

All curbs and gutters shall be constructed with Class "B" concrete containing an admixture conforming to ASTM C 494, Type D, unless designated otherwise on the plans or in the special provisions.

A. Precast Curb Blocks. The dimension of the curb blocks shall conform to the dimensions shown in the Standard Details. The front and top exposed faces and the top 2 inches of the back face of the curb block shall be smoothly finished. No air pockets or exposed rock shall appear on any surface.

Any precast curb block which does not conform to the standard dimensions or surface finish shall not be used.

B. Cast-in-Place Gutter or Cast-in-Place Curb and Gutter. Concrete gutter or integral curb and gutter shall be formed on a prepared subgrade or subbase and shall be true to the established line and grade. The dimensions and slope shall conform to the Standard Details and as shown on the construction plans.

All through gutters across street intersections and wherever specified on the plans shall be reinforced with galvanized welded wire fabric with a minimum cover of 2 inches. Unless specified otherwise in the Standard Details for the County, the wire fabric shall be 6"x6"-6/6.

C. Forms. Form materials shall be free from warps, bends, twists, or other defects which will impair the appearance of the completed work.

Wood forms shall be surfaced on the upper edges and on the sides against which the concrete is to be placed.

Form sections when set in place shall possess adequate strength and rigidity to remain true to the established line and grade.

41.3 DETAILS

A. Subgrade. Before erecting the forms, the subgrade or subbase shall be graded and compacted. Wherever unsuitable material is encountered, it shall be removed and replaced with select borrow and compacted to the required elevation in accordance with the requirements under Section 12, "Roadway Excavation."

B. Erecting Forms. All forms, wood or metal, shall be clean and oiled prior to setting in place. The erected forms shall be adequately secure to prevent movement in any direction during placement of the concrete.

C. Placing Precast Curb Blocks. All curb blocks shall be placed on a prepared subgrade, well bedded and true to the established line and grade. The joints between blocks shall be 1/2 inch wide. The joints shall be filled with mortar for the full depth and height of the blocks. After the mortar has gained sufficient strength, the backfill shall be thoroughly and carefully tamped into place.

D. Placing Concrete. Prior to pouring concrete, the prepared subgrade or subbase shall be dampened. The concrete shall be poured, spaded, and tamped thoroughly into the forms.

E. Finishing. Within a few hours after placing of concrete, the gutter or the integral curb and gutter forms shall be removed and the exposed faces shall be hand finished with a steel trowel and all irregularities corrected. All exposed edges shall be rounded with an edging tool.

On grades exceeding 6%, the gutter surface shall be lightly broomed in the direction parallel to the curb face.

F. Joints. Transverse weakened plane joints shall be formed on the gutter or on the integral curb and gutter spaced as shown on the plans. The joints shall not exceed 12-foot intervals. The joints may be formed with a removable metal strip or by sawing. Construction joints shall be keyed with a minimum of one #3 tie bar 15 inches long.

G. Curing and Protecting. The newly formed concrete curb and gutter shall be cured as specified under Section 39, "Portland Cement Concrete."

Barriers shall be erected and maintained for at least 5 days to prevent accidental damage to the curb and gutter.

H. Maintenance. The Contractor shall repair and clean, at his own expense, all curb and gutter damaged, discolored, or splashed with asphalt or concrete during construction. Damaged section shall be removed entirely and reconstructed. No patching or refinishing shall be permitted.

41.4 MEASUREMENT AND PAYMENT

Measurement for payment shall be by the lineal foot based on the actual work completed in place.

Payment for curb and gutter shall be made at the unit price bid per lineal foot and shall be full compensation for furnishing all material, tools, equipment, and labor necessary to construct the work including the subgrade preparation.

SECTION 42 - CONCRETE SIDEWALK

42.1 DESCRIPTION

This work shall consist of constructing concrete sidewalks and other walkways to the established line and grade.

42.2 MATERIALS

Unless specified otherwise on the plans, Class "B" concrete containing an admixture conforming to ASTM C 494, Type D, and/or ASTM C 260, shall be used in constructing the sidewalks. Premolded expansion joint filler shall conform to the requirements under ASTM D 1751.

42.3 DETAILS

A. Subgrade. The sidewalk area shall be graded to the required cross section, watered and thoroughly compacted to the established subgrade. Whenever unsuitable material is encountered, it shall be removed to a depth of 6 inches below the subgrade surface and replaced with select borrow and thoroughly compacted.

B. Forms. Metal or wood forms shall be free from warp, and shall be clean and oiled before setting in place. The forms shall be true to established line, grade and cross slope. The forms shall be sturdy and rigidly held in place by stakes, clamps, spreaders or braces to insure against movement during and after placement of concrete.

C. Placing and Finishing. Prior to pouring of concrete, the subgrade shall be dampened. Concrete shall be poured continuously and shall be thoroughly tamped and floated to a smooth and even surface. The pouring and constructing of alternating blocks shall not be permitted.

The finished surface shall be scored into squares with sides equal to the sidewalk width, in 4-foot squares, or as shown on the plans.

D. Joints. Expansion joints shall be constructed at every 96- to 100-foot spacing and at the beginning and at the end of curb returns. The joints shall be constructed with premolded expansion type filler. Contraction joints shall be spaced no farther than 30 feet apart. Construction shall be as specified under Section 37, "Portland Cement Concrete Pavement."

E. Curing and Protecting. The finished concrete sidewalk shall be cured as specified under Section 39, "Portland Cement Concrete," and shall be protected against damage or defacement of any kind. Sidewalk which is not acceptable by the Engineer because of damage or defacement shall be removed and replaced by the Contractor at his own expense.

42.4 MEASUREMENT AND PAYMENT

Concrete sidewalk shall be measured for payment by the square foot. Payment shall be made at the unit price bid and shall be full compensation for furnishing the material, tools and labor necessary to complete the work, including the preparation of the subgrade.

SECTION 43 - CONCRETE BLOCKS, CRADLES AND JACKETS

43.1 DESCRIPTION

This work shall consist of constructing concrete blocks, cradles, and jackets in accordance with these specifications and to the dimensions shown on the drawings.

43.2 MATERIAL

A. Non-reinforced Concrete Blocks, Cradles, and Jackets. Concrete shall be Class "C" and shall conform to the requirements under Section 39, "Portland Cement Concrete."

B. Reinforced Concrete Blocks, Cradles, and Jackets. Concrete shall be Class "B" and shall conform to the requirements under Section 39, "Portland Cement Concrete." Reinforcing steel shall conform to the requirements under Section 48, Reinforcing Steel."

43.3 CONSTRUCTION DETAILS

A. Concrete Blocks. The dimensions of the precast concrete blocks shall be as indicated in the Standard Details or as shown on the plans.

The blocks shall be placed adjacent to each bell on both pipes and fittings. Wherever pipe is laid without a cradle or is over 4 feet in laying length, the pipe shall have two blocks for support. One block shall be placed adjacent to the bell and the other approximately at the middle.

B. Concrete Cradles. When directed by the Engineer or where shown on the plans, concrete cradles shall be constructed under the entire length of the pipe. The width and depth of the cradle shall be as indicated in the Standard Details or as shown on the plans. Before placing the concrete, the pipes shall rest firmly on concrete blocks. The concrete shall be tamped into place. No keyways or curing shall be required.

Reinforcement when called for shall be of the sizes specified and shall be spaced as shown on the detail drawings.

C. Concrete Jackets. Concrete drain pipes and sewer pipes may be jacketed in place or precast and lowered into place.

SECTION 44 CEMENT RUBBLE MASONRY

44.1 DESCRIPTION

This work shall consist of furnishing and placing of cement mortar and rocks to the lines and grades shown on the plans and as specified under these specifications.

44.2 MATERIALS

A. Stone. Stone shall be clean, durable, free from seams or other imperfection. When tested under AASHTO Test Method T96, it shall show a wear not to exceed 50%. It shall have a minimum specific gravity of 2.4. The sizes and shapes shall be as shown on the plans or specified in the special provisions.

B. Mortar. Mortar for bedding shall consist of one part cement and not more than three parts fine aggregate. It shall meet the requirements as provided in Section 39, "Portland Cement Concrete." Hydrated lime may be added to the mortar and the quantity shall not exceed the recommendation of the manufacturer. The lime shall be treated as an addition to and not as replacing any cement. Sufficient water shall be used to provide a workable consistency. Mortar shall be used and placed in final position within 1½ hours after mixing.

44.3 DETAILS

Large flat stones shall be selected for the bottom or first course and shall be laid in a full mortar bed in practically horizontal position. Selected stones, roughly squared and pitched to lines, shall be used at all angles and end faces of walls. All stones shall be fully bedded in mortar and so placed as to break joints at least 6 inches.

Headers shall be as detailed on the drawings.

The face stones shall be well bedded without spalls. Natural flat surface or cut face of stones shall be used in the exposed face of the wall. Space between the backing stones shall be filled with spalls and mortar. Voids in any part of the wall shall not be permitted.

Weep holes 3 inches in diameter shall be provided in the walls at locations shown on the plans or at approximately 8-foot centers. Filter material conforming to the requirements of Section 28.2G, at least 2 cubic feet in volume, shall be placed at each weep hole.

Stones for the top course shall be wide enough to cover the top of the wall with the top face practically flat. They shall be set in full mortar bed.

Unless specified otherwise by the Engineer or in the plans and/or special provisions, jointing shall be made according to the following procedure. After the stones are placed, loose mortar shall be removed from the wall faces. The joints shall be cleaned of all mortar to a depth of 1 inch, wetted, and pointed with portland cement mortar mixed in the proportions of one part cement to one part fine aggregate or beach sand by volume. The pointed masonry shall be kept moist for a minimum period of 24 hours.

Cement rubble masonry walls shall be finished with a 2-inch mortar capping composed of one part cement to 2 parts fine aggregate or beach sand.

44.4 MEASUREMENT

Cement rubble masonry shall be measured for payment in cubic yards, which shall be computed based on the dimensions shown on the plans or ordered by the Engineer.

44.5 PAYMENT

Payment shall be made at the unit price bid per cubic yard as measured above, and shall be full compensation for furnishing all materials, labor, tools, and incidentals necessary to construct the work in place. Excavation for foundations shall be measured and paid for under Section 13, "Structure Excavation and Backfill."

SECTION 45 CONCRETE MASONRY UNITS

45.1 DESCRIPTION

This work shall include furnishing and installing concrete masonry units as indicated on the plans.

45.2 MATERIALS

Concrete masonry units shall be manufactured with sand-gravel aggregates and portland cement and shall conform to

ASTM C 55 for building brick,
ASTM C 90 for hollow loadbearing masonry units, and
ASTM C 145 for solid loadbearing masonry units.

Unless specified otherwise, hollow load-bearing masonry units shall be 8" x 8" x 16" nominal size and building brick shall be 2" x 4" x 8" nominal size. The masonry units delivered at the job site shall be uniform in color and texture for the entire lot.

Cement shall be portland cement conforming to ASTM C 150, Type I or Type II. Masonry cement shall conform to ASTM C 91. Hydrated lime shall conform to ASTM C 207.

Horizontal reinforcement for CMU walls shall be made from cold drawn steel conforming to ASTM A 82 and shall be hot-dip galvanized after fabrication.

45.3 DETAILS

A. Workmanship. Every part of the masonry work shall be executed in the best workmanlike manner in accordance with accepted good practice of the trade and in full compliance with applicable building codes and ordinances.

All masonry work shall be plumb, level, straight, and true to dimensions shown on the plans.

B. Masonry Units. No concrete masonry units shall be laid on a newly poured concrete foundation until at least 24 hours after the concrete has been poured. Masonry

units shall be laid on mortar bed with "push joints," and no slushing or grouting of a joint shall be permitted. Dampening of masonry units prior to laying shall not be permitted unless specified otherwise in the special provisions.

C. Mortar. Mortar shall be freshly prepared and uniformly mixed at the job site and shall conform to ASTM C 270, except that the mortar shall develop a compressive strength of 2,500 psi at 28 days. The following table may be used as a guide.

MORTAR

(Proportions by Volume)

Portland Cement	Masonry Cement	Hydrated Lime* Min.	Hydrated Lime* Max.	Damp Loose Aggregate
1	---	1/2	1-1/4	Not less than 2-1/4 and not more than 3 times the sum of the volumes of cement and lime used.
---	1	---	---	

*When plastic or waterproof cement is used, hydrated lime may be added, but not in excess of one-tenth the volume of cement.

D. Joints. Horizontal and vertical masonry joints shall be approximately 3/8-inch wide with full mortar coverage on the face shells and on the webs. Unless specified otherwise in the plans or special provisions, faces of all joints shall be tooled with a round bar to produce a slightly concave surface.

E. Reinforcing. Unless noted otherwise in the plans or special provisions, the following reinforcing shall be used in the work:

Horizontal reinforcing: Horizontal reinforcing shall be placed in the mortar beds at 24-inch intervals, and the area of reinforcement shall not be less than 0.0013 times the gross cross-sectional area of the wall. Horizontal reinforcing shall be lapped at all joints and corners.

Vertical Reinforcing: One #4 reinforcing bar shall be placed at 32-inch intervals and at all openings, corners and beginning and end of walls.

