KINGDOM OF THAILAND

CHIANG MAI

WATER SUPPLY EXPANSION PROJECT

VOLUME II

SPECIFICATIONS

MARCH 1973

PREPARED FOR
OVERSEAS TECHNICAL COOPERATION AGENCY
GOVERNMENT OF JAPAN
BY
TOKYO ENGINEERING CONSULTANT CO., LTD.
TOKYO JAPAN

KINGDOM OF THAILAND

CHIANG MAI

WATER SUPPLY EXPANSION PROJECT

VOLUME II

SPECIFICATIONS

MARCH 1973

PREPARED FOR
OVERSEAS TECHNICAL COOPERATION AGENCY
GOVERNMENT OF JAPAN
BY
TOKYO ENGINEERING CONSULTANT CO., LTD.
TOKYO JAPAN

C O N T E N T S

Chapter 1 General Conditions

1-1 General Requirements

1-2 Scope of the Works

1-3 Contract Drawings

1-4 Construction

1-5 Materials

1-6 Technical Requirements

1 General Conditions

1-1 General Requirements

1-1-1 Scope of Applicability, Interpretation and Language

a) Scope of Applicability

The Specifications shall apply to all the various construction and work done by PWD acting with or through the Contractor.

b) Special Specifications

Items not regulated by the General Conditions shall be determined separately by means of Special Conditions.

c) Interpretation

When matters arise which are not clearly indicated in the Specifications, the Drawings, or the Bills of Quantities, or when the contents of the articles conflict, a determination shall be made by consultation between the PWD and the Contractor. However, the Contractor shall comply with the directions of the PWD in regard to minor details which are commonly recognized as normally required from a technical point of view.

d) Language

The language in which the Contract Documents are drawn will be in English and all correspondence, drawings, documents and written matter relevant to this Contract shall be in English.

1-1-2 Administrative and Other Responsibilities

a) Laws and Regulations

During all the construction of the Works, the Contractor shall comply with all laws and regulations concerning the work, including rules and regulations of PWD, and all other concerned laws and regulations, including the Labor Standards Laws, Traffic Laws, and Construction Industry Laws of Thailand.

b) Required Procedures and Reports

The Contractor shall carry out without delay all procedures or

reports required for purposes of the Work by various governmental or public agencies, and other enterprises.

c) Responsibility for Indemnity

The Contractor shall indemnify the PWD or any third party for any claims, losses, judgments, or suits of every nature or description, including damages for death, arising from any act or omission of the said Contractor, his agents, or anyone directly or indirectly employed by either of them in the execution or the guarding of the Work. Certificates of such insurance shall be filed with the Engineer, if he so require, and shall be subject to his approval for adequacy of protection. However, in event of fire, or any natural disaster or happening which can not reasonably be considered the fault of the Contractor, the matter shall be submitted to arbitration by three arbitrators, one each chosen by the two concerned parties, and one selected by these two arbitrators.

d) Risks Excepted

The Contractor shall not be responsible for any damage, loss or injury which may occur to the Works from any war hostilities (whether war be declared or not), as invasion act by foreign enemies, rebellion, revolution, insurrection or military or civil usurpation of power (other than among the Contractor's own employees), riot, commotion or disorder.

The Contractor shall (unless and until the Contract is terminated in accordance with this clause) complete the Works, provided that the PWD shall be entitled any time after such war begins to terminate the Contract by written notice to the Contractor. Upon such notice, the Contract shall terminate, but without prejudice to the rights of either party in respect to any prior breach thereof.

e) Performance Bond

Within one calendar month after the signing of the Contract, the Contractor shall at his own cost provide a Performance Bond in the sum of Five (5) per cent of his Contract Price for the due per-

formance of the Contract, and such sum shall be neither released nor refunded until fulfilment of all of the Contractor's obligations under the Contract.

f) Licenses, Visas and Duties

The PWD will upon application from the Contractor provide reasonable assistance in obtaining the prompt issuance of all necessary import licenses or permits for the importation into Thailand of all equipment, materials and supplies which are required in order to perform the work of the Contractor, visas for the Contractor's foreign personnel, permits for the release of those supplies which are subject to any statutory controls and priorities and permits for the movement of all supplies, machinery and materials to be transported by the Contractor.

The Contractor shall include in the Contract Price and shall be subject to and required to pay all taxes, duties, fees, permits and assessments of whatever nature levied or assessed by the Government of Thailand or any other local bodies or corporations.

g) Use of Royalties and Patents

In completing the Work, the Contractor shall bear all responsibilities involved in use of construction methods, processes, or articles, the patent rights or other rights to which are held by a third party.

h) Reports, Drawings and Other Documents

(1) The Contractor shall submit reports on standard forms specified by the PWD on the specified dates. When a change occurs in regard to a report already submitted, the Contractor shall speedily submit a revision report.

(2) The Contractor shall produce detailed work drawings or other documents as required.

(3) The Contractor shall produce Plan Drawings, and Location Drawings of the completed works, and submit them to the Engineer. This shall not be required for completion of portions.

i) Responsibilities for Costs

The Contractor shall pay for the costs of surveying, tests, examinations, trial excavations, reports and procedural work in connection with the Works and inspection.

j) Access to Site

The PWD, the Engineer and any person authorized by them shall have access at all times to the Works, to the Site, to all workshops and places where work is being prepared or materials, manufactured articles or machinery are being obtained for the Works. The Contractor shall provide all necessary assistance in obtaining such access.

1-1-3 Contractor, Contractor's Representative and Other Personnel

a) Contractor and Contractor's Representative

The Contractor or a resident representative or superintendent shall at all times be resident at the Site and shall perform all required duties concerning the construction, and supervise all work on the Site in compliance with instructions of inspectors or other personnel included in the term "Engineer's Representative."

During the work, the Contractor (or the Contractor's Representative) shall maintain continual contact with the inspectors and Engineer's Representative, so as to carry out quickly and smoothly the completion of the Works.

b) Contractor's Personnel

The Contractor shall select conscientious, reliable personnel, and carry out the works in a disciplined manner. For work requiring mature skills, the Contractor shall use experienced, skilled workmen.

c) Assigned Matters and Sub-Contracting

The Contractor shall not assign or sublet either the whole work or a substantial portion thereof. In event the Contractor assigns or sublets a portion of the work, he must give prior written notice to the PWD.

d) Objections to the Contractor's Representative or Other Personnel

In event the PWD finds that the Contractor's Representative, important technical personnel or specialists, workmen, service personnel, assignees, or sub-contractors are especially unsuitable for the construction of the Works, the PWD may demand their replacement, which shall be in writing with reasons clearly indicated.

1-1-4 Provision of Temporary Offices, Utilities and Bench Marks

a) Offices

The Contractor shall erect a temporary office at the job site adequately furnished, and maintained in a clean, orderly condition for the duration of construction. The Contractor or his authorized representative shall be present in the office at all times while work is in progress. Instructions received there from the Engineer shall be considered as delivered to the Contractor.

On any part of the Works where it is deemed necessary by the Engineer, the Contractor shall provide a suitable office properly equipped with phone and any other required apparatus for the laboratory representative or inspector on duty at the Works to protect him from the weather while conducting the necessary tests for materials used.

b) Utilities

(1) Light and Power

The Contractor shall furnish temporary lighting facilities, complete with wiring, lamps, and similar equipment as required to adequately light all work areas and with sufficient power capacity to meet the reasonable needs of all sub-contractors. He shall make all necessary arrangements for temporary electric service and shall pay all expenses in connection therewith. The cost for power will be borne by the PWD.

(2) Air, Steam and Water

The Contractor shall provide all air, steam and water as may be required for the cleaning and testing of pipelines and equipment necessary for his and his sub-contractors' work.

c) Temporary Bench Marks

The Contractor shall establish temporary bench marks as ordered by the Engineer, located where there is no danger of shifting location or height.

Where appropriate locations do not exist for temporary bench marks, the Contractor shall establish and maintain suitable permanent, immovable locations, by driving wood or concrete piles.

1-1-5 Quantities

The quantities set out in the Bid Schedule are the estimated quantities of the Works and they are not to be taken as the actual and correct quantities of the Works to be executed by the Contractor in fulfillment of his obligations under the Contract.

1-1-6 Measurement

a) Works to be Measured

The Engineer shall, except as otherwise stated, ascertain and determine by a measurement the value of work done in accordance with the Contract. He shall when he requires any part or parts of the Works to be measured give notice to the Contractor who shall forthwith attend or send a qualified agent to assist the Engineer in making such measurement and shall furnish all particulars required. Should the Contractor not attend or neglect or omit to send such agent then the measurement made by the Engineer or approved by him shall be taken to be the correct measurement of the work. For the purpose of measuring such permanent work as is to be measured by records and drawings the Engineer shall prepare records and drawings month by month of such work and the Contractor as and when called upon to do so in writing shall

within fourteen (14) days examine and agree upon such records and drawings with the Engineer and shall sign the same when so agreed and if the Contractor does not so attend to examine and agree on any such records and drawings they shall be taken to be correct. If after examination of such records and drawings the Contractor does not agree with the same or does not sign the same as agreed they shall nevertheless be taken to be correct unless the Contractor shall within fourteen (14) days of such examination lodge with the Engineer notice in writing of the respects in which such records and drawings are claimed by him to be incorrect in which case the Engineer shall re-examine and any decision of the Engineer subsequent to such re-examination shall be final and conclusive.

b) Method of Measurement

The Works shall be measured net notwithstanding any general or local custom except where otherwise specifically described or prescribed in the Contract.

c) Metric System of Measures

All work completed under the Contract will be measured by the Engineer according to the Metric System of Measures, unless otherwise specified.

The method of measurement and computations to be used in determination of quantities of material furnished and of work performed under the Contract will be in accordance with that specified in the Specifications or if not specified in accordance with those methods generally recognized as conforming to good engineering practice.

Structures will be measured according to neat lines shown on the plans or as altered to fit field conditions.

d) Measurement and Payment

(1) Measurement

i) Within 30 days after award of the Contract, the Contractor shall submit to the Engineer a breakdown of all the lump sum

prices in the Contract. Where applicable the breakdown shall include estimated quantities and unit costs. This breakdown shall be subject to approval by the Engineer and when so approved shall become the basis for determining progress payments for the applicable items and for negotiation of Variation Orders if required.

ii) When variations in the quality or reduction in quantity of the Works are approved by the Engineer, payment will be adjusted as specified in the Contract.

iii) Measurements will only be made on the basis of materials placed in the completed work. No measurements for payment are to be made on the basis of weight or truck volume unless specifically approved for each individual case by the Engineer.

iv) All longitudinal measurements for length, area or volume will be made horizontally along the center line of the work, and no volume deductions will be made for existing facilities located within the established limits of the work. Vertical measurements for volume of excavation will be measured from the ground surface existing at the time of construction to normal grade. Measurement for width will be made between specified limits.

v) When a complete structure or structural unit is specified as the unit of measurement (lump sum item), the unit will be understood to include the complete structure.

vi) When changes are made to a structure which require certain additional work which affect the quantities, measurement of the additional quantities will be made according to dimensions ordered in writing by the Engineer.

vii) In computing volumes of excavation, embankments and fills, the average end area method will be used.

(2) Payment

i) Payment to the Contractor will be made on the basis of estimates of the value of work completed as prepared by the Engineer.

ii) Payment to the Contractor will be made for lump sum items constructed in accordance with the plans and specifications. Where an increase in the quantities is directed by the Engineer to construct a structure for which a lump sum has been bid, additional payment will be made on basis of a Variation Order.

iii) The Contractor shall accept the compensation, as herein provided, in full payment for furnishing all materials, labor, tools, equipment and incidentals necessary for the completed work and for performing all work contemplated and embraced under the Contract and for all losses or damages arising from the nature of the work or from the action of elements or from any unforeseen difficulties which may be encountered during the prosecution of the work until its final acceptance by the PWD.

1-1-7 Inspection of the Works

a) All facilities, including pipelines, shall be tested for conformity or compliance with the Specifications.

b) When any of the circumstances listed below apply, the Contractor shall notify the PWD and shall request inspection of the PWD.

1) Inspection of stages of the work or materials which are difficult or impossible to inspect after completion (Interim Inspection)

2) In case of Partial or Installment Payments (Progress Payment Inspection)

3) In event the work is terminated (Termination Inspection)

4) On completion of correction of the Works (Correction Inspection)

5) Other inspections as necessary.

6) On completion of the Works (Inspection of Completion)

c) The PWD, when requested to make an inspection, shall notify the Contractor of the date for the inspection. The Contractor shall give not less than seven (7) days' notice of all tests in order that

the Engineer or his representative may be present. Two copies of all test certificates shall be supplied to the Engineer or his representative before the materials or components are used in the Works, unless the Engineer directs otherwise. Inspections by the PWD shall be promptly made, and at the nearest practicable point to the source of supply.

d) The Contractor or his representative shall be present at inspections by the PWD, and cooperate in the inspection as necessary. In case the Contractor or his representative is not present at an inspection, he shall abandon any right of protest as to the results.

e) The PWD, may, if necessary, conduct crushing or breaking tests.

f) The PWD may, if necessary, conduct on-the-spot inspections, after notifying the Contractor.

g) The PWD may order portions of the Works which have passed interim inspections corrected at the time of the final or completion inspection of the Works.

h) In case any work is questioned, condemned, or fails to pass inspection, the Contractor shall do anew, re-do, or correct either a part or all of such work according to the directions of the PWD, and submit it for another inspection, subject to the approval of the Engineer.

i) All costs -- including those for labor, equipment and materials -- for surveying, testing and repair, re-doing, or correcting of any defects -- in quality, shape or otherwise -- shall be borne by the Contractor.

1-1-8 Contract Changes, Suspension or Termination

a) Changes in the Contract

The PWD may, when deemed necessary, and after consulting the Contractor, change by written notice the completion dates, the content of the work, and the concerned contract prices. The cir-

cumstances for making such alteration of the Contract are listed as follows:

1) In event of major changes in the type of facility being constructed or in event of major increases or decreases in the designed quantities.

2) In event obstacles or circumstances arise during the work which were hard to foresee, including but not limited to, fire or natural disasters, which affect greatly the original design.

b) Suspension of Works

The PWD may, when deemed necessary, suspend the Work or any part thereof, under the following conditions:

1) In event the Engineer or his inspector deems it necessary because of fire, or related construction work.

2) In event the Contractor, without due reason, fails to follow the Engineer's or his representative's directions.

3) In event the Contractor acts improperly.

4) When the PWD orders suspension for other adequate reasons.

c) Payment at Termination

If the Contract be terminated under Clause 3-1-1-2 (d), or for other reason not the Contractor's responsibility, the Contractor shall be paid by PWD for all unpaid work executed prior to the date of termination at the rates and prices provided in the Contract. In addition, the Contractor shall be paid for all preliminary items so far as the work or service has been performed, and a proper proportion as certified by the Engineer of any Works or service partially performed. Lastly, the Contractor shall be reimbursed for any expenses involved in termination, including transportation back home for overseas personnel, if any, severance pay, or any other legitimate, or necessary, or legally required expenses.

d) Extension of Time for Completion

Should the amount of extra or additional work, or special circumstances of any kind whatsoever which may occur, be such as

fairly to entitle the Contractor to an extension of time for the completion of the Works, the Engineer shall make recommendations to the PWD with regard to the amount of such extension. Final determination of time extension and amounts of money payable under the Contract shall be subject to approval by the PWD.

1-1-9 Delivery of Completed Work, Transfer of Title, and Use of Completed Portions of the Works

a) Delivery of completed work shall be effective as of the time the work in question satisfactorily passes the final inspection of completion. When title to the work or material is vested in the Contractor, such title shall pass to the PWD with delivery. Title to finished portions or units of the construction work or to objects in the process of manufacture shall pass from the Contractor to the PWD on payment of the contract price. But the Contractor shall be liable for adequate protection of all such completed portions of the work or manufactured equipment until the final delivery of the entire completed Works.

b) The PWD shall have the right to use or operate part or all of any completed portions of the work, upon obtaining the consent of the Contractor.

1-2 Scope of the Works

1-2-1 Location and Site

All the work embodied in this Work is located at Chiang Mai. The major portion will be the Water Treatment Plant proposed to be built at a construction site near the Super Highway, with other main works for its intake facility located about 2.5 km. to the north. Distribution pipelines extend to the whole municipal area.