For Seismic Zones 2 and 3, the reinforcing shall be placed in accordance with Seismic Zones 2 and 3 design criteria, respectively. All cells with reinforcing shall be grouted with 2500 psi concrete with 3/8-inch maximum size aggregate.

Lintels: Adequately reinforced lintels shall be placed above all openings.

F. Protection and Curing. The Contractor shall protect the adjoining work from mortar droppings. The newly laid masonry shall be protected from accidental damage and rain until the mortar has set.

45.4 MEASUREMENT AND PAYMENT

Measurement for payment of concrete masonry units shall be by the square foot, linear foot, or lump sum as provided for and indicated in the proposal. Payment made at the bid price shall be full compensation for furnishing all labor, materials, tools, and equipment and performing all work involved in constructing such concrete masonry in place complete as shown on the plans.

SECTION 46 REINFORCED CONCRETE DRIVEWAY APRONS

46.1 DESCRIPTION

This work shall consist of constructing reinforced concrete driveway aprons in conformity with the Standard Details and as shown on the plans.

46.2 MATERIALS

Class "B" concrete containing an admixture conforming to ASTM C 494, Type D, and/or ASTM C 260, shall be used in constructing the reinforced concrete driveway aprons. Unless specified otherwise in the Standard Details for the County, reinforcement shall be 6"x6"-6/6 galvanized welded wire fabric.

46.3 DETAILS

A. General. Concrete aprons shall be constructed on improved streets with curbs and shall extend from the back of the curb to the property line. The details and dimensions shall conform to the Standard Details and the plans.

B. Existing Curbs and Sidewalks. Existing curb blocks and sidewalk shall be removed before constructing the apron. Where the curbing is the precast units, whole units shall be removed. Pre-cast drop curb blocks and driveway curbs may be installed or the curb may be cast integrally with the driveway apron as shown on the Standard Details. Where the curbing is of the cast-in-place type, the curb shall be neatly cut off with a concrete saw either vertically or diagonally starting at the curb-gutter line and the apron constructed as shown on the Standard Details.

C. Placing and Finishing. Before pouring concrete, the subgrade and the forms shall be prepared in conformity with the requirements under Section 42, "Concrete Sidewalks."

The concrete shall be placed on the prepared subgrade. The reinforcing mesh shall be placed at mid-depth of the driveway apron. The concrete shall be floated to a smooth and even surface.

The finished surface of aprons shall be broom finished and scored as shown on the Standard Details.

46.4 MEASUREMENT AND PAYMENT

Reinforced concrete driveway aprons shall be measured for payment by the square foot. Payment shall be made at the unit price bid and shall be full compensation for removing existing improvements, preparing the subgrade or subbase, and furnishing the necessary material, tools, and labor to construct the work in place, including reinforcement.

SECTION 47 STEEL STRUCTURES

47.1 DESCRIPTION

This work shall consist of constructing steel structures as shown on the detail drawings and plans, as specified in the special provisions, and in conformance with these specifications. This work shall include furnishing, erecting, fabricating, and painting of the steel structures and appurtenant items.

47.2 MATERIALS

Steel used in the completed structures shall be of the quality designated on the plans or in the special provisions.

Unless noted otherwise, carbon steel shapes, plates, and bars of structural quality for use in the construction of bridges, buildings, and for general structural purposes shall conform to the specifications of ASTM A 36. Bolts, nuts, and washers shall conform to the requirements of ASTM A 307. All anchor bolts, including nuts and washers, shall be hot-dip galvanized in accordance with ASTM A 123 or cadmium-plated. High strength bolts and hardware including nuts and washers where called for on the plans, shall conform to the requirements of ASTM A 325. Bolts and hardware including nuts and washers, cast iron, wrought iron, and specialty grade steel shall conform to the applicable ASTM specifications.

47.3 FABRICATION AND CONSTRUCTION DETAILS

Fabrication of components, erection of steel members, and the workmanship shall be performed under recognized standard structural and engineering practices, and as specified under current editions of the "Uniform Building Code" and the American Institute of Steel Construction's "Manual of Steel Construction."

A. Boltholes. Holes may be punched full size, punched and reamed, or drilled. The finished holes shall be 1/16 inch larger than the diameter of the bolt.

B. Welding. Welding and all inspection of welding made to control the quality of welds and workmanship shall be performed in accordance with the requirements of the American Welding Society. Welding in the shop and in the field shall be done by operators who have been previously qualified by tests as prescribed by the American Welding Society's "Standard Qualification Procedure."

Surfaces to be welded shall be free from loose scale, rust, grease, paint, and other foreign materials.

C. Surface Preparation for Painting. All steel surfaces to be painted shall be dry, free from rust, scale, oil, grease, and other detrimental foreign matter. The surfaces shall be prepared by hand cleaning, solvent cleaning, power tool cleaning, or blast cleaning.

Oil, grease, soil, drawing and cutting compounds, and other contaminants shall be removed by the use of solvents, emulsions, cleaning compounds, or steam.

Loose mill scale, loose rust and loose paint shall be removed by hand cleaning, power tool cleaning or blast cleaning. Hand cleaning shall include hand hammering, hand chipping, or hand wire brushing. Power tool cleaning shall include power wire brushing, power impacting, power grinding, power sanding, or by a combination of these methods. Blast cleaning shall include dry sandblasting, wet or water vapor sandblasting, grit blasting, or shot blasting.

D. Painting. All surfaces to be painted shall be clean, dry, free from dust, rust, scale, oil, grease, and other detrimental foreign matter.

All surfaces shall have one shop and one field coat of red lead and two finish coats of aluminum or exterior enamel paint in accordance with the plans. All paint shall come from new unopened containers and shall be applied in accordance with manufacturer's instructions.

47.4 SHOP DRAWINGS

A minimum of six sets of shop drawings shall be submitted by the Contractor to the Engineer for review and approval. The drawings shall show and give complete information for the fabrication and erection.

The Contractor shall be responsible for the accuracy of the shop drawings, although the drawings may have been reviewed and approved by the Engineer. He shall also be responsible for shop fits and field connections.

47.5 PAYMENT

The cost of structural steel items shall not be paid for directly but shall be considered incidental and included in the prices bid for the various items of work.

SECTION 48 REINFORCING STEEL

48.1 DESCRIPTION

This work shall include furnishing, fabricating, and placing reinforcement of the shape, size and dimensions shown on the drawings and as specified under these specifications.

48.2 MATERIALS

A. Deformed Bar Reinforcement. Unless specified otherwise, all bars for concrete reinforcement shall be deformed grade 40 bars meeting the requirements of ASTM A 615.

B. Wire Mesh Reinforcement. Wire mesh shall meet the requirements under ASTM A 185. The gage, spacing arrangement of wires, and dimensions shall be indicated on the drawings or specified in the special provisions.

48.3 CONSTRUCTION DETAILS

A. Steel Lists. Two copies of all reinforcing steel lists shall be furnished the Engineer for his use in administering the contract. Furnishing such lists to the Engineer shall not be construed to mean that the lists shall be reviewed for accuracy. The Contractor shall be responsible for the accuracy of the lists and for furnishing and placing all bar reinforcing steel in accordance with the detail drawings.

B. Cleaning. Steel reinforcement shall be thoroughly cleaned of any loose rust, mill scale, mortar, oil, dirt, or undesirable coatings of any character.

C. Bending. Bar reinforcement shall be cold bent to the shapes shown on the plans. Bending or rebending in a manner that will injure the material shall not be permitted. Bars with kinks or with bends which cannot be straightened without injury to the material shall be rejected.

Standard hooks shall comply with the ACI Building Code.

D. Placing and Fastening. Bar reinforcement shall be accurately placed in the positions as shown on the plans and securely held during the placing and setting of concrete. Bars shall be held in position at the distances from the forms and between layers by the use of precast mortar blocks, CRSI, Type I, metal chairs, hangers, spacers, supporting wires or other approved devices of sufficient strength to resist crushing or displacement under full concrete load. Bars at all intersections shall be tied with No. 14 or No. 16 wire except where spacing is less than one foot in each direction when alternate intersections shall be tied. The compressive strength of the precast mortar blocks shall be equal to that of the surrounding concrete. The use of stones, bricks, metal pipes and wood blocks shall not be permitted.

The minimum center to center spacing of parallel bars shall be 2-1/2 times the diameter of round bars, but in no case shall the clear distance be less than 1-1/3 times the maximum size of the coarse aggregate, nor 1 inch.

Wire mesh shall be rolled flat and held firmly in place against vertical or transverse movement by means of devices satisfactory to the Engineer before placing concrete.

E. Covering. Unless specified otherwise, the minimum cover measured from the surface of the concrete to the face of any reinforcement bar, shall be not less than 2 inches except in slabs where the minimum cover shall be 1 inch. Additional coverage shall be provided for reinforcement in footings, in principal structural members in which the concrete is deposited against the ground, and in structures exposed to salt water, unusual corrosive conditions, or abrasive actions.

F. Splicing. All reinforcing bars shall be furnished in the full lengths indicated on the plans. Splicing of bars, except where shown on the plans, shall not be permitted without the approval of the Engineer. Splices shall be staggered as far as possible.

Splices of tensile reinforcement at points of maximum stress shall be avoided. Where permitted, the length of lap for deformed bars shall be not less than 24, 30, and 36 bar diameters for specified yield strengths of 40,000, 50,000, and 60,000 psi, respectively, nor less than 12 inches.

Mesh reinforcement shall overlap each other by not less than two meshes and shall be securely fastened at the ends and edges. The edge lap shall be not less than one mesh in width.

48.4 MEASUREMENT

Reinforcing steel shall be measured for payment as indicated in the proposal based either on the lump sum, included in the respective concrete items, or by the calculated weight computed from the quantities of the reinforcing steel placed as shown on the plans. Unless specified otherwise, wire mesh reinforcement shall be measured for payment by the square foot.

No allowance will be made for splices or for clips, wire, separators, wire chairs and other material used in fastening the reinforcement in place.

48.5 PAYMENT

Payment for reinforcement as measured above shall be made as indicated in the proposal at the lump sum bid, included in the respective concrete items, or the unit price bid and shall be full compensation for furnishing, fabricating, and placing the reinforcement in place complete, including the separators or fasteners.

SECTION 49 STREET SURVEY MONUMENTS

49.1 DESCRIPTION

This work shall consist of constructing standard street survey monuments at locations designated on the plans in conformance with the Standard Details.

49.2 MATERIALS

A. Concrete. Class "B" concrete shall be used.

B. Casting. Cast iron frames and covers shall conform to ASTM A 48, Class No. 30. The castings shall be painted with one coat of Inertol Standard or equal. The bearing surfaces of the frames and covers shall be such that the covers will lie flat in any normal position on the rings.

C. Pipe. Pipe shall be galvanized standard weight pipe conforming to ASTM A 120.

D. Pin. Pin for making the survey point shall be brass and burred or feathered on one end for anchorage. It shall be placed before the concrete has acquired its initial set.

49.3 DETAILS

Each monument shall be constructed in accordance with the Standard Details. The finished concrete surface shall be coated with lamp black where monuments are constructed in asphalt concrete pavement.

49.4 MEASUREMENT AND PAYMENT

Survey monuments shall be measured for payment by the actual number constructed. Payment shall be made at the unit price bid each and shall be full compensation for constructing the work in place complete.

SECTION 50 - SOIL PREPARATION

50.1 DESCRIPTION

This work shall include the clearing to subgrade, cultivation, furnishing and placing screened topsoil in all planting areas, fine grading and adding soil amendments.

50.2 MATERIALS

A. Imported Screened Soil. Imported Screened Soil shall be screened, (1/2" screen), natural, fertile friable soil reasonably free of stones, noxious seeds, roots, sticks, weeds, subsoil in any quantity. For the City and County of Honolulu only, types known as "Palolo Clay or Lualualei Clay" are unacceptable. Soil shall have satisfactory mechanical characteristics and it shall not be screened subsoil.

The Contractor shall submit to the Engineer a typical sample of the topsoil considered for delivery to the site. The Contractor, at his expense, shall provide all fertilizers and amendments to bring it up to the level recommended by the Cooperative Extension Service for the satisfactory growth of turf grasses and/or ground covers. Upon delivery, the Engineer reserves the right to reject the topsoil should in his opinion the topsoil does not appear similar to the previous submitted sample.

B. Treblephosphate. Treblephosphate shall be of the analysis 0-47-0.

C. Lime. Lime shall be of agricultural type or approved equal.

D. Commercial Fertilizer. Commercial fertilizer shall be pelletized, 10-30-10 or approved equal. The Contractor shall furnish the Engineer duplicate copies of invoices for all chemical amendments delivered and utilized in the project. Each invoice shall be dated and shall bear the signature of the Contractor's representative who received the lot.

E. Addition of Amendments. Addition of commercial amendments shall be done after the soil analysis and the spreading of imported screened soil to the site.

50.3 DETAILS

All areas to be planted in grass and ground cover shall be cleared of all plant growth, stones over 3 inches in diameter and all debris. The areas shall be cultivated with the soil amendments as specified to a depth of 6 inches and returned to a smooth and even grade. Imported topsoil shall be used as required. Top dressing shall be done in all eroded or depressed areas immediately after they occur with amended topsoil.