1-2-2 Extent of Works

Type	Intake Facilities	Water Treatment Facilities	Distribution Facilities
Civil	Embankments (including intake)(1 set)	Intake Well (2 sets)	Distributing Mains (1 set)
	Grit Chamber (1 set)	Chemical Sedimentation	Pipe Viaducts
	Clearing and Leveling Site (1 set)	Rapid Sand Filters (2 sets)	Road Crossings
	Conduits (valves and other necessary equipment) (1 set)	Reservoir (1 set)	Valves (air valves, etc.)
	Illumination (including staff quarters)	Clearing and Leveling Site (including earth work and landscaping)	Fire Hydrants
	Water for Use at Site (1 set)	Distributing Pipe at Site (including for existing water treatment plant) (1 set)	Other Items as Needed to Ensure Efficiency
		Water for Use at Site (1 set)	

Type	Intake Facilities	Water Treatment Facilities	Distribution Facilities
Building Works	Generator Room (1)	Generator Room	
	Staff Quarters (1)	Warehouse	
	Intake Pump Room	Maintenance Main Pipe	
		Staff Quarters	
		Elevated Tank for Washing Water	
		Chemical Dosing Room	
		Filter Control Room	
Electric Works & Installation of Equipment	Power Equipment (raw water pumps and equipment to draw water)	Chemical Feeding Equipment (chlorine dosing, neutralization, alum dosing, etc.)	Power Equipment (distribution pumps, filter back washing pumps, and other equipment for purification or delivery of water)
	Site Illumination (including quarters)	Equipment for Sedimentation Basin (agitator, link-belt, sludge removal pump, and other necessary equipment)	
	Generator	Equipment for Filters (collection apparatus, washing equipment, transmission main and other necessary items)	
		Meter Equipment	
		Site Illumination (staff quarters, etc. included)	
		Generator	
		Transformer Equipment	
		Power Equipment	

1-3 Contract Drawings

1-3-1 Drawings for Civil Works

No.	Drawing	Scale
1	General Plan	1/10000
2	Water Flow System and Water Flow Level of Water Treatment Plant	1/250
3	Intake Area Landscaping · Bird's-Eye View	
4	Intake Area · General Plan	1/250
5	Intake Area Earth Volume Calculation Drawing	1/250
6	Intake Area Landscaping · General Plan	1/250
7	Intake Area Landscaping · Detail Drawing	1/20
8	Grit Chamber Temporary Works · General Plan	1/100
9	Grit Chamber Temporary Works Coffering · Detail Drawing	1/100
10	Grit Chamber · Structural Drawing	1/100
11	Grit Chamber · Detail Drawing (1)	1/50
12	Grit Chamber · Detail Drawing (2)	1/100
13	Grit Chamber · Detail Drawing (3)	1/40
14	Grit Chamber Screen & Sluice Gate	1/20
15	Raw Water Pump · Detail Drawing	1/40
16	Intake Area Elevated Water Tank	1/50
17	Grit Chamber Reinforcing Bar Arrangement Diagram	1/100
18	Grit Chamber Reinforcing Bar Arrangement Drawing (1)	1/50
19	Grit Chamber Reinforcing Bar Arrangement Drawing (2)	1/50
20	Grit Chamber Reinforcing Bar Arrangement Drawing (3)	1/50
21	Grit Chamber Reinforcing Bar Arrangement Drawing (4)	1/50
22	Grit Chamber Reinforcing Bar Arrangement Drawing (5)	1/50
23	Grit Chamber Reinforcing Bar Arrangement Drawing (6)	1/50
24	Grit Chamber Reinforcing Bar Arrangement Drawing (7)	1/50
25	Grit Chamber Reinforcing Bar Arrangement Drawing (8)	1/50
26	Grit Chamber Reinforcing Bar Arrangement Drawing (9)	1/50
27	Grit Chamber Reinforcing Bar Arrangement Drawing (10)	1/50

No.	Drawing	Scale
28	Grit Chamber Reinforcing Bar Arrangement Drawing (11)	1/50
29	Raw Water Main (1/7)	1/250
30	Raw Water Main (2/7)	1/250
31	Raw Water Main (3/7)	1/250
32	Raw Water Main (4/7)	1/250
33	Raw Water Main (5/7)	1/250
34	Raw Water Main (6/7)	1/250
35	Raw Water Main (7/7)	1/250
36	Water Treatment Plant · Bird's-Eye View	
37	Water Treatment Plant · General Plan	1/500
38	Plant Area Earth Volume Calculation Drawing	1/500
39	Plant Area Landscaping · General Plan	1/500
40	Plant Area Landscaping · Detail Drawing (1)	1/20
41	Plant Area Landscaping · Detail Drawing (2)	1/10
42	Receiving Well Structural Drawing	1/50
43	Receiving Well Reinforcing Bar Arrangement Drawing	1/50
44	Chemical Sedimentation Basin Structural Drawing	1/100
45	Chemical Sedimentation Basin · Detail Drawing	1/20
46	Chemical Sedimentation Basin Agitator	1/30
47	Chemical Sedimentation Basin Trough Detail Drawing	1/4
48	Chemical Sedimentation Basin Blow Off Pump & Piping	1/30
49	Chemical Sedimentation Basin Double Chain Conveyor General Plan	1/100
50	Chemical Sedimentation Basin Reinforcing Bar Arrangement Drawing (1)	1/50
51	Chemical Sedimentation Basin Reinforcing Bar Arrangement Drawing (2)	1/50
52	Chemical Sedimentation Basin Reinforcing Bar Arrangement Drawing (3)	1/50
53	Chemical Sedimentation Basin Reinforcing Bar Arrangement Drawing (4)	1/50

No.	Drawing	Scale
54	Chemical Sedimentation Basin Reinforcing Bar Arrangement Drawing (5)	1/50
55	Chemical Sedimentation Basin Reinforcing Bar Arrangement Drawing (6)	1/50
56	Chemical Sedimentation Basin Reinforcing Bar Arrangement Drawing (7)	1/50
57	Chemical Sedimentation Basin Reinforcing Bar Arrangement Drawing (8)	1/50
58	Chemical Sedimentation Basin Reinforcing Bar Arrangement Drawing (9)	1/50
59	Rapid Sand Filter · Structural Drawing	1/100
60	Rapid Sand Filter · Detail Drawing	1/100
61	Rapid Sand Filter Piping · Detail Drawing	1/60
62	Rapid Sand Filter Pipe Gallery · Detail Drawing	1/50
63	Rapid Sand Filter Surface Washing Equipment · Detail Drawing	1/20
64	Rapid Sand Filter · Trough Detail Drawing	1/5
65	Rapid Sand Filter · Perforated Pipe Under Drain System · Detail Drawing	1/20
66	Rapid Sand Filter · Reinforcing Bar Arrangement Drawing (1)	1/50
67	Rapid Sand Filter · Reinforcing Bar Arrangement Drawing (2)	1/50
68	Rapid Sand Filter · Reinforcing Bar Arrangement Drawing (3)	1/50
69	Rapid Sand Filter · Reinforcing Bar Arrangement Drawing (4)	1/50
70	Rapid Sand Filter · Reinforcing Bar Arrangement Drawing (5)	1/50
71	Rapid Sand Filter · Reinforcing Bar Arrangement Drawing (6)	1/50

No.	Drawing	Scale
72	Rapid Sand Filter · Reinforcing Bar Arrangement Drawing (7)	1/50
73	Rapid Sand Filter · Reinforcing Bar Arrangement Drawing (8)	1/50
74	Rapid Sand Filter · Reinforcing Bar Arrangement Drawing (9)	1/50
75	Clear Water Reservoir & Distribution Pump Well · Structural Drawing	1/100
76	Distribution Pump · Detail Drawing	
77	Clear Water Reservoir & Distribution Pump Well · Reinforcing Bar Arrangement Drawing (1)	1/100
78	Clear Water Reservoir & Distribution Pump Well · Reinforcing Bar Arrangement Drawing (2)	1/50
79	Clear Water Reservoir & Distribution Pump Well · Reinforcing Bar Arrangement Drawing (3)	1/50
80	Clear Water Reservoir & Distribution Pump Well · Reinforcing Bar Arrangement Drawing (4)	1/50
81	Clear Water Reservoir & Distribution Pump Well · Reinforcing Bar Arrangement Drawing (5)	1/50
82	Clear Water Reservoir & Distribution Pump Well · Reinforcing Bar Arrangement Drawing (6)	1/50
83	Clear Water Reservoir & Distribution Pump Well · Reinforcing Bar Arrangement Drawing (7)	1/50
84	Piping in the Plant Area	1/250
85	Piping in the Plant Area · Detail Drawing	1/50
86	Supply Pipe in the Plant Area	1/500
87	Drainage System · General Plan	1/500
88	Drainage System · Detail Drawing	1/50
89	Effluent Pipe to the Ping River	1/500
90	Chemical Dosing System · Solution Tank & Piping	1/40
91	Chemical Dosing System · Chlorinator Installation Drawing & Flow Sheet	1/40

No.	Drawing	Scale
92	Chemical Dosing System · Electrical System for Aluminium Sulphate	1/10
93	Chemical Dosing System · Electrical System for Chlorine & Lime Soda	1/10
94	Chemical Dosing System · Chemical Dosing Equipment Installation Plan	1/40
95	Chemical Dosing System Piping	1/250
96	Chiang Mai Water Treatment Plant No. 1 · General Plan	1/250
97	Receiving Well (Chiang Mai W. T. Plant No. 1) · Structural Drawing	1/50
98	Receiving Well (Chiang Mai W. T. P. No. 1) · Reinforcing Bar Arrangement Drawing	
99	Distribution Main · General Plan (1980 A.D.)	1/10000
100	Distribution Main · General Plan (2000 A.D.)	1/10000
101	Distribution Main 1 ~ 4 (1/2)	1/500
102	Distribution Main 1 ~ 4 (2/2)	1/500
103	Distribution Main 5 ~ 9 (Super Highway) (1/2)	1/500
104	Distribution Main 5 ~ 9 (Super Highway) (2/2)	1/500
105	Distribution Main 9 ~ 51 (Tung Hotel Road) (1/2)	1/500
106	Distribution Main 9 ~ 51 (Tung Hotel Road) (2/2)	1/500
107	Distribution Main 51 ~ 58 (1/4)	1/500
108	Distribution Main 51 ~ 58 (2/4)	1/500
109	Distribution Main 51 ~ 58 (3/4)	1/500
110	Distribution Main 51 ~ 58 (4/4)	1/500
111	Distribution Main · Water Treatment Plant No. 1 ~ 73 (1/2)	1/500

No.	Drawing	Scale
112	Distribution Main · Water Treatment Plant No. 1 ~ 73 (2/2)	1/500
113	Distribution Main 73 ~ 58 (1/2)	1/500
114	Distribution Main 73 ~ 58 (2/2)	1/500
115	Distribution Main 1 ~ 23 (1/2)	1/500
116	Distribution Main 1 ~ 23 (2/2)	1/500
117	Distribution Main 23 ~ 70 (Singhart Road) (1/3)	1/500
118	Distribution Main 23 ~ 70 (Singhart Road) (2/3)	1/500
119	Distribution Main 23 ~ 70 (Singhart Road) (3/3)	1/500
120	Distribution Main 26 (Rincome Hotel) ~ 29 (University) (1/3)	1/500
121	Distribution Main 26 (Rincome Hotel) ~ 29 (University) (2/3)	1/500
122	Distribution Main 26 (Rincome Hotel) ~ 29 (University) (3/3)	1/500
123	Distribution Main 34 ~ 69	1/500
124	Aqueduct Plan and Profile	1/250
125	Aqueduct Abutment -- A1 Detail Drawing	1/50
126	Aqueduct Abutment -- A2 Detail Drawing	1/50
127	Aqueduct Girder · Detail Drawing (1)	1/25
128	Aqueduct Girder · Detail Drawing (2)	1/25
129	Aqueduct Pier · Detail Drawing	1/50
130	Booster Pump	1/25
131	Distribution Main Road Crossing	1/500
132	Specimen Drawings for Fire Hydrant & Sluice Valve Symbols of Distribution Pipe	1/25
133	Specimen Drawings for Pipe Protection	

1-3-2 Drawings for Architectural Works

No.	Drawing	Scale
1	Intake Pump Room • Elevated Drawing • Floor Plan • Finishing Schedule • Sectional Detail	1/100
2	Intake Pump Facility • Beam Plan • Rigid Frame Girder Drawing • Reinforcing Plan • Electrical System • Ventilation System	1/100
3	Water Intake Generator Room • Elevation Drawing • Sectional Detail Drawing • Finishing Schedule	1/100
4	Water Intake Generator Room • Beam Plan • Foundation Plan • Column List • Bar Arragement	1/100
5	Lodging House • Plan • Elevation Drawing • Sectional Drawing	1/100
6	Lodging House • Detail Drawing • Stairway Detail Drawing	1/50
7	Lodging House • Detail Drawing	1/50
8	Lodging House • Structural Detail Drawing	1/100
9	Lodging House • Septic Tank Detail Drawing	1/20
10	Lodging House • Joints Detail Drawing	1/10
11	Lodging House • Piping Diagram	1/100
12	Lodging House • Electrical System	1/100
13	Lodging House • Electrical Diagram	1/100
14	Warehouse • Plan • Elevation Drawing • Roof Construction Plan • Sectional Drawing • Finishing Schedule Fittings Schedule • Sectional Detail Drawing	1/100
15	Warehouse • Foundation Plan • Beam Plan • Line Framing Elevation Drawing • Line Bar Arrangement Drawing	1/100
16	Water Intake Generator Room • Electrical System • Ventilation System	1/100

No.	Drawing	Scale
17	Elevated Water Tank for Backwashing • Plan • Elevation Drawing • Sectional Drawing	1/100
18	Elevated Water Tank for Backwashing • Foundation Plan • Detail Drawing	1/50
19	Elevated Water Tank for Backwashing • Structural Detail Drawing	1/20
20	Elevated Water Tank for Backwashing • Structural Drawing • Pile Detail Drawing	1/10
21	Chemical Dosing Room • Plans • Elevated Drawings • Sectional Drawings • Finishing Schedule	1/100
22	Chemical Dosing Room • Development Drawings • Fittings Schedule • Sectional Detail Drawing	1/50
23	Chemical Dosing Room • Beam Plans • Foundation Plan • Girder List • Bar Arrangement Drawing	1/100
24	Operating Room of Filter • Elevation Drawing • Sectional Drawing • Plans • Finishing Schedule • Roof Construction Plan	1/100
25	Operating Room of Filter • Beam Plan • Line Framing Elevation • Line Bar Arrangement Drawing • Girder Beam List • Slab List	1/50
26	Distribution Pump Room • Elevation Drawing • Sectional Drawing • Sectional Detail Drawing • Roof Construction Plan • Finishing Schedule • Fittings Schedule	1/100
27	Distribution Pump Room • Beam Plan • Line Bar Arrangement Drawing • Ventilation System	1/100
28	Water Treatment Plant Generator Room • Finishing Schedule • Elevation Plans • Sectional Detail Drawings	1/100
29	Water Treatment Plant Generator Room • Beam Plan • Foundation Plan • Girder List • Slab List • Line Bar Arrangement Drawing	1/100

No.	Drawing	Scale
30	Lodging House • Ground and First Floor Plan	1/100
31	Lodging House • Elevation Drawing • Sectional Drawing	1/100
32	Lodging House • Beam and Foundation Plan	1/100
33	Lodging House • Detail Drawing	1/10
34	Lodging House • Detail Drawing	1/50
35	Lodging House • Structural Detail Drawing	1/10
36	Lodging House • Septic Tank Detail Drawing	1/10
37	Lodging House • Joints Detail Drawing	1/10
38	Lodging House • Piping Diagram	1/100
39	Lodging House • Electrical System	1/100
40	Lodging House • Electrical Diagram	1/100
41	Office • Finishing Schedule Plan	1/100
42	Office • Sectional Drawing • Elevation Drawing Sectional Detail Drawing • Detail Drawing	1/100
43	Office • Sectional Detail Drawing • Roof Construction Plan	1/50
44	Office • Fittings Schedule	1/50
45	Office • Foundation Plan • Beam Plan • Line Framing Elevation Plan	1/100
46	Warehouse • Plan • Elevation Drawing • Roof Construction Plan • Sectional Drawing • Finishing Schedule Fittings Schedule • Sectional Detail Drawing	1/100
47	Warehouse • Foundation Plan • Beam Plan • Line Framing Elevation Drawing • Line Bar Arrangement Drawing	1/100
48	Fittings for Electrical System	1/100
49	Fittings for Sanitation System	1/100
50	Chemical Dosing Room • Ventilation System	1/100
51	Operating Room of Filter Sedimentation Basin • Electrical System	1/100

No.	Drawing	Scale
52	Distribution Pump Room • Electrical System	1/100
53	Water Treatment Plant Generator Room • Electrical System • Ventilation System	1/100
54	Office • Electrical System	1/100
55	Chemical Dosing Room • Electrical System	1/100
56	Office • Sanitation System	

1-3-3 Drawings for Electrical Works

No.	Drawing	Scale
E 01/10	Water Intake Area • Skeleton Drawing	
E 02/10	Water Intake Area • Electric Power System	1/20
E 03/10	Water Intake Area • Outdoor Sub-Station • Generator Room • Raw Water Pump Room • Wiring Diagram	1/100
E 04/10	Water Intake Area • Electric Wiring System	1/250
E 05/10	Water Treatment Area • Skeleton Drawing	
E 06/10	Water Treatment Area • Electric Power System	1/20
E 07/10	Water Treatment Area • Flow Sheet • Graphic Panel	1/15, 1/20
E 08/10	Water Treatment Area • Electric Wiring System	1/500
E 09/10	Water Treatment Area • Sub-Station • Generator Room • Distribution Pump Room • Chemical Feeder Room • Wiring Diagram	1/100
E 10/10	Water Treatment Area Sedimentation Basin • Rapid Sand Filter • Wiring Diagram •	1/50, 1/100

1-4 Construction

1-4-1 General Conditions

a) Detailed Rules, Schedules and Procedures

The Contractor shall set up detailed rules, plans or schedules, and procedures, and execute the Works after obtaining the approval of the Engineer.