50.4 INSPECTION

An inspection shall be held upon completion of the fine grading just prior to planting. All uneven and unsmooth work shall be redone until accepted by the Engineer.

50.5 MEASUREMENT AND PAYMENT

Soil preparation shall not be measured for payment unless provided for in the special provisions, and full compensation shall be included in the bid prices for the various other bid items.

Imported screened topsoil, including fertilizers and amendments, shall be measured for payment by the cubic yard. Payment shall be made at the unit price bid and shall be full compensation for furnishing, placing and compacting the soil in place, including preparation of the surface area.

SECTION 51 - PLANTING TREES, SHRUBS, GROUND COVER AND GRASS

51.1 DESCRIPTION

This work shall include the furnishing of all labor, material, equipment and incidentals necessary for the planting of trees, shrubs, ground cover and grass complete in place.

51.2 MATERIALS

A. Nomenclature and Horticultural Practices. All trees, shrubs, and ground covers shall be true to name. The scientific and common names shall follow the standard as adopted by the American Joint Committee on Horticultural Publication No. 50 "Gardens of Hawaii," published by the B. P. Bishop Museum. Horticultural practices shall conform with the rules and grading as adopted by the most recent edition of the American Standard of Nursery Stock.

B. Quality and Size. All plant material shall be uniform and have a habit of growth that is normal for the species and shall be sound, healthy, vigorous and free from insect pests, plant diseases, and injuries. They shall have normal, well-developed branch systems, together with vigorous root systems. All materials shall be equal in size or exceed the measurements specified in the Plant List, which are minimum acceptable sizes. Any necessary pruning shall be done at time of planting.

C. Plant List. The plant list shall be as shown on the landscape plan.

D. Grass. Grass shall be common bermuda (Cynodon Dactylon) unless otherwise specified. Grass may be planted either by sprigging or seeding, unless otherwise indicated on the plans. Grass sprigs shall be healthy living runners and stolons. They shall be freshly dug up and free from weeds. Grass seeds shall be of fancy grade and shall be 50% hulled and 50% unhulled.

E. Mulch. Mulch shall be specially processed fiber containing no growth or germination inhibiting factors. It shall be such that after addition and agitation in the hydraulic equipment with seed, fertilizer, water and other additives not detrimental to plant growth, the fibers will

form a homogeneous slurry. When hydraulically sprayed on the soil, the fibers shall form a blotter-like ground cover which readily absorbs water and allows infiltration to the underlying soil. In every application, complete coverage of the soil shall be attained. Mulch shall be applied at the minimum rate of 1,500 pounds per acre.

F. Imported Screened Soil. Imported Screened Soil shall be as specified in Section 50, "Soil Preparation".

G. Commercial Fertilizer. Commercial fertilizer shall be pelletized, 10-30-10 or approved equal. It shall be uniform in composition, free flowing and shall be delivered in unopened containers bearing the manufacturer's statement of analysis.

H. Fertilizer for Tree. Mag Amp (7-40-6) Slow-Release fertilizer shall be used for trees.

I. Stakes. Stakes for container stock trees shall be 2" x 2" x 8'-0" construction heart rough redwood; stakes for field grown trees shall be 3-feet long minimum, No. 4 reinforcing bars or redwood stakes.

J. Guys. Guys shall be No. 12 gauge galvanized wire, single strand for container grown trees and double strand for field grown trees. Guys for field grown trees shall be flagged by white cloth or by stapling a white painted 1" x 2" x 12" wood strip to each guy at eye level.

K. Tree Ties. Tree ties shall be No. 12 gauge pliable galvanized steel wire encased in new or used reinforced rubber or plastic hose or commercial ties.

51.3 DETAILS FOR PLANTING OF TREES, SHRUBS AND GROUND COVER

A. General. Trees, shrubs and ground cover shall be planted in accordance with the landscape plan.

B. Planting Pits. Reasonable care shall be exercised to have pits dug and soil prepared prior to moving plants to their respective locations for planting to ensure that they will not be unnecessarily exposed to drying elements or to physical damage. The diameter of all plant pits shall be at least twice the diameter of the plant ball or container. The

depth of pits for trees and shrubs shall be sufficient to accommodate the ball or roots when the plant is set to finished grade, allowing for at least 12 inches for trees and six inches for shrubs of prepared soil in the bottom of the pit.

C. Setting Plants. All plants shall be set at such a level that, after settlement, they bear the same relation to the finished grade of the surrounding ground. Each plant shall be set upright and faced to provide the best appearance possible.

D. Planting. Plants shall be planted in an approved backfill which shall be thoroughly settled by watering and tamping. Backfill for all plants shall consist of one part organic matter to four parts of imported screened soil, unless otherwise indicated on the landscape plan. Add 12 ounces Mag Amp (7-40-6) per 25-gallon tree, 8 ounces per 15-gallon tree and 4 ounces per 5-gallon tree. The organic material and topsoil shall be thoroughly mixed together before being placed in the plant pit. If the on-site soil available from the excavation of planting pits, as herein specified, is insufficient in quantity or of poor quality for backfill, the Contractor shall provide the necessary additional imported screened soil. Backfill shall not be packed. As may be necessary, an earth berm may be built around the pit as a watering basin and filled with water.

E. Guying and Staking. Trees shall be supported immediately after planting.

1) Field grown trees shall be braced with at least three equally spaced guys, two of which shall be set on the side of the prevailing wind. Guys shall be encased in tree ties and attached to the tree trunk at approximately two-thirds the height of the tree. They shall be flagged and kept taut throughout the contract period.

2) Container grown trees shall be secured with two hose encased ties twisted to form a figure "8." One tie shall be set at two-thirds and the other at one-third the trunk height of the tree.

F. Pruning. Pruning of trees and shrubs shall be limited to the minimum necessary to remove injured twigs and branches, and to compensate for the loss of roots during trans-

planting, but never to exceed one-half of the branching structure. Cuts over 3/4 inch in diameter shall be painted with an approved tree paint.

G. Ground Cover Planting. Plants shall be spaced equally and uniformly at the distance indicated on the landscape plan. Finished grade shall be smooth and uniform and tree watering basins shall not be altered. Water immediately after planting.

51.4 DETAILS FOR GRASS PLANTING

A. Sprigging or Seeding

1) Preparation of Planting Area. The planting area shall be prepared in accordance with Section 50, "Soil Preparation." Grass planting shall commence immediately after the soil has been prepared.

2) Planting of Sprigs. Immediately following harvesting, the sprigs shall be thoroughly watered, then covered and kept moist during storage and transportation until planted. Sprigs shall be planted in furrows spaced not more than 6 inches apart and approximately 1/2" deep. Sprigs shall be distributed in furrows, immediately covered with a light layer of soil and lightly rolled and watered. Further hand grading shall be required if undulations appear after rolling, Re-sprigging of thin areas shall be required of the Contractor at no additional cost.

3) Planting Grass Seed. Ground surface shall be raked to a smooth even plane. The Contractor shall broadcast seeds uniformly by mechanical sower at a minimum rate of 5 lbs. per 1,000 square feet. He shall sow one-half the seeds in one direction, and the remainder at right angles to the first direction. The seeds shall be incorporated into the top 1/4 to 1/2 inch of soil.

After sowing, the seeded area shall be compacted by hand or mechanical roller weighing 60 to 90 pounds per lineal foot of roller.

The area shall be thoroughly and gently watered, and kept moist during the germination period.

4) Fertilizing. The first application of commercial fertilizer, 10-30-10, shall be made prior to planting operations under soil preparation, and the second application shall be made during the last week of the maintenance period. Last application shall be spread at the rate of 20 lbs./1000 sq. ft.

B. Hydromulching.

1) Approval of Area to be Hydromulched. The Contractor shall notify the Engineer not less than 24 hours in advance of any hydromulching operation, and shall not begin work until area prepared or designated for hydromulching has been approved. Approval shall include inspection of fine grading to provide for the collection and disposal of surface and subsurface water to protect planting areas against unnecessary erosion. Approval shall not relieve the Contractor of his responsibility to restore any damage to the grade until the planted areas are accepted. Following the Engineer's approval, hydromulching of the approved planting areas shall begin promptly.

2) Hydromulch Equipment. The hydromulch equipment shall be capable of mixing all the necessary ingredients to a uniform mixture and to apply the slurry to provide uniform coverage. Seeds, fertilizer, and mulch mix shall be applied in one operation by approved hydraulic equipment. The equipment shall have a built-in agitation system with an operating capacity sufficient to keep the mix in uniform distribution until pumped from the tank. Distribution and discharge lines shall be large enough to prevent stoppage and shall be equipped with hydraulic discharge spray nozzles which provide a uniform distribution of the slurry.

Areas inaccessible to hydromulching application shall be sprigged, fertilized and mulched by approved hand methods.

3) Watering. Water shall be applied immediately following mulching in such quantities as to moisten the soil and mulch. Watering shall be

continued in such manner, quantity and frequency to insure proper germination and growth and shall be done in a way that will prevent erosion. Watering equipment shall be of a type that will not cause damage to the planted areas. Water systems that cause erosion or runoff and deemed unacceptable by the Engineer shall be corrected by the Contractor.

4) Erosion and Sedimentation. Should the slope erode or silt be transported to pose as potential pollutants, it shall be immediately removed and prevented from entering into water channels. Areas eroded more than 3 inches deep or 6 inches wide shall be restored to the original grade.

5) Fertilizing. In addition to the fertilizer applied as part of the initial hydromulching application, at least one additional fertilizer application shall be made to each planted area at the end of the maintenance period.

The Contractor shall furnish and pay for all water required for planting and during period of maintenance.

Any area that does not show a thorough "catch" shall be re-sprigged and fertilized and subsequent care shall be repeated until the entire area is completely covered with a healthy growth of grass.

51.5 PERIOD OF MAINTENANCE

Maintenance shall begin immediately after completion and approval of all planting and shall continue for 60 calendar days thereafter unless otherwise specified in the Proposal or on the drawings. The care of plants prior to completion of all planting shall not be considered as part of the maintenance period but only as incidental to landscape work.

Maintenance shall include watering, weeding, fertilizing, topdressing, mowing, repairing stakes, guys and ties, spraying for disease and insects, replanting and any other work necessary to maintain all plants in a healthy growing condition. The Contractor shall be responsible for the protection of all

plants and planting areas during the maintenance period. During the last week of the maintenance period, the Contractor shall fertilize the entire planting areas as specified.

51.6 FINAL INSPECTION AND ACCEPTANCE

At the completion of all planting operations and maintenance period, an inspection shall be performed.

The Contractor shall request the inspection in writing to the Engineer 7 working days prior to the completion of the maintenance period in order that a mutually agreeable time for inspection may be arranged.

The Contractor, and the Engineer, or their representatives shall be present at the inspection.

Any plant material found not to be in healthy growing condition shall be replaced by the Contractor.

Acceptance of the grass planting after the 60-day maintenance period shall be conditioned upon the following:

1) 95% germination of the overall area shall be required for grass planting.

2) All germinated areas shall be healthy and living at the end of maintenance period.

3) Weeds shall not exceed an area greater than 15% of the overall grass area.

4) Grass shall be mowed and not taller than 1 inch in height. All clippings must be removed.

5) All depressions shall be filled to proper grade and area regrassed as required.

The maintenance period shall be extended at no additional cost if the grass planting does not meet the above requirements. Acceptance of the ground cover planting after the maintenance period shall be contingent upon an 80% coverage.

If all plant materials are approved and accepted at this inspection by the Engineer, the Contractor shall be relieved of further maintenance.

All plants and trees shall be guaranteed to be in vigorous growing condition for one year. If any plant material fails to survive by the end of one year, and if proper maintenance has been exercised, it shall be replaced with the same size and species by the Contractor at no cost to the County.

51.7 MEASUREMENT AND PAYMENT

Planting shall be measured for payment as indicated in the proposal by the linear foot for hedges, by the actual number of trees, shrubs or other plants successfully prepared and planted or by a lump sum.

Planting of ground cover or grass shall be measured for payment by the square foot or by a lump sum.

Payment shall be made at the bid price and shall be full compensation for furnishing the material, tools, labor and equipment necessary to prepare the ground, plant the trees, shrubs, ground cover or grass, and maintain the planted area until a healthy growth is evident for a period not less than 60 days.

SECTION 52 - TRANSPLANTING OF EXISTING TREES

52.1 DESCRIPTION

This work shall include the furnishing of all labor, material, equipment and incidentals necessary for the transplanting of trees, complete in place.

52.2 MATERIALS

A. Topsoil. Topsoil shall be as specified in Section 50, "Soil Preparation."

B. Manure. Manure shall be at least eight months old stable or cattle manure free from shavings, sawdust, refuse and other materials harmful to plant growth.

C. Commercial Fertilizer. Commercial fertilizer shall be slow release MagAmp (7-40-6) or approved equal. It shall be uniform in composition, free flowing and shall be delivered in unopened containers bearing the manufacturer's statement of analysis.

D. Stakes. Stakes for field grown trees shall be 2" x 2" x 3' long minimum, No. 4 reinforcing bars or approved equal.

E. Guys. Guys shall be No. 12 gauge galvanized steel wire, double strand, and shall be flagged by white cloth or by stapling a white painted 1" x 2" x 12" wood strip to each guy at eye level.

F. Tree Ties. Tree ties shall be No. 12 gauge pliable galvanized steel wire encased in new or used reinforced rubber or plastic hose or commercial ties.

52.3 DETAILS

A. General. Existing trees designated on the drawings for relocation elsewhere on the project site shall be moved from their original location prior to construction operations when so directed by the Engineer. Transplanting of these trees shall be handled by experienced workmen. The equipment and the methods employed in transplanting shall be such as to prevent loss of essential feeding roots, or injuries to bark, branches or roots. All plants shall have the roots adequately

protected from the drying action of sun and wind at all times, i.e., after being dug, while being transported and while awaiting the final installation. The Contractor shall replant as specified herein and in accordance with standard nursery practices.

B. Protection of Trees. The Contractor shall be responsible for the protection of tops, trunks, and roots of existing trees that are to remain on the project site. Existing trees subject to construction damage shall be boxed or otherwise protected before any work is started. The Contractor shall remove boxing and other protection when directed. He shall remove interfering branches without injury to trunks and cover scars with tree paint. Only those portions of the branches which will clearly be in the way of construction equipment shall be removed in accordance with standard nursery practices.

C. Pruning. All trees to be transplanted shall be pruned by a licensed contractor and experienced workmen prior to being transplanted. Pruning procedures shall be in accordance with standard horticultural practice. Approximately one third of the branch structure shall be removed so as to preserve the natural character of the trees. Pruning shall be done with clean, sharp tools. All cuts shall be made smooth with no tearing or ripping of the bark. All cut surfaces one inch or more in diameter shall be painted with a standard tree wound dressing. All dead and/or broken branches shall be removed from the trees.

D. Plant Holes. Plant holes for trees shall be dug at least 12 inches deeper and 12 inches wider than the root spread of the tree. The soil in the bottom of the hole shall be loosened with a pick or other means to a depth of 12 inches. Trees to be transplanted shall not be moved until after the new plant holes have been properly excavated and prepared to receive the trees.

E. Balling. The trees shall be removed with a ball of soil at the roots. For larger trees, the ball should be at least four feet larger than the trunk of the tree on each side at ground level. Any roots which are bruised or broken shall be pruned with a clean cut as soon as possible. The cut section of all exposed roots shall be coated with a moist paste of a standard acceptable hormone for stimulation of new root growth. Burlap covering of root shall be held in place with wire or twine.

F. Backfilling. Prepared soil shall be used for backfilling the plant hole. This soil shall be a mixture of 1 part manure to 4 parts topsoil and a measure of commercial fertilizer as specified by the manufacturer for a plant of the size being planted. The soil in the bottom of the holes shall have 3 lbs. of slow release MagAmp fertilizer and 5 lbs. of approved soil conditioner. The plant hole shall be backfilled with the prepared soil placed in layers around the roots or ball. Each layer shall be carefully tamped in place in a manner to avoid injury to the roots or ball or disturbing the position of the tree. When approximately two-thirds of the plant hole has been backfilled, the hole shall be filled with water and the soil allowed to settle around the roots.

G. Tree Guying. Trees shall be supported immediately after planting. All trees and palms shall be guyed. Guying shall be done with at least three guys spaced equally about each tree. Each guy shall consist of a double strand of No. 12 gauge pliable galvanized steel wire encased in rubber tie. It shall be attached to the tree trunk or crown at an angle of about 60 degrees at about two-fifths the height of the tree and anchored to notched stakes or rods which have been driven into the ground at an angle away from the tree. Stakes or rods shall not protrude above the surface of the ground. Wires shall be tightened and kept taut. Trees shall stand plumb after guying. White flag strips shall be provided on each guy wire at 3 foot intervals to cover two-thirds of each guy.

H. Maintenance. Maintenance shall be for a period of 60 days after the completion and approval of all planting by the Engineer. Planting maintenance shall include all necessary watering, pruning, wound dressing, disease and insect pest control, protective spraying, straightening plants which lean or sag, adjustment of trees which settle or are planted too low, and any other procedures consistent with good horticultural practice necessary to insure normal, vigorous and healthy growth.

The Contractor shall be responsible for the use of all materials, labor, and equipment, and any injury to plant material caused by such material, labor and equipment shall be corrected and repaired by the Contractor at his own expense.

Transplanted trees should be watered so that the quantity of water applied at one time shall be sufficient to penetrate the soil to a minimum depth of 30 inches at a rate which will prevent saturation of the soil.

52.4 MEASUREMENT AND PAYMENT

Transplanting of trees shall be measured for payment by the actual number of trees successfully prepared and transplanted. Payment shall be made at the unit price bid and shall be full compensation for preparing, transplanting and maintaining the trees for a period not less than 60 days.

SECTION 53 - POSTS AND RAILINGS

53.1 DESCRIPTION

This work shall include furnishing and installing posts, handrailings, guard railings, bridge railings or barrier railings in accordance with the details shown on the plans, as specified in the special provisions, and as directed by the Engineer.

53.2 MATERIALS

A. Concrete Posts and Rails. Class "A" concrete shall be used in forming the concrete posts or rails and Class "B" concrete shall be used in constructing post footings. All concrete work shall meet the requirements under Section 39, "Portland Cement Concrete."

Reinforcing steel for the concrete structures shall meet the specifications under Section 48, "Reinforcing Steel."

B. Wood Posts and Rails. All wood posts and rails shall be Douglas fir, S4S, construction grade, complying with the current "Standard Grading and Dressing Rules" adopted by the West Coast Lumbermen's Association of Portland, Oregon. The lumber shall be treated with preservative in accordance with the manufacturer's recommendation before delivery to the site. Creosote oil or solutions, water borne preservatives, and oil borne preservatives shall comply with the specifications under AASHTO M 133.

C. Fittings. Carriage bolts, nuts, washers and brackets shall be galvanized in conformity with ASTM A 123.

D. Metal Posts and Guard Rails. Steel posts shall be of the section and length as specified or as shown on the plans. Steel shall conform to the requirements of ASTM A 36. All steel posts shall be galvanized after fabrication.

Unless specified otherwise, metal guard rails shall be corrugated sheet steel beams conforming to AASHTO M 180. The rail dimensions and gage shall be indicated on the plans or special provisions but shall not be less than 12 inches in width, three inches in depth and not less than 12 gage thick.

E. Steel Hand Rails. Hand railings shall be fabricated from welded or seamless steel pipe conforming to the requirements of ASTM A 120, or tubular sections of hot rolled mild steel.

F. Paint. The paints for wood posts and rails shall be ready mix white exterior paint of lead and zinc base conforming to AASHTO M 70 or Federal Specification 141 applied over an approved primer.

53.3 DETAILS

A. Shop Drawings. If the details of the posts and railings are not fully shown on the plans, the Contractor shall submit prints of shop drawings to the Engineer for approval before fabrication is permitted.

B. Concrete Posts. Concrete posts other than posts for bridge railing shall be precast to the dimensions shown on the plans. The surface finish shall be smooth, even texture, free from cracks, rock pockets and chipped edges. Warped or defective posts will be rejected. Curing time shall be 7 days. Posts may be erected 14 days after casting.

C. Metal Posts and Guard Rails. All metal work shall be fabricated in the shop and galvanized before delivery to the job site. The posts and rails shall be free from kinks, twist or bends, and shall be uniform in appearance.

D. Wood Posts and Rails. The dimensions of wood posts and rails shall be shown on the plans. The rails shall be at least two spans in length, except that end rails and rails in sharp curves may be single span in length. All wood posts and rails shall be finished with one coat of wood primer and two coats of exterior white paint. Contact surfaces between posts and rails and all butt joints shall receive the three coats of paint before assembly. Each coat shall be thoroughly dried before applying the next coat.

E. Steel Hand Rails. The size and thickness of the steel pipe shall be shown on the plans. Unless specified otherwise in the special provisions, all connections shall be welded and ground flush with the adjacent surfaces.

The completed railing elements, hardware, and other fittings shall be galvanized.

Railing panels shall be straight and true to dimensions. Adjacent railing panels shall align with each other with a variation of not to exceed 1/16 inch.

Posts shall be set in sockets or on grout pads as shown on the plans. Grout shall consist of one part portland cement and 3 parts sand.

F. Welding. Welding shall be performed by the electric arc process and all welds on exposed surfaces shall be ground flush with the adjacent surfaces. All field welds shall be cleaned and painted with a prime coat and two coats of matching paint. In case of galvanized parts, the cleaned field welds shall be coated with "Galvalloy," "Galvicon," or an approved equal in accordance with ASTM 780, Annex A 1.

G. Erection. All posts shall be set to the established line and grade and shall be vertically plumb. Where posts are placed directly in the ground, the backfill shall be tamped in 8-inch layers. Any post not true to alignment, or the top of which is not to established elevation, or not rigidly embedded shall be removed and re-set.

Rails shall be attached to the posts with care and shall form a straight continuous line or smooth curve in their finished position. Bends or jogs shall be corrected by the Contractor at his own expense.

Railings on cast-in-place concrete bridges shall not be installed or constructed until the falsework has been released.

53.4 MEASUREMENT AND PAYMENT

Posts and rails shall be measured for payment by the actual number of posts constructed or by the linear foot of post, post and rail, or rail constructed in place. No measurement shall be made of guard rails placed in excess of the length approved by the Engineer.

Payment shall be made at the unit price bid each or per linear foot and shall be full compensation for furnishing all necessary materials, equipment, tools, and labor to erect and complete the posts and railings in place.

SECTION 54 - CHAIN-LINK FENCE

54.1 DESCRIPTION

This work shall consist of furnishing and constructing chain-link fence in place complete. The type of material, height, size, fabrication and details shall be designated on the plans or in the special provisions, and shall comply with these specifications.

54.2 MATERIALS

All materials and fittings shall be new, and all ferrous materials shall be hot-dip galvanized in accordance with the requirements under ASTM A 123.

Unless otherwise specified, galvanized steel chain-link fences shall be furnished.

A. Fabric. Steel chain-link fabric shall conform to ASTM A 392. Unless specified otherwise, the fabric shall be 9 gage. All fabric shall be woven into approximately 2-inch mesh and galvanized after fabrication.

When aluminum chain-link fence is specified, the fabric shall be aluminum alloy having a minimum tensile strength of 30,000 psi, a minimum yield strength of 25,000 psi, and a maximum elongation of 8 percent. The fabric shall be woven into approximately 2-inch mesh and conform to ASTM B 211.

The top edge of all fence fabric shall be knuckled finished unless specifically indicated otherwise on the plans, and the bottom edge shall be barbed salvage.

B. Posts and Rails. The base material for the manufacture of steel pipe used for posts, braces, top rail, and gate frames shall conform to ASTM A 120.

The use of other types of post sections shall be indicated on the plans.

C. Fittings, Wires, and Rods. All fittings and hardware shall be galvanized. Couplings shall be of the outside sleeve type and at least 7 inches long.

Tension wires shall be at least 7 gage galvanized coil spring steel wire. Unless specified otherwise, ties used to fasten the fabric to posts, rails, and gate frames shall be not less than 12-gage galvanized steel.

Truss of tension rods used in trussing gate frames and line posts adjacent to end corner, slope, or gate posts shall be adjustable 3/8-inch diameter galvanized steel rod.

POSTS, RAILS AND BRACES

Use	O.D. (Inches)	Weight per foot (Pounds)
End, corner, slope, and gate posts for single gates 6 feet or less in width and double gates 12 feet or less in width for 6-foot fence or higher	2-7/8	5.79
End, corner, slope, and gate posts for single gates 6 feet or less in width and double gates 12 feet or less in width for fence less than 6 feet in height	2-3/8	3.65
Line posts for fence 6 feet or higher	2-3/8	3.65
Line posts for fence less than 6 feet in height	1-7/8	2.72
Top rail for fence higher than 4 feet, braces and stiffeners for gates	1-5/8	2.27
Top rail for fence 4 feet or less in height	1-3/8	1.68
Frame for gates	1-7/8	2.72

D. Repair of Galvanized Surfaces. All surfaces cut, broken, burned, or abraded, shall be coated with "Galvalloy," "Galvicon," or an approved equal.

54.3 DETAILS

Line posts shall be spaced at not more than 10-foot intervals and shall be placed vertically plumb.

All posts shall be set in Class "B" concrete footing as shown on the plans. End, corner, slope, and gate posts shall be braced to the midpoint of the nearest line post or posts with horizontal braces used as compression members and the line posts trussed from the brace back to the bottom of the end, corner, slope or gate post with 3/8 inch rods with turnbuckles. Change in line or grade where the angle of deflection is 30 degrees or more shall be considered as corner and slope points, respectively, and corner or slope posts shall be installed at these points.

Unless otherwise specified all fences shall be installed with a top rail and a bottom tension wire.

54.4 MEASUREMENT AND PAYMENT

Chain-link fence shall be measured for payment by the lineal foot of completed fence, deducting the widths of gates. Gates will be paid for at the unit price bid each for the particular width and height constructed in place completed as indicated on the plans.

Payment shall be made at the unit bid price each for gates and per foot for fence and shall be full compensation for furnishing materials, tools, labor and equipment, and doing all the work involved in constructing the fence and gates in place complete.