The Contractor shall phase the work for smooth progress in the construction, comparing actual progress with the schedules, and giving constant due attention to the manner in which the work is progressing. Especially on parts of the work where time limits are established, the Contractor shall consult adequately with the Engineer and plan the phasing of this work.

b) Working or Shop Drawings

1) Working or Shop Drawings prepared by the Contractor for any structure shall consist of such detailed plans as may be required for the accurate execution of the Works according to designed details and dimensions and which are not included in the Drawings furnished by the Engineer. They shall include shop details, erection plans and installation details, which must be approved by the Engineer before any work involving these Shop Drawings shall be performed. Shop Drawings for cofferdams, centering and form work may be required and in such cases shall likewise be prepared by the Contractor and shall be subject to examination by the Engineer. Where required, actual size drawings shall be provided by the Contractor and approved by the Engineer.

2) It shall be expressly understood that approval of the Shop Drawings by the Engineer shall not be construed as a complete check but will indicate only that the general method of construction and detailing is satisfactory. Approval shall not be construed as permitting any departure from the contract requirements. Approval of such Shop Drawings will not relieve the Contractor of the respon-

sibility for any error which may exist as the Contractor shall be responsible for the dimensions and detailing of adequate connection details or of mutual agreement of dimensions and details and satisfactory construction of all Works. It is mutually agreed that the Contractor shall be responsible for agreement and conformity of his Working Drawings with the approved Drawings and Specifications.

3) Where work consists of repairs or extensions or alterations of existing structures the Contractor shall take such field measurements of original construction as may be required to accurately join old and new work. Any measurements which may appear upon the Drawings to indicate the extent and nature of such repair or extension shall not relieve the Contractor of this responsibility.

4) Within sixty (60) calendar days after receipt of Notice of Award, the Contractor shall submit copies of the following for approval by the Engineer.

i) Certified dimensional drawings of each piece of equipment and auxiliary apparatus to be furnished.

ii) Certified foundation and anchor bolt plans and details.

iii) Schematic piping and electrical wiring diagrams and other data as required for completion of the installation.

iv) Certified pump performance curves from shut-off to as near as possible to specified performance at variable speed, showing head, capacity, efficiency, brake horsepower and required actual positive suctional head.

v) Detail plans showing foundation plans for all items and any other drawings and data as required for the complete installation.

vi) Schematics and complete details of control systems.

5) The Contractor shall submit to the Engineer or his designated authorized representative copies of all Working or Shop Drawings as called for under these Specifications or requested by the Engineer. These Working or Shop Drawings shall be complete and shall

contain all required detailed information. If approved by the Engineer each copy of the Working or Shop Drawings will be identified by the Engineer as having received such approval by being so stamped and dated. The Contractor shall make any correction required by the Engineer and resubmit corrected Drawings for approval. Four copies are to be submitted for approval.

One set of approved Working or Shop Drawings will be returned to the Contractor. If the Contractor desires more than one set, the requirements of the sub-clause above will be increased accordingly. The remaining three sets will be retained by the Engineer.

6) The Contract Price shall include the cost of furnishing all Working or Shop Drawings and the Contractor will be allowed no extra compensation for such Drawings.

7) Drawings and Schedules shall be checked and coordinated with the work of all description involved before they are submitted for the approval of the Engineer and shall bear the Contractor's stamp of approval as evidence of such checking and coordination. Drawings submitted without this stamp of approval may be returned to the Contractor for resubmission.

8) The Contractor shall submit all Drawings sufficiently in advance of construction requirements to permit no less than fourteen (14) working days for checking and appropriate action.

9) If Drawings show variations from the Contractor requirements because of standard shop practice or for other reasons, the Contractor shall describe such variations in his letter of transmittal. If acceptable, the Engineer may approve any or all such variations subject to proper adjustment in the Contract requirements. If the Contractor fails to describe such variations he shall not be relieved of the responsibility for executing the work in accordance with the Contract, even though such Drawings have been approved.

10) If the Drawings or Schedules as submitted show any departure from the Contract requirements which the Engineer finds to be in the interest of the PWD and to be so minor as not to involve a change in the Contract Price or time for completion, the Engineer may approve the Drawings.

c) Net Dimensions

All dimensions specified in Design Drawings or Bills of Quantities shall be net or finished dimensions.

d) Elevations

All elevations of construction works shall be as specified by the Engineer.

e) Services of Manufacturer's Representative and Operating Manuals for Equipment

The Contractor shall include in his bid price the cost of competent representatives of the manufacturers of all equipment to be furnished to supervise the installation, adjustment, and testing of the equipment and to instruct the PWD's operating personnel in their operation and maintenance.

This supervision may be divided into two or more periods as required by the installation program or as directed by the Engineer.

See also the detailed specifications for additional requirements for furnishing the services of manufacturer's representatives.

In addition, four complete sets of operating and maintenance instructions shall be furnished, covering all equipment supplied. Such instruction manuals shall be delivered directly to the Engineer.

f) Underground and Surface Installations

1) Before beginning the construction, the Contractor shall verify by trial excavation and other methods the location, size, and type of underground installations throughout the entire construction area.

2) The Contractor, in event that during the work measures become necessary to protect or relocate any installation either underground or surface under other jurisdiction, shall at once inform

the Engineer, request the presence of the responsible agents, and resume construction only after completion of the relocation or protective measures.

3) The Contractor shall be responsible to provide adequate measures for temporary protection of any installations liable to damage during the construction work. After completion of the construction work, such installations shall be restored to their original state.

4) The Contractor shall obey instructions as given by agents responsible for care of underground or surface installations in the construction area.

g) Explanations to Residents Near the Construction Site

Before starting construction, the Contractor shall, after consulting the Engineer, explain the construction to residents near the construction area, and endeavor to obtain adequate cooperation and understanding.

The Contractor shall promptly report to the Engineer when negotiation concerning the work is necessary with residents of the area or concerned public or government bodies, or when contacted by them. Furthermore, the Contractor shall take appropriate measures.

h) Cooperation with Other Construction Work

In event other work is underway near the construction area, the Contractor and the contractors for such other work shall mutually cooperate in proceeding with their work.

i) Photographs and Other Documents of the Construction

1) The Contractor shall, throughout all the construction and in accordance with instructions from the Engineer, photograph the various phases of the work, collect these photographs, and submit them to the Engineer as a photo album at the time of the inspection.

2) The Contractor, if so requested by the Engineer, shall make photo records of existing facilities, etc., prior to discarding or tearing them down.

3) The Contractor shall, as a basic rule, photograph all portions which cannot be inspected from outside after completion of the work.

4) The Contractor shall keep all documents concerning the construction filed in proper order so the Engineer can inspect or check them at any time.

j) Working Hours

The Contractor shall consult with the Engineer in determining working hours on the construction.

1-4-2 Construction Site

a) Measures for Safety and Traffic

The Contractor shall, to ensure that there is no impediment to flow of water or water transportation, etc. that might inconvenience the public, carry out the following provisions, and also shall take adequate measures for safety and for traffic.

1) The Contractor shall build necessary facilities so that the public is not inconvenienced nor is there loss of or danger to life or property.

2) The Contractor shall faithfully comply with regulations of concerned public and government bodies as concerns construction affecting safety and traffic, and shall make adequate installations accordingly.

3) When it is necessary for executing the Works to stop traffic or navigation, the Contractor shall take all precautions, and shall, under direction of concerned public and government bodies, set up warning lights, barricades, or post required signs at locations where necessary.

4) When there is vehicular or pedestrian traffic within the construction zone, the Contractor shall erect the required installations for this traffic.

5) The Contractor shall endeavor to prevent accidents by stationing guards at the Site and safety personnel wherever required by the construction work.

6) Scaffolding and bridging shall be of types and materials suitable for the period of construction, place, scale, and nature of the construction, so that they are safe and convenient for both work and inspection. Particularly, special items of scaffolding for handling heavy materials shall be clearly defined by drawings and written instructions for making them.

When work is done at high places on the construction site, the Contractor shall install equipment to guard completely against falling objects.

7) The Contractor shall provide adequate lighting for the construction site at night.

8) The Contractor shall install suitable safety equipment to prevent damage or loss of efficiency to wells, trees and shrubs, water areas, and underground or surface structures. In case the Contractor damages such objects, or needs to remove or tear them down in order to execute work, or moves such objects, he must follow directions from the PWD.

9) When any obstacle to the Works is discovered, the Contractor shall immediately inform the Engineer or his representative and receive their instructions.

10) When an accident occurs during the course of the Work, the Contractor must, while taking the proper measures, promptly make a report to the Engineer or his representative as to the nature of the damage, the course of the event, and its cause.

11) The Contractor shall station experienced personnel to take care of materials and equipment used for the Work, checking regularly the equipment's efficiency and ensuring its perfect maintenance. The Contractor shall ensure against error in operating the equipment.

The Contractor shall employ qualified electricians for electrical work for temporary construction.

12) The Contractor, when using dangerous materials such as explosives or gasoline, shall not only comply with all pertinent regulations, but shall also take all possible precautions.

13) The Contractor must exert adequate effort to limit loss to a minimum, and to take quick appropriate measures in event of an emergency or disaster.

The Contractor must have verified, and make available, adequate information on how to contact the proper authorities, and how to assemble the personnel in emergencies upon the outbreak of any emergency or disaster.

The Contractor shall have in reserve necessary personnel to carry out emergency measures in event of such disasters as flood, high waves, heavy rains, typhoons, etc.

b) Prevention of Fires

1) The Contractor, in executing the Works, shall exert every effort to prevent public fire damage, in accordance with the conditions under which he obtains permits to use roads or permits to exclusively use roads.

2) The Contractor must have fire prevention equipment installed at all times within the Construction Site, and be continually prepared for any measures necessary for fire prevention.

3) The Contractor shall appoint responsible persons to oversee possible sources of fire, and conduct regular patrols against outbreak of fire. Fire extinguishers shall be located in suitable places, with their maintenance clearly provided for. There must be no obstructions to use of the fire extinguishers.

c) Care and Orderly Maintenance of the Construction Site

1) The Contractor shall keep the Construction Site and its surrounding area clean, arranging equipment, tools, excess earth and sand, etc. in such a manner as not to impair safety or traffic during the construction.

2) The Contractor must render clean and orderly any areas used, disposing of temporary facilities, and clearing equipment and excess materials before the completion of the Works.

1-4-3 Facilities for the Construction Works

a) Office, Materials Yard, etc.

The Contractor shall provide and maintain for the proper operation of the work a field office, employees' lodging or bunkhouses, storehouses, materials yard or warehouse, machine installation area, and areas to operate equipment as necessary.

b) Construction Equipment and Tools

1) The Contractor must use construction tools and equipment suitable for the work of the Contract.

2) Inspection as deemed necessary by the Engineer for any equipment shall be made by established performance tests and the results of such tests shall be submitted to the Engineer for approval.

3) In event the PWD considers any equipment or tools unsuitable, the Contractor shall replace it with suitable items promptly.

c) Signs and Markers at the Construction Site

1) The Contractor shall provide suitable signs and markers, including sign boards at prominent places at the Construction Site, bearing the name of the construction work, the places, the beginning and completion dates, name of the authority, the name and address of the Contractor, etc.

2) The Contractor shall provide an informational sign board as directed by the PWD, for the purpose of informing local residents and passers-by regarding the nature of the construction, and to request their cooperation.

d) Electricity and Water Used in the Work

The Contractor shall build facilities to provide electric power and water for the work, complying with all regulations concerning electric power and water installation.

e) Land and Water Surface Required for the Work

The Contractor shall acquire rights of use, on his own responsibility, for land and water surfaces necessary for performing the work, and shall bear the costs thereof.

1-5 Materials

1-5-1 General Requirements

a) Standards for Materials

1) Except where otherwise specified or authorized by the Engineer in writing, all materials shall conform to relevant standards of the latest edition of the International Standards Organization or other authoritative standards which ensure equal or higher quality.

2) Any materials not fully specified herein, and for which standards are not included in the ISO, shall be of high quality and approved specifically by the Engineer.

b) Inspection of Materials

1) Materials used in construction shall pass inspection for quality and size, with testing of samples where deemed necessary. Items may be exempted from inspection when they have certificates of standard recognized or approved by the PWD.

2) The Contractor shall be present at inspection of materials. If he fails to attend, the Contractor shall forfeit any right of protest over the results of inspection.

3) Materials rendered not usable due to testing or inspection shall not be counted among the required quantities.

4) Even though materials have passed inspection, any materials which, at the time they are used, evidence damage or deterioration, shall be replaced with new materials which shall be newly tested.

c) Mixing or Combining

When materials require mixing or combining, this work shall be done in the presence of an inspector. However, in case the PWD considers it satisfactory, sample testing may be done instead.

d) Fabrication

Materials requiring fabrication shall be inspected by the Engineer after fabrication.

e) Materials Rejected by Inspection

The Contractor must promptly replace with suitable materials any materials rejected by inspection. The same applies to materials damaged or deteriorated subsequent to inspection.

f) Care of Materials after Inspection

The Contractor shall store in specified places all materials which have passed inspection, and shall be responsible for all loss, damage, or deterioration.

g) Transportation of Materials

All materials used in construction shall be delivered to their construction site as per a construction phasing chart, in such a manner that the construction work suffers no hindrance.

h) Maximum Use of Thai Goods

So far as may be consistent with his obligations under the Contract, the Contractor shall make maximum possible use of materials, supplies, and equipment indigenous to or produced in Thailand.

i) Cost of Samples

All samples shall be supplied by the Contractor at his own cost.

j) Shipping Instructions for Imported Equipment

1) All parts shall be properly protected so no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the equipment is ready for operation.

2) All equipment must be properly protected against any damage during prolonged exposure to the hot, humid climate in Thailand while awaiting completion of installation.

3) All spare parts, small packages, and items not mounted at the place of manufacture shall be packaged and properly protected for prolonged storage before use, and shall be adequately and correctly labelled on the outside of the package so as to ensure easy, positive identification.