Compensation for clearing the line of the fence, disposing of the debris and excavated material, excavating and constructing the concrete footings, and other related work shall be considered as included in the unit price bid for chain-link fence and gate.

SECTION 55 - RECONSTRUCTING DRIVEWAY RAMPS WITHIN PRIVATE PROPERTIES

55.1 DESCRIPTION

This work shall consist of reconstructing driveway ramps within private properties as indicated on the plans.

55.2 EXISTING DRIVEWAYS

A. Asphalt Concrete. Where the existing driveway ramp is constructed of asphalt concrete, the Contractor shall reconstruct the driveway ramp with 1-1/2-inch asphalt concrete surfacing over a compacted coral or aggregate base. The width, length, thickness of the base, and slope of the reconstructed driveway ramp shall be shown on the plans.

B. Reinforced Portland Cement Concrete. Where the existing driveway is of portland cement concrete, a 4-inch pavement of Class "B" concrete reinforced with wire mesh shall be constructed on a prepared subgrade or base as shown on the plans.

C. Dirt or Gravel. Where the existing driveway is unimproved, or consists of only a gravel surfacing, a surfacing of coral or crushed aggregate with a minimum compacted thickness of 4 inches shall be constructed as shown on the plans.

55.3 DETAILS

The Contractor is responsible for locating and protecting underground utility lines within the driveway ramp area whether or not such lines are shown on the plans. He shall exercise extreme care in excavating or constructing new embankment and to avoid damaging abutting structures, trees, plants or other improvements.

The subgrade or embankment, base course, and coral or crushed rock surfacing shall be compacted to at least 90% of its maximum density. Asphalt concrete surfacing shall be compacted to at least 95% of its maximum density.

The materials used and workmanship shall meet the requirements of the various applicable sections of these specifications.

55.4 MEASUREMENT AND PAYMENT

Reconstruction of driveway ramps within private properties shall be measured for payment by the square foot or by the lump sum bid and shall be full compensation for furnishing the material, equipment and labor necessary to complete the work in place, including reinforcement.

SECTION 56 - PROJECT SIGNS

56.1 DESCRIPTION

This item of work shall consist of furnishing, erecting, and removing project signs at the job site.

56.2 MATERIAL

A. Signboard. The project signboards shall be 3/4 inch thick "AC" exterior grade fir plywood, 4 feet in height and 8 feet long. For the County of Kauai only, signboard area shall not exceed 16 square feet, in compliance with County Ordinance No. 120.

B. Paints. All paints used shall be exterior enamel paint manufactured by either Sherwin-Williams, Glidden, Boysen, Dutch Boy, Pittsburg, Dupont, W. P. Fuller, Sealube, or equal.

56.3 DETAILS

A. Painting. Painting shall be done by a commercial sign painter using hand brushes only, resulting in a first-class finished work. Block lettering shall be used throughout and the use of stencils will not be permitted.

B. Information on Signs. The sign shall show the information indicated in the special provisions.

C. Sample. The Contractor shall submit to the Engineer for approval, a 1-1/2"=1'-0" scale sample of the proposed project signboard, with proper sizes and spacings of the lettering. Approval of the sample project signboard shall not relieve the Contractor of providing and erecting first-class signboards at the job site.

D. Erection. The signs shall be erected at locations as directed by the Engineer, adequately braced in such a way as not to interfere with the vision of the sign, and shall be maintained in a good condition throughout the progress of the work. The Contractor shall erect the signs within 5 calendar days after receiving the notice to proceed.

E. Removal. After the final approval of the completion of the project, the signs shall be removed from the job site and become the property of the Contractor.

56.4 PAYMENT

The cost of furnishing, erecting, and the removing of the project signs, shall not be paid for directly but shall be considered incidental and included in the prices bid for the various items of work.

SECTION 57 STREET LIGHTING SYSTEM (FOR CITY AND COUNTY OF HONOLULU ONLY)

57.1 DESCRIPTION

Electrical work shall consist of furnishing all labor, materials and equipment and installing complete in place and in operating condition a street lighting system in accordance with the requirements of the contract.

This work shall include the furnishing and installing of metal lamp posts with brackets, luminaires, pad mount transformers, lamps, electrical conductors and conduits, fittings, pole line hardwares, insulators, substation equipment, concrete bases, pull boxes and all other materials necessary for operating and controlling the street lighting systems and for salvaging and relocating existing street lights and furnishing and installing all materials necessary to connect the relocated lights to the existing light circuits, all as specified herein as shown on the plans.

57.2 REGULATIONS AND CODE

All electrical equipment shall conform to the standards of the National Electrical Manufacturers Association (NEMA), the Underwriters' Laboratory Inc. (UL), or the Electronic Industries Association (EIA), where applicable. In addition to the requirements of the plans, these specifications and the special provisions, all materials and workmanship shall conform to the requirements of the National Electrical Code, hereinafter referred to as the Code; Rules for the Overhead Electrical Line Construction, General Order No. 6 of the Hawaii Public Utilities Commission; Local Joint Pole Agreements; Standards of the American Society for Testing and Materials (ASTM); American National Standards Institute (ANSI or ASA); Occupational Safety and Health Act (OSHA); Insulated Power Cable Engineers Association (IPCEA); local Power Company rules; and any local ordinances which may apply.

Wherever reference is made to any of the standards mentioned above, the reference shall be construed to mean the Code, Order or Standard, that is in effect on the day the Notice to Contractors for the work is dated.

Wire sizes shall be based on American Wire Gage (AWG).

57.3 WARRANTIES, GUARANTEES AND INSTRUCTION SHEETS

Manufacturers' warranties and guarantees furnished for materials used in the work and instruction sheets and parts lists supplied with materials shall be delivered to the Engineer prior to acceptance of the project. All apparatus and workmanship shall be guaranteed for 1 year and, should any failure resulting from normal operation occur during that time, the Contractor shall replace the defective equipment or correct the workmanship at no cost to the City and County. An exception shall be light sources which shall be guaranteed for 1,000 hours operation.

57.4 MAINTAINING EXISTING AND TEMPORARY ELECTRICAL SYSTEMS

Existing electrical systems, or approved temporary replacements thereof, shall be kept in effective operation for the benefit of the traveling public during the progress of the work, except when shutdown is permitted to allow for alternatives or final removal of the systems. Lighting system shutdowns shall not interfere with the regular lighting schedule, unless otherwise permitted by the Engineer. The Contractor shall notify the Engineer prior to performing any work on existing systems.

Where damage is caused by the Contractor's operations, the Contractor shall at his expense, repair or replace damaged facilities promptly in accordance with these specifications. Should the Contractor fail to perform the required repairs or replacements, the cost of performing such repairs or replacements will be deducted from any moneys due or to become due to the Contractor.

The exact location of the existing conduit runs and pull boxes shall be ascertained by the Contractor before using equipment that may damage such facilities or interfere with any system.

57.5 SAFETY PRECAUTIONS

Before starting work on existing series street lighting circuits, the Contractor shall obtain daily a safety circuit clearance from the serving utility. By-pass switch plugs shall be pulled and "Men at Work" signs posted at switch boxes before any work is done.

57.6 TYPES OF SYSTEM

The type of street lighting system shall be one of the following:

A. Multiple, 120 volts, unmetered, with individual photocells and connected directly to the utility's lines through fuses or breakers.

B. Multiple, 120/240 volts or 240/480 volts, metered, grouped, with single switching and timing devices and photocell control.

57.7 MATERIALS

A. High Pressure Sodium Luminaires.

1) Luminaire

a) Luminaires shall be standard make and manufactured by a manufacturer of recognized experience and ability, who is now regularly engaged in the manufacture of street lighting luminaires.

b) Luminaires shall consist basically of a cast aluminum housing, an Alzak processed aluminum reflector, a lamp-grip mogul multiple socket and support assembly which is adjustable to provide variations in light distribution and a pressed glass refractor. Heat resisting gasket shall effectively seal the lamp chamber against insects, moisture and dust. The luminaire door (refractor holder) shall be hinged to the luminaire at the house side and fastened at the street side by an automatic type latch operable with gloved hands, and designed in such a manner that it will not accidently fall when the door is opened.

c) Luminaires shall have a slip-fitter suitable to accept 1-1/4" through 2" pipe brackets without the need of rearrangement of any of the mounting components, and which will allow for leveling the unit plus or minus 5° (min). The mounting bolts shall pass through the luminaire

housing to provide firm attachment to the mounting arm. All hardware shall be stainless steel or hot-dipped galvanized. Slipfitter shall be provided with a pipe stop to prevent pipe from damaging ballast.

d) Luminaire housing shall be provided with a EEI-NEMA standard twist locking-type mounting receptacle for individual photo control. The receptacle shall be pre-wired to the terminal board for the same operating voltage as the ballast.

e) Luminaires shall have an integral ballast, starter board, capacitors and a heavy duty terminal block. Capacitors shall not contain PCB oil.

f) All luminaire components shall be securely mounted against horizontal and vertical movement.

g) An adjustable socket, to provide various light distribution patterns shall be provided.

h) All luminaires are to be identified as specified in NEMA standard number 0D150-1977 entitled Field Identification of High Intensity Discharge Lamps and Luminaires Used in Roadway Lighting Equipment. NEMA decal shall be applied on luminaire housing.

i) The net weight of luminaires, including ballasts, designed to operate 70, 100, and 150-watt high pressure sodium-vapor lamps shall not exceed thirty-five (35) pounds.

j) Luminaire light distribution shall be as specified.

2) <u>Ballast for High Pressure Sodium-Vapor Lamps</u>

a) Ballasts shall be designed for operation on a multiple circuit, shall be enclosed

in the luminaire housing and shall be pre-wired to lamp socket and to terminal board. Ballast core and coil shall be dipped in insulating varnish and baked. Ballast connections shall be equipped with tab-type terminals securely attached to the ballast on a support bracket.

b) Ballast shall be reactor-type designed to operate high-pressure sodium-vapor lamps. Ballast shall operate on nominal 120 volts, 60 Hz A.C. or 240V. 60 Hz A.C.

c) Ballast shall operate at a minimum of 90% power factor.

d) Starter board shall be mounted in a metal holder securely attached to the luminaire housing and shall be provided with tab-type terminals. Starter board shall be mounted vertically in luminaire. Starter board shall be suitable for field interchangeability without field adjustment.

e) Ballast output voltage to be 55 volts for 100 watt and 150 watt lamps and 52 volts for 70 watt lamps. The ANSI ballast shall be S62 for 70 watt lamp, S54 for 100 watt lamp, and S55 for 150 watt lamp.

f) Ballast shall be suitable for operation under open or short circuit conditions for six (6) months without significant loss of ballast life.

g) Ballast construction shall consist of precision wound coils on phenolic bobbins and welded laminated steel cores.

B. 90-Watt Low Pressure Sodium Luminaires.

1) <u>Luminaire</u>

a) Luminaires shall be of standard make and manufactured by a manufacturer of recognized experience and ability, who is now regularly engaged in the manufacture of street lighting luminaires.

b) The luminaire shall consist basically of upper and lower body made of ABS material, aluminum finish, 3/32" nominal wall thickness; reflector with an internal surface of polycarbonate gloss white with a reflection factor of 88%; a lamp socket assembly, bayonet type, with spring loaded nickel plated contacts and with adjustments to provide for variations in lighting distribution; and an injection molded prismatic, polycarbonate refractor, hinged and secured with spring latches for rainwater tightness. All external surfaces shall be protected with a fused layer of ultra-violet inhibiting Korade film. Gaskets shall be of high temperature neoprene rubber plus a sealing ring in mast arm opening to prevent entry of insects to ballasts and optical assemblies.

c) The luminaire shall have a slip-fitter suitable to accept a minimum 12" straight tenon, 1-5/8" O.D. to 2-1/2" O.D., without the need of rearrangement of any of the mounting components, and which will be secured by means of two (2) locking bolts. All hardware shall be stainless steel, hot-dipped galvanized, or cadmium plated.

d) The luminaire housing shall be provided with an EEI-NEMA standard three-terminal twist locking type mounting receptacle for individual photo control. The receptacle shall be pre-wired to the terminal board for the same operating voltage as the ballast.

e) The terminal strip shall have protective barriers between each terminal. The terminal board shall accommodate for wire sizes up to No. 8.

f) All luminaire components shall be securely mounted against horizontal and vertical movement.

g) The new weight of the luminaire, including ballast, designed to oeprate 90-watt low pressure sodium lamp shall not exceed 36 pounds.

h) The luminaire light distribtuion shall be as required.

i) Socket position and lamp support should be adjustable for three burning positions.

2) <u>Ballast for Low Pressure Sodium Vapor Lamps</u>

a) Ballast shall be designed for operation on a multiple circuit, shall be enclosed in the luminaire housing and shall be pre-wired to the lamp socket and to the terminal board. Ballast core and coil shall be dipped in insulating varnish and baked.