1-5-2 List of Materials

a) Stone

The stone to be used in the Works shall be of the best quality suitable for their respective uses, and shall be adequately hard, durable, tough, resistant to abrasion and weathering, and free from earthy or friable matter or other defects. Crushed stones shall not be flaky or elongated, and the sources of supply shall be approved by the Engineer. The Contractor shall make his own arrangements to secure a sufficient supply of specified stone for the Works.

b) Sand and Gravel

The materials shall be fully suitable for the intended work in regard to density, moisture content and size. Where civil work comprises the major portion of the construction work, the use of tests shall be limited to materials for which the location of its source is not specified. When testing determines the material to be unsuitable for the construction, either the source shall be changed or measures shall be taken to improve the quality. For filling, material shall be used which can be satisfactorily packed. The Contractor shall not use materials which contain grass or wood, organic or other impurities liable to cause changes in volume over time, or soft rock or clays which are unstable as moisture dries out. Quality shall be as indicated in the Special Conditions.

1) Gravel shall be clean, hard, and durable without thin, long particles, of a mesh size suitable for its intended use in the construction, and without dust, dirt, organic or other deleterious materials.

2) Unscreened gravel shall contain an appropriate amount of sand, and the gravel shall have an appropriate mixing of large and small particles.

3) Sand shall be clean, hard, and durable, without dust, dirt, organic, or other deleterious materials.

c) Cement, Admixture, and Water

1) The Contractor shall maintain an adequate supply of cement and admixtures for concrete of quality suited to their intended use in producing concrete for the Works, ensuring that a uniform concrete is used throughout the same structure.

2) The Contractor shall conduct quality tests to determine suitability of materials before using.

3) Particularly, the Contractor shall test cement for quality as directed by the Engineer when large amounts of cement are being constantly used, or when the possibility exists of weathering or deterioration.

4) Admixtures

i) Quality of all admixtures for use with cement, and the methods of use shall be as specifically indicated in the Specifications.

ii) Quality and testing of the water reducing agent, and its air entraining admixture, shall comply with applicable Standards.

5) Water shall be free from harmful amounts of oils, acids, alkali, or organic matters, or other deleterious impurities.

6) Ready-mix concrete shall comply with Specifications and Standards, and shall be the product of firms approved by the PWD.

7) Fine aggregates shall be clean, hard, tough, and of appropriate sieve size. They shall be free of silt, foreign materials or organic matter. Sieve requirements shall conform to Standards.

8) Coarse aggregates shall be clean, hard, tough materials of appropriate size, and free of thin stone slivers, organic matter, or other deleterious matter. Mesh size shall conform to Standards.

d) Concrete Fabrications

Concrete fabricated objects used in the Work shall be of size, shape, and quality fully appropriate for the intended use, and shall be free of defects, damage, or breaks. Items approved by the Engineer shall be used. All concrete fabricated items shall conform to ISO standards.

e) Bituminous Material

All bituminous material used in the Works shall be fully adequate for the intended use, and shall comply with ISO standards' section on bituminous material. Whenever the Engineer deems necessary, tests shall be made based on ISO data and submitted to the Engineer.

f) Steel

As a basic rule, all materials for which there are ISO standards should conform to these standards. When materials are used which are not ISO standard materials, the Contractor shall obtain approval of the Engineer, and such materials should be equal or superior to ISO standards.

g) Wood

Wood materials shall be of shape and quality appropriate for their intended use, and neither wood materials nor fabricated objects shall have deleterious defects in excess of permitted limits. Quality shall be as indicated in the Special Conditions.

1-5-3 Summary of Standards and Requirements for Materials

Requirements for testing of materials for use in the construction work are as follows. In event a material does not have ISO standards, other applicable standards shall be used such as JIS, AWWA, and BS. Material of the same class as or superior to materials meeting the above standards may be used with the approval of the Engineer. Testing of materials shall be made, and results submitted to the Engineer, if he considers testing necessary. Materials not listed shall be as specified in the Special Conditions.

Detailed lists of the standards for ISO, JIS, AWWA and BS are given in order.

a) ISO (International Organization for Standardization)

R-7-1954 (JIS B 0203)	Pipe Threads for Gas List Tubes and Screwed Fitting where Pressure-tight Joints are made on the Threads (1/8 inch to 6 inches)
R-13-1955 (JIS G 5523)	Cast Iron Pipes, Special Casting and Cast Iron Parts for Pressure Main Lines
R-49-1957 (JIS B 2301)	Malleable Cast Iron Pipe Fittings Screwed in accordance with ISO Recommendation R-7
R-50-1957 (JIS B 2302)	Steel Sockets Screwed in accordance with ISO Recommendation R-7, Minimum Lengths
R-64-1958 (JIS G 3452)	Steel Tubes, Outside Diameters
R-65-1958 (JIS G 3452)	Steel Tubes Suitable for Screwing in accordance with ISO Recommendation R-7
R-73-1968 (JIS Z 2243)	Brinell Hardness Test for Steel
R-82-1959 (JIS Z 2241)	Tensile Testing of Steel
R-85-1959 (JIS Z 2248)	Bend Test for Steel
R-87-1959 (JIS Z 2248)	Simple Bend Testing of Steel Sheet and Strip Less Than 3 mm Thick
R-134-1962 (JIS G 3444)	Non-Screwed Steel Tubes for General Purposes
R-148-1960 (JIS Z 2202) (JIS Z 2242)	Beam Impact Test (V-Notch) for Steel
R-160-1960 (JIS A 5301)	Asbestos-Cement Pressure Pipes
R-166-1960 (JIS G 3452)	Drift Expanding Test on Steel Tubes

R-167-1960 (JIS G 3444) (JIS G 3452) (JIS G 3457)	Band Test on Steel Tubes
R-202-1961 (JIS G 3452) (JIS G 3444)	Flattening Test on Steel Tubes
R-221-1961 (JIS G 3452)	Steel Tubes-Thicknesses
R-330-1963 (JIS K 6742)	Pipes of Plastic Materials for the Transport of Fluids
R-336-1963 (JIS G 3444) (JIS G 3452) (JIS G 3457)	Plain End Steel Tubes, Welded or Seamless General Table of Dimensions and Masses per Unit Length
R-410-1964 (JIS Z 2243)	Tables of Brinell Hardness Values for Use in Test Made on Flat Surfaces
R-544-1966 (JIS Z 3201)	Diameters and Tolerances for Electrodes for Arc Welding and Filler Metals for Gas Welding
R-547-1966 (JIS Z 3211)	Lengths and Tolerances of Electrodes for the Welding of Mild Steel and Low Alloy High Tensile Steel
R-559-1967 (JIS G 3452) (JIS G 3457)	Steel Pipes for Gas, Water and Sewage, Welded or Seamless
R-560-1967 (JIS G 3452) (JIS G 3454-56)	Cold Drawn Precision Steel Tubes, Metric Series. Dimensions, Tolerances and Masses per Meter
R-630-1967 (JIS G 3101)	Structural Steels
R-635-1967 (JIS Z 3211)	Code of Symbols for Covered Electrodes for Arc Welding of Mild Steel and Low Alloy High Tensile Steels
R-680-1968 (JIS K 5202)	Chemical Analysis of Cements, Main Constituents of Portland Cement
R-1106-1969 (JIS Z 3104)	Recommended Practice for Radiographic Inspection of Fusion Welded Butt Joints for Steel Plates up to 50mm (2 in.) Thick

ISO/TC77	First Draft Proposal for the Revision of the ISO Recommendation R-160 "Asbestos-Cement Pressure Pipes"

b) JIS (Japanese Industrial Standard)

A 1101	Method of Slump Test
A 1102	Method of Test for Sieve Analysis of Aggregates
A 1103	Method of Test for Amount of Material Finer Than Standard Sieve 0.088 in Aggregates
A 1104	Method of Test for Unit Weight of Aggregates
A 1105	Method of Test for Organic Impurities in Sand
A 1106	Method of Test for Flexural Strength of Concrete
A 1108	Method of Test for Compressive Strength of Concrete
A 1109	Method of Test for Specific Gravity and Absorption of Fine Aggregate
A 1110	Method of Test for Specific Gravity and Absorption of Coarse Aggregate
A 1111	Method of Test for Surface Moisture in Fine Aggregate
A 1113	Method of Test for Tensile Strength of Concrete
A 1202*	Method of Test for Specific Gravity of Soils
A 1203*	Method of Test for Moisture Content of Soils
A 1204*	Method of Grain-Size Analysis of Soils
A 1205*	Method of Test for Liquid Limit of Soils
A 1206*	Method of Test for Plastic Limit of Soils
A 1210*	Method of Test for Moisture-Density Relations of Soils Using Rammer
A 1211*	Method of Test for the California Bearing Ratio of Soils
A 1214*	Method of Test for Density of Soil in Place by the Sand-Cone Method

A 1216	Method of Unconfined Compression Test of Soil
A 1217	Method of Test for Consolidation of Soils
A 1218	Method of Test for Permeability of Soils
A 1219	Method of Penetration Test of Soils
A 5301	Asbestos-Cement Water Pipe
A 5302*	Reinforced Concrete Pipes
A 5303*	Centrifugal Reinforced Concrete Pipes
A 5304	Sidewalk Concrete Flags
A 5307	Concrete Curbs
A 5308	Ready-Mix Concrete
A 5310*	Centrifugal Reinforced Concrete Piles
A 5314*	Method of Mortar Lining for Asbestos-Cement Water Pipes
A 5315*	Asbestos Cement Joints for Asbestos-Cement Water Pipes
A 5520*	Cast Iron Joints and Fittings for Asbestos Cement Water Pipes
A 5528	Steel Sheet Piles
A 5751	Oil-Based Caulking Compounds for Buildings
A 6005	Asphalt Felt
A 6006	Asphalt Roofing
A 7201*	Standard Practice for Driving Centrifugal Reinforced Concrete Piles
B 2061	Water Taps (Bibs and Faucets)
B 2062	Sluice Valves for Water Works Purposes
B 2063	Air Valves for Water Works
B 2301	Malleable Iron Screwed Fittings
B 2302	Screwed Type Steel Pipe Fittings

B 8301	Testing Method for Centrifugal Pump and Axial-Flow Pump
B 8313	Small Size Centrifugal Pumps
B 8322*	Double Suction Centrifugal Pumps
G 3101	Hot Rolled Steels for General Structures
G 3104	Rolled Steel for Rivet
G 3106	Hot Rolled Steels for Welded Structures
G 3112	Steel Bars for Concrete Reinforcement
G 3442	Galvanized Steel Pipes for Water Service
G 3443	Coating Steel Pipes for Water Service
G 3444	Carbon Steel Tubes for General Structural Purposes
G 3451	Fittings for Coating Steel Pipes for Water Service
G 3452	Carbon Steel Pipes for Ordinary Piping
G 3457	Electric Arc Welded Carbon Steel Pipes
G 3491	Asphalt Protective Coatings for Steel Water Pipe
G 3492	Coal-Tar Enamel Protective Coatings for Steel Water Pipe
G 4304	Hot Rolled Stainless Steel Sheet and Plate
G 4305	Cold Rolled Stainless Steel Sheet and Plate
G 4306	Hot Rolled Stainless Steel Strip
G 4307	Cold Rolled Stainless Steel Strip
G 5101	Carbon Steel Castings
G 5121	Stainless Steel Castings
G 5122	Heat-Resistant Steel Castings
G 5502	Spheroidal Graphite Iron Castings
G 5522	Cast-Iron Pipe Centrifugally-Cast in Sand-Lined Molds for Water Works

G 5523	Cast-Iron Pipe Centrifugally Cast in Metal Molds for Water Works
G 5524	Cast-Iron Pressure Fittings for Water Works
K 1450	Aluminium Sulfate for Water Works
K 6353*	Rubber Goods for Water Works Service
K 6742*	Unplasticized Polyvinyl Chloride Pipes for Water Works Service
K 6743	Fittings for Unplasticized Polyvinyl Chloride Pipes for Water Works Service
K 6762	Polyethylene Pipes for Water Works Service
K 6763	Polyethylene Pipe Fittings for Water Works Service
K 6773	Flexible Polyvinyl Chloride Water-Stops
R 5201	Physical Testing Methods of Cement
R 5202	Chemical Analysis of Portland Cement
R 5203	Testing Method for Heat of Hydration of Cement
R 5210	Portland Cement
Z 2241	Method of Tension Test for Metallic Materials
Z 2242	Method of Impact Test for Metallic Materials
Z 2243	Method of Brinell Hardness Test
Z 2248	Method of Bend Test for Metallic Materials
Z 3201	Gas Welding Rods for Mild Steel
Z 3211	Covered Electrodes for Mild Steel

* Japanese Industrial Standard which has not yet been officially published in English.

c) AWWA (American Water Works Association)

B 100-53	Filtering Material
B 201-59	Soda Ash
B 301-59	Liquid Chlorine
B 403-69	Aluminum Sulfate -- Lump, Ground, or Liquid
B 405-60	Sodium Aluminate
B 501-64	Caustic Soda
C 106-70	Cast-Iron Pipe, Centrifugally Cast in Metal Molds, for Water or Other Liquids
C 108-70	Cast-Iron Pipe, Centrifugally Cast in Sand-Lined Molds, for Water or Other Liquids
C 110-64	Cast-Iron Fittings, 2 in. through 48 in., for Water and Other Liquids
C 111-53	A Mechanical Joint for Cast Iron Pressure Pipe and Fittings
C 151-65	Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids
C 201-66	Fabricated Electrically Welded Steel Water Pipe
C 203-66	Coal-Tar Enamel Protective Coatings for Steel Water Pipe
C 205-62T	Cement-Mortar Protective Lining and Coating for Steel Water Pipe
C 206-62	Field Welding of Steel Water Pipe Joints
C 207-55	Steel Pipe Flanges
C 208-59	Dimensions for Steel Water Pipe Fittings
C 300-64	Reinforced-Concrete Water Pipe -- Steel Cylinder Type, Not Prestressed
C 302-64	Reinforced-Concrete Water Pipe -- Noncylinder Type, Not Prestressed

C 400-65	Asbestos-Cement Water Pipe
C 500-61	Gate Valves for Ordinary Water Works Service
C 501-67	Sluice Gates
C 502-64	Fire Hydrants for Ordinary Water Works Service
C 504-70	Rubber-Seated Butterfly Valves
C 600-64	Installation of Cast-Iron Water Mains
C 601-68	Disinfecting Water Mains
C 602-67	Cement-Mortar Lining of Water Pipelines in Place
C 603-65	Installation of Asbestos-Cement Water Pipe

d) BS (British Standards Institution)

BS 78	Cast Iron Spigot and Socket Pipes (Vertically Cast) and Spigot and Socket Fittings - Part 1, Pipes
BS 486	Asbestos Cement Pressure Pipes
BS 1211	Centrifugally Cast (Spun) Iron Pressure Pipes for Water, Gas and Sewage
BS 1218	Gate Valves
BS 1387	Galvanized Steel Pipes
BS 2035	Cast Iron Flanged Pipes and Flanged Fittings

e) ASTM (American Society for Testing and Materials)

A 6	Rolled Steel
A 7-61T	Steel for Bridges and Buildings
A 15-62T	Billet-Steel Bars for Concrete Reinforcement
A 36	Structural Mild Steel Bars and Shapes
A 48 (class 30)	Cast Iron
A 53	Mild Steel for Railing, Posts, Flanges, Sleeves
A 123	Galvanizing
A 184-65	Fabricated Steel Bar on Rod Mats for Concrete Reinforcement
A 185-61T	Welded Steel Wire Fabric for Concrete Reinforcement
A 242	Corrosion Resistant Structural Shapes, Plates and Bars Where Noted
A 305-56T	Specifications for Deformations of Deformed Steel Bars for Reinforcement
A 307	Bolts and Nuts
A 325	High-Strength Steel Bolts
A 615-68	Deformed Billet-Steel Bars for Concrete Reinforcement
A 616	Rail-Steel Deformed Bars for Concrete Reinforcement
C 31-627	Method of Making and Curing Concrete Compression and Flexure Test Specimens in the Field
C 33	Aggregates
C 39-61 & Tent. Rev. June 1963	Method of Test for Compressive Strength of Molded Concrete Cylinders
C 40-60	Method of Test for Organic Impurities in Sands for Concrete

C 136-63T	Method of Test for Sieve or Screen Analysis of Fine and Coarse Aggregates
C 150	Portland Cement, Type I and Type II
D 92-57	Method of Test for Flash and Fire Points by Cleveland Open Cut
D 1143	Load-Settlement Relationship for Individual Vertical Piles under Static Axial Load
D 1190	Concrete Joint Sealer, Hot-Poured Elastic Type
D 1191	Concrete Joint Sealers

Note: The latest revised standards shall be applicable for each of the above listed groups.