Ballast shall be reactor type for 480 volts only and high leakage reactance (HX-HPF) for 120/240V and 277/208V, designed to operate at a minimum of 90% power factor.

b) Ballast shall operate on nominal 120 volts, 60 Hz A.C. or 240 volts, 60 Hz A.C. as required.

c) The ballast nominal open circuit volage shall be 480 volts for 90-watt low pressure sodium lamps.

d) The ballast shall be suitable for operation under open-circuit conditions for an indefinite period of time and the failed lamp be replaced in no more than six months time.

e) The ballast construction shall consist of wound coils and welded laminated steel cores meeting 180C insulation rating.

f) The ballast shall be mounted on tray with quick disconnect features.

C. 55-Watt Low Pressure Sodium Luminaires.

1) Luminaire

a) Luminaires shall be of standard make and manufactured by a manufacturer of recognized experience and ability, who is now regularly engaged in the manufacture of street lighting luminaires.

b) The luminaire shall consist basically of a high quality, corrosion resistant die-cast aluminum housing or fabricated and welded aluminum housing, aluminum finish 0.080" nominal wall thickness; reflector of high gloss white enamel internal surface of housing; a lamp socket assembly, bayonet type, with spring loaded nickel plated contacts and an injection molded prismatic, polycarbonate refractor, hinged and secured with spring latches for rainwater tightness. Gaskets shall be of high temperature neoprene rubber to prevent entry of insects to ballast and optical assemblies.

c) The luminaire shall have a slip-fitter suitable to accept a minimum 4.5 inch straight tenon, 1-5/8" O.D. to 2-3/8" O.D., without the need of rearrangement of any of the mounting components. Mast arm shall be secured by means of two (2) locking bolts. All hardware shall be stainless steel, hot-dipped, galvanized, or cadmium plated.

d) The luminaire housing shall be provided with an EEI-NEMA standard three terminal twist locking type mounting receptacle for individual photo control. The receptacle shall be pre-wired to the terminal board for the same operating voltage as the ballast.

e) The terminal strip shall have protective barriers, between each terminal. The terminal board shall accommodate wire sizes up to No. 8.

f) All luminaire components shall be securely mounted against horizontal and vertical movement.

g) The new weight of the luminaire, including ballast, designed to operate 55-watt low pressure sodium lamp shall not exceed 25 pounds.

h) The luminaire light distribution shall be IES Type III, short non-cutoff.

i) The luminaire shall be supplied without terminal board cover plate.

2) <u>Ballast for Low Pressure Sodium Vapor Lamps</u>

a) Ballast shall be designed for operation on a multiple circuit, shall be enclosed in the luminaire housing and shall be pre-wired to the lamp socket and to the terminal board. Ballast core and coil shall be dipped in insulating varnish and baked. Ballast shall be reactor type for 480 volt only and high leakage reactance (HX-HPF) for 120/240V and 277/208V designed to operate low pressure sodium vapor lamps and shall operate at a minimum of 90% power factor.

(b) Ballast shall operate on nominal 120 volts, 60 Hz A.C. or 240 volts, 60 Hz A.C., as required.

c) The ballast nominal open circuit voltage shall be 480 volts for 55-watt low pressure sodium lamps.

d) The ballast shall be suitable for operation under open-circuit conditions for an indefinite period of time and the failed lamp be replaced in no more than six (6) months time.

e) The ballast construction shall consist of wound coils and welded laminated steel cores meeting 180°C insulation rating.

D. Pad Mount Transformers

Pad mount transformers shall be of the outdoor, factory-assembled metal enclosed type and shall consist of a primary compartment, a secondary compartment, and a transformer section, assembled and shipped as an integral unit. Cable compartments shall be sized in accordance with proposed ASA Standards for pad mounted transformers. The assembly shall be low profile and neat in appearance. Ratings shall be as indicated. The voltage ratings of potheads, insulators and wiring shall be as indicated on the plans. Transformer shall be the product of a manufacturer who has produced units of similar rating within the 3-year period prior to the date of invitation for bids and the transformer have operated for a period of one year prior to the invitation for bids. Contractor shall promptly submit proof showing satisfactory performance and product reliability of the transformer to the Director upon request.

Primary compartment shall be metal enclosed air filled with load break and hook-stick operated switch with current limiting power fuses coordinated to the transformers, and clamp type cable terminals (single-conductor potheads) for the cable provided. Load break switch shall be rated 95 KV BIL, 200 amperes continuous, 200 amperes RMS load break, 9,000 amperes momentary, 5,000 amperes close-in. Voltage rating shall be not less than the nominal voltage of the system to which it is connected. Circuit opening shall be visible. Fuse shall be current limiting, non-expulsion fuses capable of interrupting specified amperes safely and quietly. Lightning arrestors shall be provided to protect windings from lightning and switching surges. An insulating barrier to isolate the high voltage compartment when the compartment door is opened shall be provided to protect personnel from accidental contact with high voltage components.

Secondary compartment shall consist of a circuit breaker mounted integrally with the transformer secondary. Interrupting rating of

the circuit breaker shall be not less than the maximum available short-circuit current of the transformer. Terminals for secondary underground cables shall consist of low voltage and neutral bushings supplied with spade terminals in the secondary compartment.

Transformer section shall contain standard distribution transformer core and coil assembly of the manufacturer. Transformer shall be mineral-oil-immersed, self-cooled, two winding type, single phase, 60 cycles. The primary and secondary voltages, KVA rating and primary taps shall be as specified. Handhole cover shall be large enough for easy changing of taps and inspection of the interior of the tank. Transformer shall conform to the requirements of latest NEMA Designation TR 1.

Materials and finish of the complete pad mount transformer assembly shall be weather-resistant and shall conform to NEMA Designation TR 1 for outdoor transformers and shall conform to weatherproof tests in NEMA Designation SG5. All hardware shall be non-corrosive. An assembly for padlocking of the unit shall be provided. Lifting lugs shall be included for lifting the entire assembly. Complete enclosure shall be constructed of heavy gauge steel. Metal shall be primed with epoxy resin primer and then the highest grade of weather-resistant paint shall be heavily applied to assure a uniform coating on all surfaces including corners, edges, crevices and welds.

Concrete pad for pad mount transformer shall be 8 inches thick reinforced with 6"x6"-10/10 galvanized steel wire mesh. Top of concrete pad shall be approximately 4 inches above finished grade. Pad shall be at least 6 inches larger than the base of the transformer on each side of the transformer enclosure. Pad should be designed so primary and secondary compartments are unobstructed and readily accessible.

E. Secondary Cables

For circuits of 600 volts or less, 600 volts insulation rating (minimum) solid copper conductor, rubber insulated and neoprene jacketed. Rubber insulation shall be 4/64 inch thick; neoprene jacket shall be 3/64 inch thick; and according to National Electric Code RHW/USE standards and IPCEA Designation S-19-81, size 1/c No. 8 AWG except in steel standards in Multiple systems, wiring shall be No. 10 American Wire Gauge.

F. Identification Tags.

For multiple street lighting refer to Department of Transportation Services Standard Drawing No. C-700, C-701 or C-702.

G. Photoelectric Control.

Tubeless, with cadmium sulphide cell.

Nominal turn-on range: 0.5 to 3.5 footcandles;
Nominal turn-off range; 2.5 to 7.5 footcandles
Inrush current rating: 100A at 105V minimum;
50A at 200V minimum.

Direct lamp load: 1,000 watts incandescent, 1,800 volt-amperes mercury vapor and high pressure sodium.

Nominal operating temperature range: 40° to 122°F.

Humidity: Test satisfactory to 100% humidity.

Lighting and surge protection when tested under voltage waves of 1.5 x 40 microseconds.

Circuit sparkover voltage: 2,500 volts maximum. 60 cycle follow current without damage, 1,000 amperes minimum.

No undue pressure at 10,000 amperes with 10 x 20 miscroseconds surge current wave.

Hi-pot test: 2,400 volts between control and metallic ground.

Power consumption: 2.00 watt maximum, daytime (Control contact open) 0.30 watt maximum, night-time (Control contact closed)

Time Delay: 10 milliseconds minimum, 500 milliseconds maximum.

Cadmium sulphite Cell Characteristics:

Hermetically sealed
Pre-aged for stability
Average sensitivity

Dissipation: 500 milliwatts, maximum.

Other Features:

No exposed metal parts (when mounted)
Fail safe operation
Sponge rubber gasket on base plate and mounting for weather-seal.
Polarized twist-lock to fit standard locking type EEI-NEMA sockets.
Provisions on bottom of photocells to record installation date.
Guaranteed two years from date of installation.
Magnetic relay, single pole, single throw, double contact normally closed.
Operating voltage: 105 - 285V, 50/60 cycles a.c.

H. Street Light Standards.

The street light pole shall be an assembly of shaft, mast arm, transformer base and anchor bolts in separate pieces. The entire assembly must be capable of withstanding 100 mph winds.

1) Shaft. The shaft shall be formed from steel meeting ASTM Designation A 570, Grade "C." Shaft shall have a round cross section

and shall be continuously tapering in diameter 0.140/0.138 inch/foot. Shaft shall be formed from steel having a minimum yield strength at 33,000 psi before cold forming. Top outside diameter shall be 3-7/8 inches. Minimum wall thickness shall be 10 or 7 gauge as specified. Shaft shall have a length of 25 or 30 feet or as specified. Severe cold working shall be avoided. Provision shall be made on each for ground connections.

2) Cap. An ornamental steel pole cap shall be provided.

3) Mast arm. Upsweep mast arms shall be formed from 2-inch pipe of the length and type specified in the Proposal to accommodate a luminaire with 2-inch slip-fitter. Mast arm shall be attached to the pole shaft by means of a rain-tight cast steel fitting.

   One-half of fitting shall be welded to the pole shaft and the other half to the mast arm. Mast arms shall be provided with a channel scroll, bolting both to the shaft and mast arm by means of 1/2 inch cap screws.

4) Base Plate. Base plate shall be 1 inch steel plate meeting ASTM A 283 with four slotted holes to accommodate four 1-inch bolts on a 10-1/2 inches bolt circle. Bolt-circle to meet EET-NEMA designations. Shaft shall be continuously welded to base plate both inside and outside.

5) Base Cover. Poles shall be provided with full base steel cover made in two halves. Cover shall completely cover the shaft base.

6) Transformer Base. Transformer base shall be fabricated from steel meeting ASTM Designation A 283. Top plate and bottom flange shall be 3/4 inch plate. Sides of transformer base shall be from 3/16 inch plate. An access door shall be provided. Anchor bolt circle shall be 15" in diameter. Base shall be bolted to the shaft flange by

means of 1-inch bolts. Base shall not be less than 20 inches high, 16 inches square at base and 13 inches square at top. Provision shall be made for ground connections.

7) Anchor Bolts. Four 1" x 40" hot dip galvanized (entire length) anchor bolts meeting ASTM A 307 shall be provided with each pole. Lower end with 90-degree bend extending 4 inches. Each anchor bolt shall be provided with 6 inches of thread and shall be furnished with two nuts and two leveling lugs. Galvanizing at anchor bolts thread area shall be brushed to allow easy running of nuts.

8) Finish. The steel light pole and other ferrous materials shall be hot dip galvanized after fabrication both internally and externally to comply with ASTM A 153 for bolts and hardware, and A 123 for poles and shafts.

9) References. Department of Transportation Services Standard Drawing Nos. A-120, A-121, A-122, A-123, and A-126.

I. Pull Boxes.

Pull boxes be cast-in-place or precast reinforced concrete boxes with cast iron frame and cover.

References: Department of Transportation Services Standard Drawing No. A-104.

J. Cast Iron Frames and Covers.

Cast iron frames and covers for pull boxes shall be of the dimensions shown on the plans. Cast iron shall conform to ASTM A 48. Casting shall be sound, smooth and clean. Frames and covers shall be fitted together and shall be painted with one shop coat of asphaltum before installation.

Reference: Department of Transportation Services Standard Drawing No. A 105.

K. Lamps.

Approved lamp sizes and types are as listed: Lamp base shall be mogul type.

WATTS		ANSI CODE
70)		S62ME-70
100)	(High	S54SB-100
150)	Pressure	S55SC-150
250)	Sodium)	S50VA-250
400)		S51WA-400
55)	(Low	L71RC-55
90)	Pressure Sodium)	L72RD-90

The glass envelope shall be attached to the base with high temperature silicone glue. The assembly shall have a notch or other mechanical device to prevent the glass envelopes from separating from the base. Such device shall be approved by the Director.

L. Rigid Steel Conduit.

Conduit shall be coated and shall conform to all requirements of ASA Designation C80.1 - 1963 and Underwriters Laboratories Standard for Rigid Metallic Conduit. The Contractor shall submit documentation that the conduits being manufactured for this project are in accordance with these Standards.

Where installed underground, all rigid steel zinc coated conduit and fittings shall have been painted with two coats of asphaltic paint, or factory coated with 0.040 inch polyvinylchloride.

Any metal exposed during installation shall be touched up.

M. PVC Conduit.

PVC conduit shall be composed of High Impact Polyvinylchloride-287 Compound and shall

conform to industry standards, and be UL listed in accordance with Article 347 of the 1971 National Electrical Code (or appropriate section of any subsequent issue) for underground and exposed use. Conduit shall be Schedule 80.

N. Ground Rod.

Five-eighth inch copperclad steel rod, length as specified, with bronze body ground rod clamp and set screw.