1-6 Technical Requirements

1-6-1 Construction Works in General

a) General Requirements

1) The Contractor shall submit Approval Drawings or written explanation for such portions of the Works as the Engineer may specify, and obtain the Engineer's approval.

2) The Contractor shall set up batter boards and lines, and execute the Works after obtaining the approval of the Engineer.

b) Temporary Works

1) General Requirements for Temporary Works

i) The Contractor shall make drawings showing the construction and location of temporary works, and obtain the Engineer's approval.

ii) The Contractor must execute promptly temporary works for which the Engineer has issued directions as to the required numbers and location, type of structure, appearance, etc.

iii) Temporary works shall be fully adequate in strength to withstand necessary stresses at all stages of the construction work, and any connecting, crossing, or supporting parts shall be built with special care.

iv) Temporary structures shall be continually inspected, and repaired or strengthened as necessary so that they are adequately efficient.

2) Drainage

i) Drainage within the construction areas shall be fully adequate. The Contractor shall provide adequate facilities to replenish water, taking care it does not stagnate and to provide sedimentation traps to prevent sand or earth from being carried away.

ii) Water replenishment shall be effected so as not to hinder the work, and shall be done at night when necessary.

iii) Waste water shall be disposed of after consultation with concerned authorities when necessary. Particularly, water shall not be discharged onto road surfaces nor into drainage pipes. Also, measures shall be taken to prevent erosion at the place of discharge if waste water is discharged into rivers or streams.

3) Coffering Work

i) Coffering work shall be executed with all care, keeping in readiness extra materials for emergency, and shall be of sturdy construction, taking into consideration high waters due to rains. These facilities shall not obstruct flow of water nor navigation. The location of coffering work, and temporary drainage routes, and their construction shall receive prior approval of the Engineer and concerned authorities.

ii) In event temporary coffering works are damaged or water flow occurs, they shall be promptly repaired and restored to normal condition.

4) Sheathing Work

i) Locations and construction of embankments shall be determined with adequate care, and built sturdily. They shall be constantly maintained in good condition.

ii) When necessary, investigations shall be made of the quality of the earth to better determine the structure and methods to be employed.

iii) Embankment or retaining walls shall be adequately strong to withstand earth pressures and also conditions such as rain that might tend to weaken them during the construction work.

iv) Before driving piles or sheet piles, stakes or markers, the Contractor shall check the presence and location of underground structures by reference to maps, and when necessary by trial boring.

v) Piles shall be driven after digging holes to an appropriate

depth and driven vertically. The heads of piles and sheet piles shall be maintained so they do not become damaged.

vi) Removal of piles and sheet piles shall be done under direction of the Engineer after the earthwork is adequately hard and settled. Holes caused by pulling piles or sheet piles shall be promptly filled with sand.

vii) When earth movements occur at the base of sheet piling due to the presence of free water or other causes, such earth flow shall be stopped by use of hurdles or sandbagging.

viii) Also refer to clause 3-1-6-3-d regarding sheet piles.

1-6-2 Earthwork

a) Excavation

1) Before starting work, the Contractor shall investigate existing surface and underground structures throughout the entire construction area, and shall use due care not to damage such structures.

2) Excavation shall follow the batter boards and shall be finished to the specified slope gradients. Instructions of the Engineer shall be followed for finishing the surface in event it is difficult to remove stumps or protruding rocks or it is considered harmful to the Works.

3) When there is danger from free water or danger of the slope deteriorating, appropriate measures shall be taken promptly.

4) When unforeseeably sunken logs, underground structures, or unfavorable earth conditions are encountered, measures shall be taken according to instructions from the Engineer.

5) The Contractor shall exert adequate care not to excavate to excess, and should such excess occur, shall take necessary measures as instructed by the Engineer.

6) When the measurements for excavation are not clearly indicated the Contractor shall determine those measurements necessary to execute the subsequent operations in constructing the Works, and consult with the Engineer.

7) The basic rule for machine excavation is that it shall be used only to within 20 cms. of the surface for the foundations of the work. Hand labor shall be employed to complete the excavation from that point.

8) The Contractor shall use installations adequate to ensure against collection of rain water or free water during excavation.

9) For specified locations, the Contractor shall test the sustaining strength and quality of earth foundations after completing excavation, and begin the next phase of the work only after the Engineer's inspection.

10) Adequate protective work shall be done to ensure against danger or damage to the foundations of existing structures close to excavation areas.

11) In event a foundation is directly on a rock base, the base shall be levelled carefully, and all surface rock removed which has been decomposed by the elements. If the surface of the rock slopes, steps shall be cut to correct this condition.

12) In event explosives are used in excavation, the Contractor must not leave any loose rock on the finished surface.

b) Refilling and Banking Work

1) Specified materials, which must not contain refuse or deleterious matter, shall be used for refilling and banking.

2) All refilling and banking shall be done in layers not over 30 cms. deep, rendered adequately solid and hard, with appropriate extra material on top if necessary.

3) Backfilling behind structures or work done close to structures shall be executed carefully so as not to damage such structures.

4) Regarding the hardness of the work, the Contractor may be required to make tests as deemed necessary by the Engineer.

5) The Contractor, when banking slopes, shall appropriately turn over the soil of the surface of the slope, or shall terrace such slopes before doing the banking.

6) The Contractor, before executing the work, shall provide adequate drainage for backfilling or banking with ordinary earth. When, unavoidably, backfilling must be done into water, the Contractor must use gravel, sand or other materials which are approved by the Engineer.

7) All areas of backfilling or banking shall be put in good order before continuing the work, and all material remaining from temporary works construction shall be removed, and the areas properly cleaned up.

c) Disposal of Excess Earth

1) The basic rule for disposal of excess earth is that it shall be transported to areas as directed by the Engineer, and shall be neatly disposed of. When there are no instructions from the Engineer, the Contractor may make disposal as he sees fit.

2) In event the Contractor disposes of excess earth as he sees fit, he shall inform the Engineer of the disposal location. The Contractor shall cover loads in transport with canvass or take other adequate measures to guard against scattering earth en route.

3) The Contractor shall provide equipment to prevent fire at the disposal site.

4) The Contractor shall bear all costs for permission to dump, all compensation, the costs of removing any temporary facilities, and all other costs whatsoever their nature.

5) In event the Engineer so orders, the Contractor shall separate excess earths by type before disposal.

d) Finishing Surfaces of Slopes

1) As each layer is completed, all slope surfaces for embankments shall be rendered firm and hard, and level from their bottom edge to top, based on batter boards.

2) The slope of cuts shall not, as a general rule, be lined with earth. Also, holes caused by removing boulders shall be well

filled with good quality earth, which must be rendered firm and hard.

3) After correcting unevenness in slopes, they shall be finished smoothly by adequate tamping.

1-6-3 Foundation Work

a) Cobblestones and Other Foundations

1) Rock for foundations shall be good quality, free of leaves, wood, or other deleterious matter.

2) When rubble or similar stone is used at the bottom of a foundation, it shall contain a specified amount of finer material and must be rendered solid and hard without unevenness.

3) When gravel is used at the bottom of a foundation, it shall be laid evenly to the specified thickness, and rendered adequately solid and firm.

b) Pile Driving

1) As a general rule, test piles shall first be driven as ordered by the Engineer. The test piles and their location shall be selected by the Engineer, and shall be driven by the methods and equipment to be used in the actual work.

2) The Contractor shall promptly submit to the Engineer data on test pile driving, including strength of the driven pile, and depth driven.

3) The Contractor shall obtain advance approval from the Engineer as to the method of pile driving and equipment to be used.

4) An appropriate cap or cushion shall be used in driving piles, so that damage does not occur to the head of the piles.

5) The Contractor shall take care to drive the pile straight, so that it does not twist or slant, or become misshapen, or broken. When damage occurs, the Contractor must either replace the pile or drive another alongside as the Engineer directs.

6) The Contractor shall, after obtaining approval of the Engineer,

cut off the undriven heads of piles which become defective before reaching the designed depth.

7) When water jet is used to drive or help drive piles, such use shall be suspended before reaching the depth required to provide the specified supporting strength, and a hammer shall be used for the last stage of driving.

8) In case the Engineer specifies settling and bearing capacities for pile driving based on calculations of support strength, the Contractor shall promptly submit records of piles driven and obtain the Engineer's approval.

9) Test Piles and Finishing Heads of Piles

i) Test piles shall be done as required in the Special Conditions. In case these specifications do not include the driving of test piles, the first pile driven for each work shall serve as a test pile, and be driven in the presence of the Engineer. The Contractor shall make necessary records, and obtain instruction from the Engineer as to driving the remaining piles.

ii) The Contractor shall measure the final penetration in centimeters of each pile, and submit a report to the Engineer.

iii) The heads of piles shall be cut off true and level so as not to damage the pile itself. Reinforcing steel shall be cut off to the specified length.

iv) When pouring concrete, adequate measures shall be taken so that the concrete does not fall into the piles.

c) Wood Piles

1) Piles shall be straight, "live" logs, peeled at the site, and with ends sharpened in accordance with the hardness of the ground.

2) When joining wood piles, the faces of the joint shall be vertical to the long axis of the logs, and shall fit well. Adequate wood or metal reinforcements shall be carefully fit around the area of the joint so that no warping or bending occurs from the shock of driving.

d) Steel Sheet Pile

1) When storing steel sheet piles, they shall be placed on sleepers which are arranged on a level area. Sheet piles shall not be stacked more than 10 sheets high to prevent deformation during prolonged storage.

2) The surface of sheet piles shall be kept clean and grease shall be applied on the joint before driving.

3) Guide pile and guide materials shall be used carefully to prevent sheet piles from twisting or slanting during the driving.

4) When sheet piles are driven, caps and cushions shall be used.

5) Should sheet piles not be driven in straight and become slanted or twisted, corrective measures shall be taken.

6) In case of inadequate penetration, imperfect driving, or crushed head, corrective measures such as jointing, cutting or removal shall be taken.

7) Removal of sheet piles shall be done after stabilizing the backfilling. The space left vacant by such removal shall be adequately filled with sand and compacted with water.

8) In case the Contractor should, after obtaining approval of the Engineer, make special-shaped steel sheet piles, they shall be carefully made, especially to prevent deformation.

e) Centrifugal Strength Reinforced Concrete Piles and Precast Concrete Piles

1) All transport, driving, and construction work concerning such piles shall conform to the standards of JIS A 7201 (Standards for Use of Centrifugal Strength Reinforced Concrete Piles).

2) Driving piles shall be in accordance with the requirements of clause 1-6-3-b.

3) Joints shall be so constructed as to ensure adequate strength.

4) In case piles are cut, the Contractor shall take adequate care that the pile is not damaged. Especially in the case of precast concrete piles, care shall be exercised that there is no impairment to the elasticity strength.

5) Trimming heads of piles shall be done only after laying foundation rubble for the footing and applying concrete surfacing.

f) Improvement of the Foundation

1) Displacement Work

i) The Contractor shall use good quality earth and sand, approved by the Engineer, for displacement work, and when deemed necessary, shall submit the results of qualitative testing of such materials.

ii) Displacement bottoms, depending on conditions at the site, shall be finished wherever ordered by the Engineer. The depth per layer of displacement material, and the degree of firmness to which it is laid, shall conform to the provisions of clause 3-1-6-2-b. Due care shall be exercised that drainage be adequate.

1-6-4 Concrete and Reinforced Steel Concrete Work

a) Materials

1) Cement

Cement for all cast-in-place concrete shall be domestic Portland cement (ASTM C-150, Type II) or high early strength Portland cement (ASTM C-150, Type III), free from injurious water soluble salts or alkalies. Cement brands shall be subject to approval of the Engineer.

2) Water

Water shall be clean and free from injurious amounts of oils, acid, alkali, organic matter or other deleterious substances.

3) Fine Aggregate

i) Fine aggregate shall consist of washed inert natural sand conforming to the requirements of ASTM Specification C-33 or JIS A 1103, and the following detailed requirements.

Standards for Size of Fine Aggregate

Sieve (mm)	Per Cent by Weight Passing Sieves
10	100
5	90 ~ 100
2.5	80 ~ 100
1.2	50 ~ 85
0.6	25 ~ 60
0.3	10 ~ 30
0.15	2 ~ 10

ii) Deleterious materials in the fine aggregate shall not exceed the following limits:

Limits for Deleterious Materials in Fine Aggregate

(Percentage by Weights)

No.	Type	Maximum Allowed % by Weight
1	Clay lumps	1.0
2	Materials dissolvable by washing tests	
	a. Concrete subject to abrasion	3.0
	b. All other concrete	5.0
3	Material with aggregate meshing 0.3 mm and floatable on liquid with density of 2.0	0.5
4	Coal and lignite	
	a. Concrete of which surface appearance is important.	0.5
	b. All other concrete	1.0

iii) Fine aggregate shall be free from injurious amounts of organic impurities. Except as hereinafter provided, aggregate tested in accordance with ASTM C-40-60 or JIS A 1105 and producing a color darker than the standard shall be rejected.

iv) When subjected to 5 cycles of the Soundness Test, using nitrium sulfate, loss in weight of fine aggregate shall not exceed 10%, as a rule.

4) Coarse Aggregate

i) Coarse aggregate shall be clean, hard, and sound with appropriate mesh values, and without flat or long particles or organic, or deleterious matter.

ii) Coarse aggregate shall contain an appropriate mixture of coarse and fine particles, the mesh of which shall conform to the limits specified in standards of Chart iv(a) below.

iii) Allowable amounts of deleterious matter are given in Chart (b) below.

iv) Loss in weight of coarse aggregate shall not exceed 12% when subjected to 5 cycles of the Soundness Test using nitrium sulfate.

(a) Standards for Mesh of Coarse Materials

Size of aggregate (mm) \ Sieve Designation (mm)	Per Cent by Weight Passing Mesh								
	60	50	40	25	20	15	10	5	2.5
50 ~ 5	100	95~100		35~ 70	---	10~ 30	---	0~ 5	---
40 ~ 5		100	95~100	---	35~ 70	---	10~30	0~ 5	---
25 ~ 5			100	95~100	---	25~ 60	---	0~10	0~5
20 ~ 5				100	90~100	---	20~55	0~10	0~5
15 ~ 5				---	100	90~100	40~70	0~15	0~5
50 ~25	100	90~100	35~ 70	0~ 15	---	0~ 5	---	---	---
40 ~20		100	90~100	20~ 55	0~ 15	---	0~ 5	---	---

(b) Standards for Admissible Amounts of Deleterious Materials(%)

No.	Type	Maximum Permissible Value
1	Clay lumps	0.25
2	Soft particles of rock	5.0
3	Chert which disintegrates in washing during testing	1.0
4	Chert with specific gravity of less than 2.0	1.0

5) Reinforcing Steel

Products of Thai manufacture shall be used for reinforcing steel. In general, deformed bar shall be used. Also, the use of round bar shall be allowed as designated. The standard for permissible expansive strength shall be 1400 kg/cm^2 for deformed bar and 1200 kg/cm^2 for round bar. Brands shall be subject to approval of the Engineer.

6) Handling and Storage of Materials

i) Cement

(a) Cement in bags shall be stacked not more than 10 bags high, and so that inspection may be conducted easily.

(b) Cement shall be kept in a warehouse with floor 30 cm or more above ground, and so built to protect the cement against excessive humidity.

(c) Lumps formed in the cement during storage shall not be used.

(d) All cement which has been stored for more than one month or which may have been subject to moisture shall be tested to determine its acceptability before using.

ii) Aggregate

(a) Fine and coarse aggregate shall be stored separately, so that dirt or foreign material is not introduced.

(b) Coarse aggregates shall be handled with due care to prevent separation, insofar as possible, of fine and coarse matter.

iii) Reinforcing Steel

(a) Reinforcing steel shall not be left directly on the ground, nor exposed to rain for a long period.

(b) After fabrication, the Contractor shall take special care due to the fact that rust tends to occur especially quickly in fabricated materials due to dew or rain.

b) Mixture

1) Mixture of concrete shall be in conformance with the Special Conditions.

2) The concrete mixture shall be determined by test, adjusting specified formulas to those used for mixing at the actual site, so that as little water is used as is practicable, while keeping the mixture workable and appropriate to the work as regards water density, endurance, and strength.

3) Concrete

Items not included in the Special Conditions shall conform to the following mixture chart.

	Maximum Permissible Size of Coarse Aggregate (mm)	Permissible Slump (cm)	Standard Mix by Weight			28-day Required Strength (kg/cm^2)
			Cement (kg)	Sand (m^3)	Water (m^3)	
Leveling Concrete	40	8~15	170	0.48	0.96	135
Non-reinforced Concrete	25	8~15	225	0.47	0.94	150
Reinforced-Steel Concrete	25	12~18	330	0.45	0.90	200

Structures not requiring watertight cement, especially concrete construction for buildings, shall conform to the chart "Standard Limits for Slump," clause 3-1-6-4-1).

c) Mixing Process

1) As a general rule, mixing shall be by machine. In case small amounts are required, providing the Engineer approves, mixing may be done by hand.

2) Errors of measurement shall be 3% or less for cement and gravel or other mixing material, and 1% or less for water. For this purpose, water shall be measured by weight.

3) The amount of one batch shall be determined by the capacity of the mixer.

4) The mixing time shall be determined by testing. If testing is omitted, mixing time shall be 1 1/2 minute or more when

using a gravity-type mixer and 1 minute or more when a force-type mixer is used.

5) In case of handmixing, mixing must be done on a metal sheet using the specified amounts of materials, and the mix must be turned until it is of one even color, then dosed with clean water. Then the mix shall be turned completely five times or more, till the required slump is obtained.

6) Ready-mixed concrete shall meet the specifications of JIS A 5308 (Ready Mix Concrete), or of specifications equal or superior.

7) Ready-mixed concrete shall be delivered, maintaining adequate contact between Contractors, so that its time of delivery will not present difficulties in regard to proper pouring and setting.

8) The place and method of unloading ready-mixed concrete shall be determined after consultation with the Engineer, so that the mixture is fully plastic and setting or separation does not occur. Data on test pieces shall be taken at the unloading point.

9) Concrete which has begun to set shall not be retempered. When separation of materials has set in, the batch shall be re-mixed before such concrete is placed.

d) Placing Concrete

1) The Contractor shall obtain the approval of the Engineer concerning transportation, the method and location of placing and the machinery and tools employed.

2) Before placing or pouring concrete, the forms shall be cleaned and all miscellaneous foreign material removed.

3) The Contractor shall, as required, lay mortar prior to placing the concrete., The mixture of the mortar shall be the same as that for the concrete.

4) Water shall be removed from the bottom of trenches or areas where concrete is to be placed, and adequate measures shall be taken that such water does not contact the newly laid concrete.

5) At the time concrete is laid, the Contractor must obtain an

inspection by the Engineer of the wooden forms, the assembling of steel reinforcements, and facilities for executing the work.

6) In case separation occurs of ingredients of the concrete during transport to the site, it shall be remixed and rendered homogeneous in quality before using.

7) Concrete transported by chute shall not be laid into the forms directly. The Contractor shall provide a receiving apparatus for concrete discharged from the chute, which shall mix the concrete as it is placed.

8) Vertical chutes shall be built of joined pipes, with the outlets freely rotatable; diagonal chutes shall be of such angle that the materials of the concrete do not separate.

9) Water rising to the surface during the placing of the concrete shall be promptly removed by suitable methods.

10) When a concrete pump is used, the following conditions shall apply:

i) Transport mains shall be as easy to move as circumstances allow.

ii) Before beginning operation of the pumps, an appropriate amount of mortar of the same composition as the mortar in the concrete shall be sent through.

iii) Delivery mains shall be straight lines insofar as possible.

iv) The discharge nozzle of the hose shall always be adequately buried into the discharged concrete.

c) Setting

1) Poles or vibrators shall be used during and after placement of concrete, making sure that the concrete is well packed around steel reinforcements and the corners of the forms.

2) Before placing concrete, mortar of the same composition as the composition of the concrete shall be used to fill difficult places, thus ensuring that the placing is thorough.

3) Experienced personnel shall be charged with operation of

vibrators, moving pouring chutes, and nozzles.

f) Curing

Concrete shall be adequately cured after placing so that it is not affected by harmful factors such as low temperatures, dryness, sudden, violent changes in temperature, etc.

g) Concrete Seams in Laying

1) As a general rule, seams or joints in concrete shall be horizontal.

2) Laying seams of waterproof structures shall be carefully done to avoid leakage. In case anti-leak boards are inserted between seams, this work shall comply with JIS K 6773 or other specifications equal or superior.

3) Before laying concrete joints, forms shall be refitted tightly. After the surface of the set concrete has been cleaned up, it should be kept adequately wet, mortar or mortar paste spread and the concrete laid promptly.

4) Structure and location of joints must comply strictly with the designs and construction plans. When compliance is difficult, the Engineer shall be consulted.

h) Concrete in Hot Climates

1) Instructions for materials are as follows:

i) Aggregates exposed to the heat for long periods of time shall be cooled in cold water if possible.

ii) Water used should be of low temperature if possible.

iii) High-heat cement shall not be used.

2) The temperature of concrete shall be under $30^{\circ}C$. when it is laid.

3) Mixed concrete shall be laid as soon as possible, within one hour.

4) The surface of concrete shall be cured by keeping it damp.

i) Watertight Concrete

1) Watertight concrete work shall be done with special care as

to mixture of its material, laying, setting, and curing.

2) The water-cement ratio shall be less than 53 per cent.

3) When composite waterproof material is used, the approval of the Engineer shall be obtained.

4) Concrete shall be handled so as to minimize separation of materials, and shall be set without defect.

5) When curing watertight concrete, the wet curing period shall be longer than for other concrete.

j) Surface Finish

The exposed surfaces of concrete shall be carefully finished, and wall edges of structures, floors, bottom slabs, etc., within a specified time, shall be rendered smooth with a metal trowel.

k) Quality Control of Concrete

1) Manufacture, quality, methods of testing ready-mixed concrete, etc., shall conform to JIS A 5308 (Ready-Mixed Concrete) or standards equal or superior. Quality control shall be strictly enforced.

2) Before commencing work, tests shall be made to determine the types of raw materials to be used, and their mixture.

3) During the work, the following tests shall be conducted to increase the uniformity of the concrete, and to maintain the required quality.

i) Aggregate tests

ii) Slump testing

iii) Tests of contained air

iv) Concrete compressive strength

v) Such other tests as the Engineer may require

l) Methods of Testing Slump Values

1) Values determined by the slump tests indicate the degree of softness, which is essential for workability.

2) Slump values shall be within the limits indicated on the chart below. However, the slump value may be 21 cm. or less for

foundations, flooring, and beams, providing the Engineer approves.

Standard Limits for Slump

Work	Slump (cm)
Foundations, Flooring, Beams	15 ~ 18
Pillars, Walls	18 ~ 21

m) Testing of Concrete

1) Test samples shall be taken immediately before pouring at the place where the concrete is to be put into the forms, insofar as this is possible.

2) Where the amount of concrete to be placed is very small, tests may be omitted, provided the Engineer approves.

3) Strength Tests for Concrete

Type of Test	Purpose	No. of Samples per Test	Test Date
Control Tests for Mix Strength	Control Mix Strength	3	After 7 days
Tests Calculating Concrete Strength of Structural Units	Estimated Strength of Structural Units at 28 Days	3	After 28 days
	Determine Time to Remove Forms	3 per location	Determined by case

n) Covering of Reinforcing Steel

Minimum Values for Protective Covering of Reinforcing Steel (mm)

Type of Structural Part		Minimum Covering	Notes
Floors, Non-supporting Walls		20	
Supporting Walls, Pillars, Beams		30	
Parts Directly Contacting Earth	Walls, Pillars, Floors, Beams	40	Leveling concrete shall be omitted from calculations.
	Foundation, Retaining Walls	50	

The protective covering for steel reinforcing of portions of concrete susceptible to weathering, such as unfinished concrete not under

roofing, shall be as listed in the Special Conditions. In event there are no applicable Special Conditions, the values shall be 10 mm greater than in the above chart.

o) Trowel Finishing of Concrete Floors

1) Scope of Use

Trowel finish is used preparatory to applying asphalt waterproofing, or applying finishing materials, or floor coverings, and for structural surfaces.

2) Types of trowel finish for concrete floor are listed in the following chart.

Types of Trowel Finish

Type	Use	Number of Times Troweled		Notes
		Wood Trowel	Metal Trowel	
A	Living quarters, office, etc.	1	3	With metal trowel, there shall be primary, secondary & final troweling.
B	Finish for storerooms, garage, corridors, etc. Also preparatory to installation or laying of finish materials	1	2	With metal trowel, do intermediate & final troweling
C	Preparation for asphalt waterproofing	1	1	Finish with metal trowel

Note: When a rotary power trowel is used for metal troweling, the number of times required for Type A and Type B shall each be reduced by one.

3) Concrete

i) Slump values shall be within the limits of the following chart, and as ordered by the Engineer.

Concrete Slump (cm.)

Reinforced Concrete	Non-Reinforced Concrete
12 ~ 18	8 ~ 15

ii) The protective covering for the outer parts of steel reinforcing shall be 10 mm more than specified in Chart 3-1-6-4-n. Thicknesses of priming or preparatory finishes for asphalt waterproofing, etc., shall not be included.

4) Leveling Methods

Before placing concrete, the Contractor shall provide the batter board leveling devices necessary for floor finishing and, in the case of Type A and B finishes, shall establish guide rails, etc., at intervals not more than 3.5 m.

5) Batter Board Leveling

i) Leveling devices for forms shall be regularly checked so that horizontals or specified slopes are maintained accurate.

ii) After placing, the concrete shall be made roughly level with shovels, etc., then tamped until coarse aggregate disappear from the surface. At the same time, it shall be made adequately level by spreading with leveling poles.

iii) The leveling devices or plumb bulkheads shall be removed after the leveling process is complete, and their spaces shall be filled in level with concrete.

iv) Areas near walls or pillars where leveling equipment can not be used shall be adequately tamped with other suitable tools. Also wood trowels may be used but not metal ones.

6) Trowel Finish

i) Wood troweling shall be done when the hardening has reached a point so that pressing concrete with the fingers leaves only a slight imprint.

ii) Primary metal troweling shall be done after the concrete is hard enough so that almost no sinking occurs when a man's weight is put on a plank resting on the concrete.

iii) Secondary metal troweling shall be so done as to eliminate depressions as well as uneven marks of troweling, leaving a flat, smooth surface. The troweling should not be so excessive

as to cause mortar to rise to the surface.

iv) Final metal troweling should be done with appropriate strength during the last stage of hardening during which concrete still responds to troweling.

v) During finishing, cement, mortar, or water shall not be scattered on the surface of the concrete.

vi) During trowel finishing, movable planks shall be used to walk over, and the concrete shall not be walked on for a suitable period afterward.

7) Curing

i) After finishing, concrete shall be cured as described below for 12 hours, and sprinkled with water for 2 days.

ii) Method of Curing

a) For Type A, tarpaulin paper or kraft paper shall be laid on the concrete, then covered with leaf fibers or sand to a depth of 20 mm.

b) For Type B and Type C, sand or leaf fiber shall be spread over the concrete. Where asphalt waterproofing is to be used, curing by water alone is sufficient.

8) Joints, Etc.

i) When joints are used for ground floor concrete, the Engineer's approval shall be obtained and the work so done that the concrete surface near the joints is not damaged.

ii) Special care shall be taken that the finished surface is not unsightly near pouring joints.

iii) Uneven places or trowel marks in surfaces prepared for applying finish materials shall be ground down with a grinder at the appropriate time.

9) Materials for Non-Reinforced Concrete

i) Coarse aggregate shall be less than 40 mm in size and less than 1/4 of the concrete thickness.

ii) No specifications are made for the content of salt in the aggregate.

10) Mixture for Non-Reinforced Concrete

i) Mixture shall be as described in the chart below. Type B shall apply where there are no pertinent Special Conditions.

Type	Mixture
A	Design mix shall be as specified in clause 3-1-6-4-b-3 when the design standard for hardness is based on Special Conditions.
B	Design mix shall be based on a water - cement ratio of 70%.

1-6-5 Forms

a) General

1) As a basic rule, forms shall be made of wood.

2) Before pouring concrete, the inside of forms shall be coated with oil or other substance to facilitate removal.

3) Beveled strips shall be provided in form angles and in corners of column and beam boxes where necessary.

4) Adequate care shall be exercised in building forms to assure correct, true forms, of adequate strength to keep them so. Upon removal of forms, the Contractor shall exercise adequate care in removing the forms so the concrete structure is not damaged, including shoring and placing adequate reshores as necessary.

5) Form boards shall be held together and rendered tight by tie-bolts, with washers. Adequate care shall be exercised to provide the required thickness of form walls.

6) The below listed materials shall not be used for forms:

i) Old forms not completely refurbished

ii) Warped or uneven forms

iii) Forms not acceptable to the Engineer for other reasons

7) As a general rule, staging shall be made of steel pipe of adequate strength, so that placing cement will not cause it to shift.

8) Forms shall not be removed until after the concrete has attained the necessary strength to support its own weight and all loads attendant to the construction work. The Contractor shall obtain the approval of the Engineer as to the time and order of removing forms.

9) Forms shall not be connected to staging.

b) Removing Forms

1) Forms shall be removed after obtaining the approval of the Engineer.

2) Time of Removal of Forms

i) Requirements for forms of foundations, beams, pillars, and walls are given in the chart below.

ii) Forms below slabs shall not be removed until the concrete has attained the specified strength as well as the age indicated in the chart below.

Minimum Periods for Retention of Forms

Type of Form		Foundations, Beams, Pillars, Walls	Slab Forms for Top Levels and Forms Under Small Beams	Forms Under Slabs
Category	Average Temp. While Forms Are in Place	Ordinary Portland Cement	Ordinary Portland Cement	Ordinary Portland Cement
Age of Concrete (days)	15°C or more	3	6	17
	5°C or more	5	10	25
Compressive Strength		50 kg/cm^2	50% of Design Standard Strength	85% of Design Standard Strength

iii) Forms below beams shall be retained 28 days, and until the compressive strength has reached the standard specified in the designs.

iv) In the case of cantilevers, projected roofing, beams for long spans, auxiliary pillars supporting floor slabs, etc., or areas where the weights during construction are unusually heavy, forms shall be retained for an extended period as the Engineer directs.

c) Inspection after Removal of Forms

After form frames are removed, defective places shall be repaired as promptly as possible. When repair involves important structural portions, the Contractor shall obtain an inspection by the Engineer.

1-6-6 Reinforcing Steel

a) Reinforcing steel shall be bent cold, without use of heat. When the use of heat is unavoidable, the Contractor shall obtain prior approval of the Engineer.

b) Fabrication of reinforcing steel shall be accurately done to the dimensions shown on the drawings. Before fabrication, all loose rust and dirt shall be removed. All members shall be placed accurately according to the drawings, and rigidly held in place by use of reinforced concrete block, etc., so that no displacement will occur during the laying of the concrete.

c) When joints are used not specified in the drawings, the Contractor shall obtain the approval of the Engineer as to their type and location.

1-6-7 Expansion Joints

a) Materials

1) Water-Stops shall be of highest grade polyvinyl chloride approved by the Engineer and conforming to the following or higher standard.

Standard for Polyvinyl Chloride

Item	Specified Valve (JIS K 6773)
Tensile Strength (kg/cm^2)	120 min.
Elongation (%)	250 min.
Ageing Test (Decrease in Weight) (%)	±10 max.
Softening Point (^oC)	-30 max.
Resistance to Alkaline Solution	
Variation in Tensile Strength (%)	±20 max.
Variation in Elongation (%)	±20 max.
Variation in Weight (%)	± 5 max.
Resistance to Sodium Chloride Solution	
Variation in Tensile Strength (%)	±10 max.
Variation in Elongation (%)	±10 max.
Variation in Weight (%)	± 2 max.