O. Rubber Insulating Tape.

Ozone resistant, 3/4 inch wide insulating rubber tape manufactured according to ASTM D 1373. Physical properties: 30 mils thick, 500 psi average tensile strength, 600% average elongation and 600 volts per mil dielectric strength.

P. Neoprene Jacketing Tape.

Oil resistant neoprene jacketing tape 3/4 inch wide, manufactured according to ASTM D 119, D 149, D 150, D 257 and D 412. Physical properties: 30 mils thick, 350% average elongation, 350 psi tensile strength, and 300 volts per mil dielectric strength.

Q. Plastic Jacketing Tape.

Polyvinylchloride jacketing tape 3/4 inch wide, manufactured according to ASTM D 150, D 257 and D 1000. Physical properties: 10 mils thick, 175% elongation, 30 pounds per inch width breaking strength, 24 ounce per inch width adhesion to backing and 11,000 volts dielectric breakdown voltage.

57.8 INSTALLATION REQUIREMENTS

A. Notification. Contractor shall notify the Electrical and Maintenance Services Division, Department of Transportation Services, City and County of Honolulu, 72 hours prior to commencing installation of street light system.

B. Posts and Standards. All posts and standards shall be installed as shown in the Standard Details. The shafts shall be plumb with the luminaire brackets in planes perpendicular to the roadway center lines or the horizontal projections of roadway center lines.

C. Luminaires. Luminaires shall be installed with the vertical axis parallel to shaft center line and longitudinal axis parallel to the roadway center line, or the horizontal projection of the roadway center line.

D. Conduit, Risers.

1) Rigid Steel Conduit. Below grade to ten feet above grade. Saw cut, ream and remove all burrs. When direct buried, paint with two coats of anti-corrosion asphalt base compound. At riser, fasten to pole with malleable iron conduit straps and brass screw 5 feet on center. All couplings must be tight.

2) PVC Conduit. Ten feet above grade and higher. Saw cut, ream and remove all burrs. When used on poles or crossarms, fasten with galvanized nails. Apply straps 6 inches from end of conduit and 5 feet on center in between. Use couplings according to manufacturer's instructions.

   Pass smooth bullet-shaped wooden test mandrel through the entire length of each conduit to test for freedom of burrs and obstructions. Mandrel shall be 10 inches long and shall have diameter of 1/4 inch less than inside diameter of duct.

E. Trench Excavation. Standard locations shall be indicated at job site with white paint on adjacent curbstone.

From this reference, Contractor shall stake standard foundation and chalk line and/or stake the center line of the conduit bank and outline of handholes. Before proceeding with work, Contractor shall obtain approval of the layout from Engineer.

Dimensions and locations of trenches for conduits shall be as shown on Drawings.

Where a trench is excavated on slope, sides are to be vertical and depth measured at lowest side. All measurements shall be measured from final grades.

All trench bottoms are to be flat and smooth. Any change of direction shall not exceed 8° for a length of conduit.

Sheathing and bracing as required shall be provided to support sides of excavations from cave-ins.

Provide drainage and pumps to keep trenches dry.

Saw cut all edges of existing sidewalks and pavement.

Trenches deeper than 3 feet or less than 18 inches deep to avoid existing equipment shall be reported to the Engineer.

Excavation required for the installation of conduits, pull boxes, junction boxes, and foundations shall be carefully performed and shall be no wider, longer, nor deeper than is necessary for the proper installation of the conduits, boxes, or foundations.

Trenches for PVC conduits to be encased in concrete shall be excavated to neat lines and to the depth shown on the plans or ordered by the Engineer.

Excavation shall not be started until immediately prior to installation of conduits, boxes, or foundations.

Trench excavation and backfill shall conform to the requirements under Section 11, "Trench Excavation and Backfill."

Adobe or material of similar nature shall not be used for backfill.

F. Lamp Post Foundations and Pull Boxes. The foundations and boxes required shall be carefully constructed

at the locations designated by the Engineer. They shall be poured in place in areas that have been carefully excavated to receive them. Each unit shall be constructed as detailed on the plans and properly connected with the facilities of which it is a component part.

All concrete shall be mixed, placed, and cured in accordance with Section 39, "Portland Cement Concrete," and Section 40, "Concrete Structures," of these specifications, except that hand mixing will be allowed.

Anchor bolts for the foundation shall be set to fit the bases of the metal lamp posts that are to be installed.

Pull box frames and covers shall be given two coats of asphaltic base paint after installation.

G. Conduits. Steel or PVC conduits shall be carefully laid in trenches prepared to receive them. Section of conduit run which crosses roadways of driveway shall be PVC conduit encased in 3 inch concrete jacket.

Where conduits are to be encased in concrete - they shall be laid to the required line and grade and rigidly held in place by concrete blocks or other means approved by the Engineer. Concrete shall then be placed under, around, and over the conduit, care being taken not to dislodge the conduit during the placing and tamping of the concrete. The depth of concrete over the conduit shall be that called for on the plans. Ends of conduit which are buried in concrete shall be capped and plugged with pipe plugs prior to the placing of the concrete.

Any bends required in steel conduits shall have a radius of not less than 12 times the nominal size of the conduit unless factory made ells are used. White lead paint shall be used on the threads of all joints and all end runs shall be capped with standard pipe caps.

Each conduit run shall be provided with a No. 10 gauge flexible galvanized pull wire extending through its entire length. An additional 2 feet shall be doubled back into the conduit at each end of the run. Conduits and sleeves entering pull boxes shall terminate flush in the wall with ends ground smooth or in insulation bushings and shall be temporarily plugged.

Ends of conduit runs shall extend at least 24 inches past the face of curb or edge of pavement unless terminating in pull boxes. All ends shall be accurately located by special markers, markings on curb or as directed by the Engineer and the locations shall be shown on the "As Built" plans as required under Subsection 57.10D of this section.

The exterior portions of all underground steel conduit shall be given two coats of asphaltic paint.

All unenergized metal parts shall be grounded.

H. Primary Supply Circuit. The primary supply circuit rated at 2,400 or 7,200 volts (verify with Hawaiian Electric Co.), single phase, 60 cycles, primary metered shall be furnished by the Hawaiian Electric Company at the adjacent pole. Contractor shall extend circuit from meter pole to transformer pole and make connection to the cutouts.

I. Bonding And Grounding. Metallic cable sheaths, conduit, and lamp posts shall be made mechanically and electrically secure to form a continuous system, and shall be effectively grounded as indicated.

At each standard, construct ground as shown on Drawings and connect to transformer base, ballast housing, lead-in conduit and cable surge cones with #6 AWG copper.

In each handhole with surge cones, drive 5/8 inch by 8 feet ground rod and connect to surge cone ground wire.

At each constant current transformer and riser pole, drive 5/8 inch by 8 feet ground rod and connect to riser conduit, transformer tank, oil switch and protective relay housing with No. 6 bare copper wire.

57.9 FIELD TEST

Prior to acceptance of the work, the Contractor shall cause the following tests to be made on all lighting circuits, in the presence of the Engineer.

1) Test for continuity of each circuit.

2) Test for grounds in each circuit.

3) A megger test on each circuit between the circuit and ground. The insulation resistance shall not be less than the values specified in Section 110-20 of the National Electrical Code.

A functional test in which it is demonstrated that each and every part of the system functions as specified or as intended herein. The Contractor shall test the system for 6 hours with all lights burning, then turn it off for one minute, then on again to check for faulty lights.

The initally applied voltage shall be applied to the entire completed circuit and shall not be greater than the rated voltage of the cable and the rate of increase shall be approximately uniform and not over 100 percent in 10 seconds nor less than 100 percent in 60 seconds. The voltage shall be increased to twice the rated voltage and held at this value for 5 minutes.

In addition, the Contractor shall exhibit the resistance to ground of the series circuit and isolating transformers is not less than 5 megohms.

Any fault in any material or in any part of the installation revealed by these tests shall be replaced, corrected by replacement or repaired by the Contractor in a manner approved by the Engineer and the same test shall be repeated until no fault appears.

57.10 MISCELLANEOUS

A. Removal of Existing Street Lights. Removal of existing street lights and poles (steel or wood light standard) shall be by the Contractor as indicated. Contractor shall deliver same to the Electrical and Maintenance Services Division Base Yard of the Department of Transportation Services at Ala Moana.

Materials that are to be delivered to the Base Yard shall be segregated and packed in separate boxes before delivery to the Base Yard. The requirement for packing in boxes does not include light standards, poles, wiring, crossarms, luminaires and transformers. However, all hardware shall be removed from poles and crossarms.

The abandoned concrete bases, steel poles and risers shall be demolished to a level of at least 12 inches below the existing ground level, and the sidewalk surface area restored to match the existing. Conduits within the bases shall be adequately plugged.

Such removal of the existing lights shall be done only after the new Street Lighting, Traffic and Fire Alarm systems have been completed and approved by the City and County and in full operation.

B. Restoring Road Pavements and Other Improvements. All road pavements and other improvements such as driveways, sidewalks, curbs, gutters and grassed areas destroyed, disturbed or removed by the Contractor shall be satisfactorily reconstructed or replaced by the Contractor.

Reconstruction of curbing, gutters, sidewalks and driveway aprons and the repairing of trenches in the street area shall be in accordance with the provisions under Section 38, "Restoring Pavement and Other Improvements."

The Contractor shall procure permits and pay all charges and fees for this work.

The restoring of road pavements, driveway aprons, sidewalks, curbs, gutters, grassed areas, etc., disturbed by the construction of this project shall not be paid for directly, but shall be considered as incidental and included in the prices bid for the various items in this proposal.

C. Equipment List and Drawings. Within 10 days following notification of award of the contract, the Contractor shall submit to the Engineer for approval, a list of equipment and material which he proposes to install, which shall include all material which is identified on the plans or in the proposal, specifications or special provisions by a manufacturer's name. The list shall be complete as to name of manufacturer, size, and catalog number of unit and shall be supplemented by such other data as may be required, including detailed scale drawings and wiring diagrams of any non-standard or special equipment and of any proposed deviation from the plans. If required to do so, the Contractor shall submit for approval sample articles of the material proposed for use. The Department shall not be liable for any material purchased, labor performed, or delay to the work prior to such approval.

D. As Built or Corrected Plans. Upon completion of the work, the Contractor shall submit an "As Built" or corrected plan, or any data therefor required by the Engineer, showing in detail all construction changes, especially location and depth of conduit and completed schematic circuit diagrams.

E. Items Not Shown. All incidental parts which are not shown on the plans or called for in the proposal or specified herein or in the special provisions and which are necessary to complete the lighting system shall be furnished and installed by the Contractor as though such parts were shown on the plans and/or specified.

F. Peak Traffic Hours. During the periods of peak traffic movements from 6:30 to 8:30 a.m. and from 3:30 to 5:30 p.m., Mondays through Fridays, all traffic lanes shall be kept open for vehicular traffic, unless determined otherwise by the Director.

G. Electric Service. The Contractor shall investigate the service application with the Hawaiian Electric Company for primary and secondary metering services and obtain all permits for this work.

Electric service work shall not be paid for directly, but shall be considered as incidental and included in the prices bid for the various items in the proposal.

H. Inspection. All material shall be subject to inspection after delivery to the site and during installation. Failure of the Engineer to note faulty material or workmanship during construction shall not relieve the Contractor of the responsibility for removing or replacing any such material at his own expense. The Contractor shall pay overtime wages for the inspector for any inspection required after normal working hours at the prevailing rate as specified by ordinance.

57.11 MEASUREMENT AND PAYMENT

The contract lump sum price or prices paid for lighting system (on metal lamp posts or on wood poles) or the contract unit prices paid per unit for the various electrical items comprising the lighting system shall include full compensation for furnishing all labor, materials, tools, and equipment and performing all the work involved in furnishing and installing the street lighting system complete in place as shown on the plans and as herein specified, including excavation and backfill, service connections, and making all required tests.

Full compensation for all additional materials and labor not specifically shown or called for which are necessary to complete the street lighting system described shall be considered as included in the lump sum or unit prices paid for the various items comprising the street lighting system and no additional allowance shall be made therefor.

SECTION 58 - TRAFFIC CONTROL SIGNALS AND APPURTENANCES (FOR CITY AND COUNTY OF HONOLULU AND COUNTY OF KAUAI ONLY)

58.1 DESCRIPTION

This work shall include the furnishing and installation of electric conduits, pull boxes, bases, traffic signal standards and traffic signal cables at the locations shown on the plans or ordered by the Director.

The work will not include wiring controllers unless otherwise specified in the special provisions.

58.2 REGULATIONS AND CODES

In addition to the requirements of these specifications, the plans, proposal and special provisions, all electrical equipment shall conform to the National Electrical Manufacturers Association standards, and all materials and workmanship shall conform to the latest applicable requirements of:

(1) National Electric Code, herein referred to as the Code.

(2) ASTM Standards.

(3) ANSI's or ASA's American Standard Practice for Street and Highway Lighting and Other Standards.

(4) Rules for Overhead Electric Line Construction, General Order No. 6 of the Hawaii Public Utilities Commission.

(5) Local Joint Pole Agreements.

(6) Local power company rules.

58.3 MATERIALS

The materials for traffic signals and appurtenances shall be as specified in the special provisions or as shown on the plans, and shall conform to the following specifications.