2) Asphalt Joint Sealer for exterior concrete paving shall be hot-poured asphalt compound meeting approved standards. It shall be mixed with fine sand in proportions of 1 to 6.

3) Joint Fillers shall be 1 cm thick wooden board or asphalt fibre, as approved by the Engineer.

b) Installation

1) In Installing Expansion Joints, adequate care shall be taken as to location and method of installation.

2) Water-Stops for all joints shall be as indicated on the Drawings, and shall be continuous around all corners and any interconnecting corners. Water-stops shall be fitted in accurately half-width at a time, one half being carefully fitted in the concrete then the other half.

Splices shall be made by welding in accordance with the manufacturer's recommendations, after obtaining the approval of the Engineer.

3) Joint Sealer shall be applied in accordance with the manufacturer's recommendations, subject to the approval of the Engineer.

1-6-8 Masonry

a) Samples

Submit to the Engineer for approval, samples of cement, sand, lime and bricks. Only materials conforming to the approved samples shall be used on the project.

b) Protection of Materials

All perishable materials for masonry work shall be delivered, stored and handled so as to preclude damage of any nature. Manufactured materials, such as cement and lime, shall be delivered and stored in their original containers, plainly marked with identification of material and maker. Materials in broken containers, or in packages showing water marks or other evidence of damage, shall not be used and shall be removed from the site.

c) Materials

1) Cement

Portland cement shall conform to ASTM Specification C 150 Type II. Masonry cements shall not be used.

2) Hydrated Lime

Lime for masonry mortar shall be hydrated, conforming to ASTM Specification C 207, Type S, or JIS A 6902 Hydrated Lime for Masonry Purposes.

3) Sand for Mortar

Sand for mortar shall consist of clean and durable particles, free from injurious amounts of organic matter.

4) Water

Water shall be free from injurious amounts of oils, acids, alkalis or organic matter, and shall be clean and fresh.

5) Bricks

Bricks used in non-load-bearing partitions which are to be plastered shall be well-baked and free from excessive cracks and flows. Bricks shall have a minimum compressive strength of 100 kilograms per square inch and absorb no more than one-sixth of their weight of water.

Bricks which are used in manholes and in buried structures shall be good, sound, hard and uniformly burned, solid, rectangular, regular and uniform in shape and size, of compact texture and satisfactory to the Engineer. The mean of five tests for absorption shall not exceed 8 per cent and no test shall exceed 11 per cent. Underburned or salmon brick will not be acceptable and only whole brick shall be used unless otherwise permitted. Rejected brick shall be immediately removed from the site of the work.

d) Installation

All bricks shall be thoroughly wet before laying. Mortar shall consist of a mixture of 350 kg. of Portland cement and one cubic meter of coarse sand as approved by the Engineer. Mixing shall be done immediately before usage. Where hydrated lime is used for mortar requiring a lime content, the Contractor will have the option of using the dry-mix method of first converting the hydrated lime into a putty. Where the dry-mix method is employed, the materials for each batch shall be well turned together until the even color of the mixed, dry materials indicates that the cementitious material has been thoroughly distributed throughout the mass, after which the water shall be gradually added until a thoroughly mixed mortar of the required plasticity is obtained. Thickness of mortar shall not exceed 1.3 cm. Joints in walls to receive plaster applied directly on the masonry shall be lightly raked to provide a bond for the plaster. Brick-work shall be carried up in a uniform manner and no section shall be raised more than one meter above the adjoining section at any time. Bricks shall be laid in common bond with all headers used for every fifth course.

Brick shall be laid with all joints filled with mortar and backs fully pargeted to form a solid masonry structure.

Install all window and door frames, set brick tightly against frames, build in all frame anchors, and fill metal frames with mortar.

Bed and grout all equipment and machinery, and items coming in contact with masonry where grouting is required, including door bucks and

frames set in masonry. The Contractor shall install all items required for the completion of the buildings as they apply to masonry.

All masonry slots, chases, or openings required for the proper installation of the work of other Sections shall be constructed as indicated on the drawings or in accordance with information furnished before the work at the points affected.

Surfaces shall be brushed as work progresses and maintained as clean as it is practicable. Unfinished work shall be raked back where possible, and toothed only where absolutely necessary. Before leaving fresh or unfinished work, walls shall be fully covered and protected against rain and wind and before continuing work previously laid shall be swept clean. The tops of walls or their unfinished work shall be protected against all damage by the elements by means of waterproof paper, tarpaulins, boards or other means approved by the Engineer.

All masonry work shall be substantially braced during construction and until final placement of associated members.

The Contractor shall provide and install miscellaneous anchors and attachment members, required both for the anchorage of his own work and that of other trades requiring attachment to masonry, which are not specifically provided under separate sections.

1-6-9 Metal Works (Structural Steel)

a) General Requirements

This section covers the providing of all structural steel complete. Welding shall be in accordance with authorized Work Sheets approved by the Engineer.

1) Design of Members and Connections for any portion of the structure not indicated on the Contract Drawings shall be completed by the fabricator and indicated on the shop drawings.

2) Substitutions of sections or modifications of details, or both, and the reasons therefor shall be submitted with the shop drawings for approval. Approved substitutions, modifications, and necessary changes

in related portions of the work shall be coordinated by the Contractor and shall be accomplished at no additional cost to the PWD.

3) Responsibility for Errors

The Contractor shall be responsible for all errors of detailing, fabrications, and for the correct fitting of the structural members.

4) Templates shall be furnished, together with instructions for the setting of anchors, anchor bolts, and bearing plates. The Contractor shall ascertain that the items are properly set during the progress of the work.

5) Qualification of Welders

Before assigning any welder to work covered by this section of the specifications, the Contractor shall provide the PWD with the names of the welders to be employed on the work together with certification that each of these welders has passed qualification tests using procedures covered in the JIS Z 3801 of equivalent standard. If required by the PWD, the Contractor shall submit identifying stenciled test coupons made by any operator whose workmanship is subject to question. The Contractor shall require any welder to retake the test, when in the opinion of the PWD, the work of the welder creates a reasonable doubt as to the proficiency of the welder. Tests, when required, shall be conducted at no additional expense to the PWD. Recertification of the welder shall be made to the PWD only after the welder has taken and passed the required retest. Welders shall have passed the qualification tests within the preceding 12-month period. The PWD may require coupons to be cut from any location in any joint for testing. All sections of welds found defective shall be chipped or cut out to base metal and properly rewelded before proceeding with the work. Should any two coupons cut from the work of any welder show strengths, under test, less than that of the base metal, it will be considered evidence of negligence or incompetence and such welder shall be permanently removed from the work. When coupons are removed from any part of a structure, the members cut shall be repaired, at no additional

cost to the PWD, in a neat and workmanlike manner with joints of proper type to develop the full strength of the members and joints cut, with preening as necessary or directed to relieve residue stress.

b) Materials shall conform to the specifications approved by the Engineer and other requirements specified below.

1) Structural Carbon Steel, except as required otherwise by the project specification, shall conform to ISO R-630 (Structural Steel).

2) Bolts and Nuts shall be best quality, adequate to meet the required purpose, and shall conform to section 1-6-10 "Miscellaneous Metal Work."

3) Washers

Beveled washers shall be square, smooth, and sloped so that contact surfaces of bolt head and nut are parallel. The diameter of the hole of square-beveled washers shall be 2 mm greater than the bolt size for bolts not larger than 2.5 cm, and 3 mm greater than the bolt size for bolts larger than 2.5 cm.

c) Shop Drawings and Erection Procedure

Shop drawings shall be submitted to the Engineer for approval. Material shall not be fabricated or delivered to the site before the approved shop drawings have been returned to the Contractor. Drawings shall include all shop and erection details, including cuts, copes, connections, holes, bolts, and welds in structural steel. All welds, both shop and field, shall be indicated by standard welding symbols. Drawings shall show the size, length, and type of each weld. Along with the shop drawings the Contractor shall furnish for information two copies of a detailed erection procedure including sequence of erection and temporary staying and bracing.

d) Inspection and Tests

The material to be furnished shall be subject to inspection and tests in the mill, shop and field by the Engineer. Inspection and tests will be conducted at the expense of the Contractor. When materials and workmanship do not conform to the specification requirements, the PWD

reserves the right to reject material or workmanship, or both, at any time before final acceptance of the structure.

e) Storage of Materials

Structural material, either plain or fabricated, shall be stored above the ground upon platforms, skids, or other supports. Material shall be kept free from dirt, grease, and other foreign matter and shall be protected from corrosion.

f) Fabrication

Structural material shall be fabricated and assembled in the shop to the greatest extent possible. Shearing, flame cutting, and chipping shall be done carefully and accurately. Sole plates of beams and girders shall have full contact with the flanges. Stiffeners shall be fitted neatly between the flanges or girders, and, where tight fits are required to transmit bearing, the ends of stiffeners shall be milled or ground to secure an even bearing against the flange angles or shall be grooved and fully buttwelded to the flange. Splice plates and fillers under stiffeners shall fit within 3 mm of the flange angles. Fillers under end angles shall not project beyond the backs of the angles. The clearance between the ends of spliced web plates shall not exceed 6 mm. Assembled pieces shall be taken apart, if necessary, for the removal of burrs and shavings produced by the reaming operation.

1) Connections shall be as indicated. Connections not indicated shall be made to conform with the AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings. One-side or other types of eccentric will not be permitted unless shown in detail and approved on the shop drawings.

2) Holes shall be cut, drilled, or punched at right angles to the surface of the metal and shall not be made or enlarged by burning. Holes in base or bearing plates shall be drilled. Holes shall be provided in members to permit connecting the work of other trades. Holes shall be clean-cut without torn or ragged edges. Outside burrs resulting from drilling or reaming operation shall be removed with a tool making

a 2 mm bevel.

3) Draw

Allowance shall be made for draw in all tension bracing.

4) Welding

Welded connection will be permitted only where indicated on the approved shop drawings. Welded construction shall conform to the following:

i) Surfaces to be Welded shall be free from loose scale, slag, rust, grease, paint and any other foreign materials except that mill scale which withstands vigorous wire brushing may remain. Joint surfaces shall be free from fins and tears. Preparation of edges by gas cutting shall, wherever practicable, be done by a mechanically guided torch.

ii) Parts to be Fillet Welded shall be brought in as close contact as practicable and in no event shall be separated by more than 6 mm. If the separation is 2 mm or greater, the size of the fillet welds shall be increased by the amount of the separation. The separation between faying surfaces of lap joints and butt joints on a backing structure shall not exceed 2 mm. The fit of joints at contact surfaces which are not completely sealed by welds, shall be close enough to exclude water after painting.

iii) Abutting Parts to be butt welded shall be carefully aligned. Misalignments greater than 3 mm shall be corrected and, in making the correction, the parts shall not be drawn into a sharper slope than 2 degrees 1.3 cm in 30.5 cm. Prior to welding, all parts shall be held securely in position by tack welds, clamps, or other means.

iv) The work shall be positioned for flat welding whenever practicable.

v) In Assembling and joining parts of a structure or of built-up members, the procedure and sequence of welding shall be such as will avoid needless distortion and minimize shrinkage stresses. Where

it is impossible to avoid high residual stresses in the closing welds of a rigid assembly, such closing welds shall be made in compression elements.

vi) In the Fabrication of built-up members, all shop splices in each component part shall be made before such component part is welded to other parts of the member. Long girders or girder sections may be made by shop splicing not more than three sub-sections, each made in accordance with this paragraph.

vii) All Complete Penetration Butt Welds made by manual welding, except when produced with the aid of backing material or welded in the flat position from both sides in square-edge material not more than 1 cm thick with root opening not less than one-half the thickness of the thinner part joined, shall have the root of the initial layer gouged out on the back side before welding is started from that side, and shall be so welded as to secure sound metal and complete fusion throughout the entire cross-section. Butt welds made with the use of a backing of the same material as the base metal shall have the weld metal thoroughly fused with the backing material. Backing strips may be removed by gouging or gas cutting after welding is completed, provided no injury is done to the base metal and weld metal and the weld metal surface is left flush or slightly convex with full throat thickness.

viii) Butt Welds shall be terminated at the ends of a joint in a manner that will ensure their soundness. Where possible, this should be done by use of extension bars or run-off plates. Extension bars or run-off plates, if used, shall be removed upon completion of the weld and the ends of the weld made smooth and flush with the abutting parts.

ix) Multiple-Layer Welds may be peened where required with light blows from a power hammer, using a round-nose tool. Peening shall be done after the weld has cooled to a temperature warm to the hand. Care shall be exercised to prevent scaling or flaking of weld and

base metal from over-peening.

5) Bolting

Bolts shall be driven accurately into the holes without damaging the thread. Bolt heads shall be protected from damage during driving. Bolt heads and nuts shall rest squarely against the metal.

g) Erection

Splices and field connections shall be made as indicated. Welding will be permitted only where indicated or approved on the shop drawings. Fasteners shall be installed as specified in paragraph (f) above on "Fabrication." Erecting equipment shall be suitable and safe for the workmen. Error in shop fabrication or deformation resulting from handling and transportation that prevent the proper assembly and fitting of parts shall be reported immediately to the Engineer, and approval of the method of correction shall be obtained. Approved corrections shall be made at no additional cost to the PWD.

1) Anchor Bolts and Anchors shall be properly located and built into connection work. Bolts and anchors shall be preset by the use of templates or such other methods as may be required to locate the anchors and anchor bolts accurately.

2) Column Bases and Bearing Plates shall be provided under columns, beams, girders, and trusses resting on walls or footings. Base and bearing plates may be attached or loose as approved on the shop drawings. Base plates and bearing plates shall be supported and aligned on steel wedges or shims. After the supported members have been plumbed and properly positioned and the anchor nuts tightened, the entire bearing area under the plate shall be dry-packed solidly with bedding mortar as specified in the requirements for concrete as specified elsewhere in these specifications. Wedges and shims shall be cut off flush with edge of column base and bearing plate, and shall be left in place.

3) Field Assembly

After assembly, the various forming parts of a completed frame or structure shall be aligned and adjusted accurately before being fast-

ened. Bearing surfaces and surfaces that will be in permanent contact shall be cleaned before the members are assembled. As erection progresses, the work shall be accurately fastened to take care of all dead load, wind, and erection stresses. Splices will be permitted only where indicated. Fitting-up bolts shall be of the same nominal diameter as the rivets, and cylindrical erection pins shall be 1 mm larger in diameter than the rivets. Unless removal is required, all erection bolts used in welding construction may be tightened securely and left in place. If erection bolts are removed, the holes shall be filled with plug welds. Poor matching of holes shall be corrected by drilling to the next larger size. Welding for redrilling will not be permitted.

4) Driftpins may be used only to bring together the several parts, and shall not be used in such manner as to distort or damage the metal.

5) Gas Cutting

The use of a gas-cutting torch in the field for correcting fabrication errors will not be permitted on any major member in the structural framing. The use of a gas-cutting torch will be permitted only on minor members, when the member is not under stress, and then only after the approval of the Engineer in charge has been obtained.

h) Painting

Painting of structural steel shall conform to the requirements specified in 1-6-15 (Painting).

1-6-10 Miscellaneous Metal Work

a) General Requirements

1) The Work includes providing miscellaneous metal work, complete, in strict accordance with this specification and the contract drawings.

2) All Items of Miscellaneous Metal shall be of sizes and shapes and constructed of material, as indicated on the drawings and as hereinafter specified. Unless otherwise specified, the items furnished shall be standard approved products fabricated in accordance with best shop methods and shall be securely installed in workmanlike manner by

approved methods. The Contractor shall verify all measurements and shall take all other measurements necessary before fabrication of the various items. Welding shall be in accordance with the ISO standards.

b) Materials

1) General

Metals shall be free from defects impairing strength, durability, or appearance, and of best commercial quality for the purpose specified. All metals shall be new material and shall have structural properties to sustain safely or withstand strains and stresses to which normally subjected. All exposed fastenings shall be of the same material, color and finish as the metal to which applied, unless otherwise shown.

2) Bolts, Nuts, Washers, Screws, Etc.

Bolts, nuts, washers, screws, etc. shall be standard commercial quality of steel galvanized unless otherwise specified.