A. Conduits. The sizes and types of conduits shall be as shown on the plans and called for in the proposal. Sizes specified refer to the nominal inside diameters.

B. Pull Boxes. Pull boxes shall be Types "A," "C" or "D" as shown on the plans and called for in the proposal.

C. Concrete. Concrete shall be Class "B" in accordance with Section 39, "Portland Cement Concrete."

D. Traffic Signal Standard. The traffic signal standard shall consist of (1) an anchor base approximately 10-1/2 inches square; (2) a uniform continuously tapered steel shaft; (3) a 4-1/2 inch pipe size slip fitter at the top of the shaft, with four or more set screws, the top of the slip fitter shall be threaded for 1-1/2 inch nipple, set screws on collar as well as on the thread for nipple; (4) anchor bolts and nuts; (5) hand hole and hand hole cover; and (6) all other necessary hardware needed to make the standard a complete unit. The entire assembly shall be constructed in a workmanlike manner with no rough edges or surfaces, no depressions, or other defects.

The shaft shall be a minimum of 11 gauge steel, fabricated from open hearth, hot rolled steel, or high tensile low alloy steel, and shall be one-piece construction tapered from 6 inches outside diameter to 4-1/2 inches outside diameter. Length of shaft shall provide for a 10 feet mounting height.

There shall be a bolt provided on the shaft on which a ground wire can be conveniently attached.

The shaft shall have a reinforced opening for a hand hole located on the side of the shaft approximately 9 inches above the bottom surface of the anchor base, complete with gasket, cover plate and non-slip fastener. The opening shall have a 4" x 6" inside minimum measurement. The base plate shall be provided with four holes, six inches apart (square), to receive the anchor bolts.

Anchor base shall be an integral part of the standard, and shall be of steel casting, steel forging, steel plate, and of sufficient strength to support the standard.

Anchor bolts shall be steel conforming to ASTM Designation A 107 and shall be a minimum of 3/4 inch diameter by 24 inches in length, with a 4-inch ell bend on the bottom end of the rod. Such anchor bolts shall be threaded 6 inches at the top. The complete anchor bolts and all nuts, bolts, and

washers shall be galvanized. Four anchor bolts shall be supplied with each pole and each anchor bolt shall have a leveling nut, washer and a top nut.

The complete standard and other ferrous material shall be hot-dipped galvanized after fabrication both internally and externally to comply with ASTM A 153.

58.4 DETAILS

A. Excavation. Trench excavation required shall be no wider or deeper than is necessary for the proper installation of conduits, pull boxes or foundations. Excavations shall not be started until immediately prior to the installation work.

Trenches for conduits to be encased in concrete shall be excavated to neat lines and to the depth shown on the plans or ordered by the Engineer.

The excavations shall be backfilled in accordance with Section 11, "Trench Excavations and Backfill."

B. Conduits. Conduits shall be carefully laid in trenches prepared to receive them. Where conduits are to be encased in concrete, they shall be rigidly held in place and care taken not to distort the conduit when the concrete is placed. Ends of conduit which are encased in concrete shall be capped with wood plugs before concrete is placed.

Any bends required in conduits shall have a radius of not less than 12 times the nominal size of the conduit unless factory made ells are used. White lead paint shall be used on the threads of all joints and all end runs shall be capped with standard pipe caps.

Each conduit shall be provided with a No. 10 gauge flexible galvanized pull wire running its entire length.

Conduits and sleeves entering pull boxes shall terminate flush in the wall with ends ground smooth and temporarily plugged. Ends of conduit runs not terminating in pull boxes shall extend at least 24 inches past the face of the curb or edge of pavement. All ends shall be accurately located by markings on the curb or by special markers. The Contractor shall furnish "as-built" plans showing all conduit runs.

C. Foundations. Signal base foundations and pull boxes shall be carefully installed or constructed in the exact locations designated. Each unit shall be constructed in the exact locations designated. Each unit shall be constructed as detailed on the plans and properly connected with the facilities of which it is a component part.

Anchor bolts in the foundations shall be set to the bases of the traffic signal standards that are to be installed.

D. Standards. Traffic Signal Standards shall be installed as shown on the plans. Exact location shall be determined by the Director.

E. Wiring. The signal heads will be wired by the respective County department.

Powdered soapstone, talc, or other approved lubricant shall be used in placing conductors in conduit.

Hand power only shall be employed in pulling cable, with both the conductor and the sheath connected to the pulling wire or cable so as to put an equal strain on both. To insure the safety of the installation, no bend having a radius shorter than ten times its diameter shall be made in the cable. At least 24 inches of slack shall be left for each conductor at each signal head, at each pull box and at each controller.

When conductors and cables are pulled into the conduit, all ends of conductors and cables shall be taped to exclude moisture, and shall be so kept until splices are made or terminal appliances attached. Ends of spare conductors shall be taped.

Metallic cable sheaths, conduit and metal poles and pedestals shall be made mechanically and electrically secure to form a continuous system and shall be effectively grounded.

58.5 MEASUREMENT AND PAYMENT

The lump sum price or prices paid for the traffic signal installation and appurtenances or the unit prices paid for various items shall include full compensation for furnishing all labor, materials, tools and equipment and for doing all the work involved in furnishing and installing the equipment and materials or modifying the existing system, or both, complete in place as

shown on the plans and as herein specified including the excavation and backfill; concrete bases; restoring vegetation, sidewalk, pavement, structures, and appurtenances damaged or destroyed during construction; salvaging existing materials; and making all required tests.

Full compensation for all additional materials and labor, not shown on the plans or called for herein, which are necessary to complete the installation or system, shall be considered as included in the prices paid for the systems, or units thereof, and no additional allowance shall be made therefor.

SECTION 59 - PARKING METER STANDARD (FOR CITY AND COUNTY OF HONOLULU ONLY)

59.1 DESCRIPTION

This work shall include the installation of parking meter standards at designated locations in accordance with the plans and specifications and includes the furnishing of all material, tools, equipment and labor necessary to complete the work.

59.2 MATERIALS

A. Parking meter standards shall be of standard 2-inch I.D. hot-dipped galvanized steel pipe painted with one coat of a good grade of aluminum industrial enamel.

B. Concrete shall be Class "B" in accordance with Section 39, "Portland Cement Concrete."

C. Grout shall be 1 part cement and 2-1/2 parts sand.

D. Anchor flanges shall be standard 2-inch galvanized cast iron (4 holes).

E. Sulfur shall be any good commercial brand.

F. Waterproofing material shall be of good commercial brand.

G. All bolts, nuts and washers shall be galvanized.

59.3 DETAILS

A. New Standards - Method No. 1. This method shall be used in all areas where the sidewalk is constructed on the ground. All work shall be in accordance with the Traffic Engineering Division "SKETCH for METHOD No. 1."

B. New Standards - Method No. 2. This method shall be used in all areas where the standards are installed in a planting strip between the curb and sidewalk. All work shall be in accordance with Traffic Engineering Division "SKETCH for METHOD No. 2."

C. New Standards - Method No. 3. This method shall be used in all areas where the sidewalk is located over basements or catch basins and the slab thickness is more than 6 inches. All work shall be in accordance with Traffic Engineering Division "SKETCH for METHOD No. 3."

D. New Standards - Method No. 4. This method shall be used in all areas where the sidewalk is located over basements or catch basins and the slot thickness is less than 6 inches. All work shall be in accordance with Traffic Engineering Division "SKETCH for METHOD No. 4."

E. The Contractor shall provide all necessary precautions to insure that the standards are not loosened or damaged prior to the installation of the parking meters. Loosened or damaged standards shall be repaired or replaced by the Contractor at his expense.

59.4 MEASUREMENT AND PAYMENT

The number of units to be paid for shall be the number of standards actually installed. Payment for the standards shall be made at the unit price bid for the respective method used for installation and shall be full compensation for the work in place complete.

SECTION 60 - STREET NAME SIGNS (FOR CITY AND COUNTY OF HONOLULU, COUNTY OF KAUAI AND COUNTY OF MAUI ONLY)

60.1 DESCRIPTION

This work includes the furnishing of all necessary material, tools, equipment and labor necessary to install in place complete reflectorized street name assembly units in accordance with the plans and specifications.

The street name assembly unit shall be composed of two reflective street name plates with the block numbers and necessary hardware for criss-cross mounting on a standard galvanized 2-inch pipe post. When approved in writing by the Engineer, a 2-inch square tubing may be used.

60.2 MATERIALS

A. Posts and Fastenings.

1) Pipe Posts. Pipe posts shall be galvanized standard weight steel pipe conforming to ASTM Designation A 120. The portion of the post to be embedded below finish grade shall be equipped with an approved device to resist turning of the post after installation. The post shall be a one-piece pipe of the required length. If permitted by the Engineer, pipe posts with one welded joint may be used, provided that the joint is below the finished grade. The pipe post shall have two 5/16-inch diameter holes, appropriately located.

2) Fastenings. The hardware for the fastenings shall consist of a cast aluminum slotted post cap, a cast aluminum slotted cross street bracket for 90° mounting, 45° right mounting or 45° left mounting, together with the necessary screws as shown on the plans. The entire assembly shall be constructed in a workmanlike manner with no rough edges or surfaces, no depressions, or other defects. The slotted post cap shall fit a standard galvanized steel 2-inch

pipe or 2-inch square tubing and shall have at least four square head or allen 1/4" x 1/2" stainless steel set screws balance spread for purposes of locking the post cap to the post. The minimum depth on the inside portion of the post cap shall be 1-1/2 inches. The cap shall have a continuous slot with the following dimension:

Opening of 0.12 inch
Depth - 5/8 inch
Continuous length - 5 inches

The slot shall be provided with at least two 1/4" x 1/2" or allen square head screws for purposes of fastening the sign to the post cap. The cross street bracket shall have the dimensions as shown on the plans together with four 1/4" x 1/2" stainless steel square head or allen set screws as shown on the plans.

B. Signs. Signs shall be sheet aluminum conforming to ASTM B 209, alloy 6061T6 flat sheet. The minimum sheet aluminum thickness shall be 0.063 inch for signs 3.00 square feet or less, 0.080 inch for signs 3.01 to 6.25 square feet, and 0.100 inch for signs over 6.25 square feet.

C. Finishings. The sign reflective sheeting material shall consist of glass spheres embedded beneath a flexible transparent plastic which is an integral part of and uniformly distributed over the entire surface of sheeting, each of which forms a smooth flat outer surface. The reflective sheeting shall be at engineering grade and conform to Federal Specifications FP-79 and L-5300C or its latest revision.

The visible color or the surface of the reflective sheeting material and of the light reflected shall conform to a standard color sample furnished by the Department and to the latest edition of the "Manual on Uniform Traffic Control Devices for Streets and Highways".

White and all colors, other than black, shall be reflectorized and shall conform to the requirements of Federal Specifications L-S300C, Table I-A.

TABLE IA
COLOR SPECIFICATIONS LIMITS AND
REFERENCE STANDARDS (REFLECTIVITIES 1, 3 AND 4)

	Chromaticity Coordinates								Reflectance Limit Ref. Std.		
	1		2		3		4		Y		
Color	x	y	x	y	x	y	x	y	Min.	Max.	Munsel Papers
White	.305	.290	.350	.342	.321	.361	.276	.308	35.0	----	6.3GY 6.77/0.8
Gold	.433	.390	.475	.420	.452	.450	.410	.420	20.0	30.0	.55Y 5.38/7.4
Brown	.445	.353	.604	.396	.556	.443	.445	.386	4.0	9.0	5YR 3/6
Yellow	.482	.450	.532	.465	.505	.494	.475	.485	29.0	45.0	1.25Y 6/12
Orange	.535	.375	.607	.393	.582	.417	.535	.399	18.0	30.0	2.5YP 5.5/14.0
Red	.602	.317	.664	.336	.644	.356	.575	.356	8.0	12.0	8.2R 3.78/14.0
Dark Red	.622	.311	.688	.311	.659	.341	.622	.341	5.0	9.0	6.8R 3.56/14.6
Green	.130	.369	.180	.391	.155	.460	.107	.439	3.5	9.0	.65BG 2.84/8.45
Blue	.147	.075	.176	.091	.176	.151	.106	.113	1.0	4.0	5.8PB 1.32/6.8

Brightness values for reflective sheeting material shall conform to the requirement of Table II of Federal Specification L-S-300C.

TABLE II

SPECIFIC INTENSITY PER UNIT AREA (SIA): MINIMUM REFLECTIVITY 1 SHEETING AND TAPE

Observation Angle°	Entrance Angle°	White	Gold	Brown	Yellow	Orange	Red	Dark Red	Green	Blue
0.2	-4	70.0	50.0	1.0	50.0	25.0	14.5	14.0	9.0	4.0
0.2	+30	30.0	16.0	0.3	22.0	7.0	6.0	6.0	3.5	1.7
0.5	-4	30.0	16.0	0.3	25.0	13.5	7.5	7.0	4.5	2.0
0.5	+30	15.0	10.0	0.2	13.0	4.0	3.0	3.0	2.2	0.8
2.0	-4	1.7	1.2	0.02	1.2	0.6	0.3	0.3	0.2	0.1
2.0	+30	1.4	1.0	0.02	1.0	0.5	0.2	0.2	0.14	0.08

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