3) Bolt or Screw Anchors

Bolt or screw anchors for fastening work to poured concrete or masonry work shall be of the expansion shield type best suited for the purpose and the ferrous metal parts shall be galvanized or cadmium plated.

4) Steel Shapes

Steel for supports and other miscellaneous items of work shall conform to the requirements of ISO or other equal or higher standards.

5) Pipe

Pipe for the supports and other miscellaneous items of work shall conform to the requirements of ISO or other equal or higher standards.

c) Shop Drawings

Shop drawings for all miscellaneous items shall be submitted for approval. Miscellaneous metal items shall not be delivered to the site before shop drawings have been approved and returned to the Contractor.

d) Miscellaneous

All miscellaneous metal shown, including fasteners and anchors for same to complete all work not specifically mentioned herein (or included

in other sections of the specifications) but shown on the drawings or required, shall be provided.

e) Installation

The miscellaneous metal work shall be positioned and securely anchored in place as shown on the drawings. The work shall be true to line and so installed as to insure satisfactory operation of any moving parts.

1-6-11 Carpentry

a) General Requirements

The work includes the providing of carpentry work, complete, in strict accordance with the specifications and the applicable drawings, and subject to the terms and conditions of the contract.

b) Materials (Lumber)

1) Contractor's Options

Lumber shall be provided in accordance with only one of the following options:

i) Option "A": All lumber shall be hardwood.

ii) Option "B": Except those items specified hereinafter to be fabricated of hardwood, all other lumber shall be of softwood pressure-treated in accordance with section 1-6-13 (Preservative Treatment of Lumber). Structural elements may be of hardwood provided that there is no intermingling of softwood for those elements.

2) Selection of an Option

The Contractor shall, in his bid or proposal submittal, clearly state the option selected. The Contractor will be required to complete the work using the option selected at the time of his bid or proposal submittal.

3) Hardwood shall be heartwood of the following specie(s), (or others as approved); the wood shall be heavy, close-grained and resistant.

	Botanical Name	Thai Name
(a)	Hopea Odorata	Takien-Thong
(b)	Hopea Pierrei	Takien-Hin
(c)	Afzelia Bakeri	Lumpaw
(d)	Afzelia Zylocarpa	Maka-Mong
(e)	Sindora Siamesis	Maka-Tah
(f)	Xylia Kerii	Dang
(g)	Shorea Obtusa	Teng
(h)	Pentacme Siamensis	Rang
(i)	Pterocarpus Macrocarbus	Pradoo
(j)	Cotylebimu Lanceolatum	Kiem
(k)	Tectona Grandis	Sak (Teak)

4) Softwood shall be heartwood of the following specie(s), (or others as approved); the wood shall be relatively light in texture; non-resistant and easily worked:

	Botanical Name	Thai Name
(a)	Dipterocarpus Sp.	Yang
(b)	Dipterocarpus Obusifelius	Hiang
(c)	Dipterocarpus Tuberculatus	Pluang
(d)	Tarritia Javanies	Choom Prack
(e)	Amoora Cucallata	Ta Sua
(f)	Sandoricum Indicum	Ka Thon

5) Gradation shall be as follows:

i) Select Grade shall be defined as selected lumber, generally clear, high quality, of good appearance, and suitable for use without waste and for natural finish.

ii) Common Grade shall be defined as unselected lumber, sound tight medium knots not larger than 2.5 cm in diameter, medium imperfections, without an excess of sapwood, without decay, without insects, without holes, without serious checks, of uneven texture, and suitable for use with some waste and for paint finish.

6) Moisture Content

Hardwood and pressure treated softwood shall not have a moisture content in excess of 20 per cent at the time of installation in a structure.

7) Dimensions

Unless otherwise shown, lumber shall not be shorter than 3.3 m in length. All lumber shall be surfaced and planed. Softwood shall be planned prior to pressure preservative treatment. All structural lumber, after planing,, shall not be less than the thickness indicated on the drawings. All finish lumber, after planing shall not vary from the indicated thickness by more than 10 per cent. Thickness and width of lumber shall be uniform throughout length.

8) Storage

Lumber shall be carefully piled off the ground in such a manner as to insure proper drainage, ventilation and protection from both weather and insects.

c) Materials (Other Than Lumber)

1) Asbestos-Cement Sheets shall be composed of asbestos fiber and Portland cement. Sheets shall be dense and tough. Weather side shall be relatively smooth. Units shall be the largest size available for the use intended; thickness shall be as shown. Chipped, cracked or broken sheets shall not be used in the work.

2) Bolts and Nuts (Machine) shall be of steel having a yield point of not less than 2300 kg/cm^2. Unless otherwise shown, bolts shall be square head, unfinished type. Nuts shall be square unfinished type also. Threads shall be in accordance with the American coarse thread series.

3) Brads; Common, shall have brad head, diamond point, smooth or mechanically deformed, and shall be galvanized or cadmium coated steel.

4) Brads; Flooring, shall have countersunk head, diamond or blunt point, smooth or mechanically deformed, bright or cement coated.

5) Fiberboard shall be manufactured from wood, cane or other vegetable fiber, by a felting or moulding process, suitable sizing material being incorporated in the product to render it water resistant. The material shall have been subjected to such drying temperature as to effect complete destruction of rot-producing fungi. The finished board may be either single or multiple ply. Surfaces shall be finished, and shall be smooth and reasonably free from coarse or hairy fibers. Units shall be the largest size available for the use intended; thickness shall be as shown.

6) Nails shall be of the proper type, and of adequate size to secure the work. Unless otherwise shown or required, nails shall be new wire, galvanized or cadmium coated for exterior work and bright for interior work.

7) Plywood shall conform to the following:

i) Thickness of a single layer of veneer shall be not less than 0.008 (0.2 mm). The lamina shall be superimposed in layers with fibers crossing at right angles in successive layers. The number of layers shall be 3, 5 or 7.

ii) Surface Veneer shall be of softwood or hardwood, and shall be suitable for paint finish.

iii) Classification

Plywood having a high water resistance shall be used for exterior work, and plywood having moderate or no water resistance shall be used for interior work. Plywood for exterior doors shall be exterior grade.

8) Screening; Wire, Insect, shall be a woven wire mesh of aluminum alloy; meshes per linear inch shall be 16/16 regular, or other as approved.

9) Screws shall be of galvanized or cadmium coated steel or aluminum or brass, slotted, flathead, countersunk type, and shall be of adequate size to secure the work.

10) Shaving Board shall be composed of wood shavings or chips mixed

with a resin binder and compressed under heat and pressure to form a board having smooth faces suitable for natural or painted finish. Units shall be free from plugs, holes and structural defects. Units shall be the largest size available for the use intended; thickness shall be as shown, and shall not vary more than 1/16 inch (2 mm) throughout the length of a unit.

11) Timber Connectors; Split-Ring Type shall be standard product of a manufacturer regularly engaged in the production of this type of connector. Connector shall be of hot-rolled carbon steel, one piece forming a closed circular shape with the ring split to form a tongue and groove and shall be unfinished. Design shall permit simultaneous bearing of the inner surface of the ring against the core left in grooving and the outer face of the ring against the outer wall of the groove. Split ring sizes and respective groove size shall be as follows:

Split Ring Size	Groove Size
2-1/2" (ø) x 0.75"(D) x 0.163"(A)	2.56"(I.D.) x 0.18"(W) x 0.375"(D)
4" (ø) x 1.00" (D) x 9.193" (A)	4.08"(I.D.) x 0.21"(W) x 0.50"(D)

12) Washers

Each bolt and nut shall be provided with a steel washer. Unless otherwise shown, washers shall be square, unfinished type. Inner hole shall closely fit the bolt. Washer sizes shall be as follows:

Bolt Size	Washer Size
3/8" ø	1-1/2" by 1-1/2" by 3/16"
1/2" ø	2" by 2" by 1/4"
5/8" ø	2-1/2" by 2-1/2" by 3/8"
3/4" ø	3" by 3" by 3/8"

d) Samples of all material, other than lumber, shall be submitted for approval prior to delivery to the site.

e) Framing (Except Trusses, Roof and Stairs)

1) General

Lumber shall be common grade, or better. Lumber, and other rough work, shall be closely fitted, and accurately set to required

lines and levels. Special framing or construction, not indicated or specified, shall be provided as necessary for the proper completion of the work. Members shall be set with the crown edge up.

i) Clearance

A clearance of not less than 2 inches (5 cm) shall be provided between chimneys and wood framing.

ii) Fastening

Members shall be rigidly secured in place. Spiking, nailing and bolting shall be done in an approved manner. Spikes, nails and bolts shall be of the proper type and sizes for the use intended. Members shall be drilled accurately so that bolts are tight fittings; washers shall be provided under heads; and nuts and bolts shall be drawn up tight. Care shall be taken so as not to split members.

iii) Splicing

Framing members shall not be spliced between bearing points, and shall be free from pronounced defects. Joints and splices shall be bolted or spiked together, and shall occur over bearings only.

2) Sills shall be set level and square, and firmly anchored. Unless otherwise shown, anchor bolts shall be unfinished steel not less than 1.25 cm diameter and not less than 30 cm long. Unless otherwise shown, anchor bolts shall be provided at all corners and splices, and spaced at not more than 1.5 m on centers intermediately between. Provide not less than 2 bolts for each sill member. Sills shall be lapped at corners and splices, and shall be bolted through the laps, or the ends shall be butted and through-bolted not more than 15 cm from the ends. Bolts shall be provided with washers under heads and nuts. Sills shall be leveled, wedged with steel shims. Sills shall be grouted with a mixture of 1 to 3 cement sand mortar to provide continuous and solid bearing.

3) Columns and Posts shall be set accurately plumb, in alignment, and shall have a full and uniform bearing. Columns shall be of the sizes and spacing indicated. The bottom end-bearing surfaces shall be set

prior to drilling holes for strap anchor bolts. Tops shall be accurately cut square to receive plates.

i) Laminated Type

At the contractor's option solid columns may be substituted for laminated type and shown. Laminate shall be nailed from each side with 20-d common nails, two near each end of each piece, others staggered with a vertical distance of 24 inches.

4) Beams and Girders shall be set level, in alignment, and properly anchored. Unless indicated otherwise units shall have not less than 8 inches (20 cm) end bearing on walls and supports.

5) Joists shall be of the sizes and spacing indicated, and shall be set accurately and in alignment. Units shall be placed with the crown edge up. Units shall have full bearing on supports. Laps shall occur over bearings only and shall be spiked. Units of insufficient length to provide a 30 cm lap shall be butted over the bearing, and shall be provided with 5 cm by depth of unit by 60 cm long wood scabs lapping each unit equally and securely spiked thereto. Units bearing on ledger boards shall be spiked securely to the sides of studs.

6) Studs shall be selected for straightness, and set plumb, true, and in alignment. Each stud shall be toe-nailed to sill or sole plate, with nails on each wide face.

7) Plates shall be same width as the studs, and shall form continuous horizontal ties. Single plates shall be spliced, and shall be thru nailed to each stud and corner post thereunder with common nails.

8) Blocking shall be installed level, and shall be closely fitted. Each unit shall be double nailed through each stud.

f) Framing; Roof

1) Rafters shall be selected for straightness, and set true, and in alignment. Rafters at ridge shall be half-lapped and nailed. Rafters shall bear on the sole plates and shall be secured to adjacent stud by bolting.

2) Tie Boards (Collar Beams) shall be horizontal and shall fully lap

the rafters. Tie boards shall be nailed to each rafter with common nails.

g) Truss Framing

1) Specie, Grade and Quality of Lumber

Lumber shall be used in accordance with the option selected, and shall be of common grade. The timbers shall be seasoned to a moisture content corresponding as nearly as practicable to that which they will attain in service. Wood at the points shall be clear and relatively free from checks, shakes and splits.

2) Fabrication

Trusses shall be fabricated, as shown, and assembled on the ground in true rigid form ready for erection.

3) Splices, other than those shown, will not be permitted without specific approval.

4) Camber

Finish truss shall have a camber of not less than 3 centimeters.

5) Bolting

Bolt holes shall be drilled with a twist drill. The drill shall produce shavings and not chips and the hole shall be smooth. Bolt holes shall be such that bolts will fit neatly and can be inserted by tapping lightly with a wood mallet. No threaded part of the bolt shall bear on the wood members. All bolt head and nuts shall be provided with washers. All bolts shall be tightened firmly without crushing wood fibers. Bolts shall be retightened as required during the time the members are essentially at moisture equilibrium.

6) Installation of Split Ring Connectors

Grooves for rings shall be accurately aligned and cut with an approved standard grooving tool. Grooves shall be cut clean and of the proper diameter so that the inner surface of the ring will bear against the core left in the grooving and the outer face of the ring will lean against the outer wall of the groove when the bolt is drawn tight.

7) Erection

Trusses shall be erected using suitable tools and equipment. Lifting shall be accomplished in such manner as will preclude damage.

h) Exterior Finish Carpentry

1) Siding; Wood (Over Studs)

i) Specie, Grade and Quality of Lumber

Lumber shall be in accordance with the option selected, and shall be of common grade.

ii) Square-Edged Units shall be smooth dressed boards 1.25 cm thick by 15 cm wide having the drop edge rounded.

iii) Placing

Siding shall be placed level using a string line. Lap for square-edged siding shall be not less than 2 cm. Lap shall be adjusted to preclude cutting or notching around openings.

iv) Framing

End joints shall occur over bearings only. Boards shall be bevel-cut parallel to the studs. End joints shall be staggered, and those occurring on the same stud shall be separated by not less than 3 boards.

v) Corners (Mitered)

Intersections at corners shall be carefully mitered to produce a tight-fitting joint.

vi) Nailing

Each board shall be nailed at each bearing. For square-edged siding, an 8-penny casing nail shall be driven at each stud, and located so that it will pass through both the outside piece and the top edge of the piece immediately under it.

i) Framing; Stair (Rough)

Lumber shall be common grade. Strings shall be one piece, closely fitted over the toe-plate, and shall be toe-nailed thereto with common nails.

j) Interior Finish Carpentry

1) Ceiling; Suspension, System For

Ceiling runners and furring shall be of common grade lumber, sizes as shown, and shall be set level to the required ceiling height. Unless otherwise shown, ceiling runners shall be spaced not more than 1 m on centers. Furring strips shall be spaced not more than 50 cm on centers, and shall be screwed to each runner at each intersection through drilled holes using screws not less than 1 cm long with counter-sunk flat heads.

i) Hangers; Stirrups, shall be formed of 3 mm thick steel, formed as shown. Each stirrup leg shall be nailed through holes therein with common nails. Runners shall be notched or shimmed level prior to nailing.

2) Ceiling

The edges of ceiling units shall be closely fitted, and the joints shall be in line both ways perpendicular to the walls. Joints shall occur over bearings only. Damaged sheets shall not be used in the work. Units shall be flat and free from any wavy condition prior to fastening.

i) Hardboard shall be nailed with casing nails 20 cm on centers 1.25 cm in from edges and along all bearings. Nails shall penetrate the bearings not less than 2 cm. Nail heads shall be flush with surface without damaging the surface of the panels.

ii) Plywood shall be applied same as hardboard.

iii) Shaving Board shall be applied same as hardboard.

iv) Ceiling Scuttles shall be constructed as shown, and shall be level with adjacent surface. Edges shall fit snugly.

3) Wall Coverings

i) Hardboard units shall be applied same as for ceiling units.

ii) Plywood units shall be applied same as for ceiling units.

iii) Siding; Wood (Interior Vertical) shall be common grade, smooth dressed boards 1.25 cm thick by 15 cm wide having both edges

rounded, applied vertically flatface to flatface with 3 cm overlap each side. Overlaps shall be nailed to each support with casing nails 5 cm long.

iv) Shaving Board shall be applied same as for ceiling units.

k) Finish Wood Flooring, unless otherwise shown, shall be of hardwood, select grade, strip, 10 cm wide, having 1.25 cm laps both sides. Flooring shall be closely fit. End joints shall occur on bearings only. Boards shall be bevel-cut parallel to the joists. End joints shall be staggered, and those occurring on the same joist shall be separated by not less than 3 boards. Boards shall be toe-nailed at each bearing using casing nails and face nailed with the same nails counter-sinking the heads. Flooring shall be job-finished smooth after installation by planing, scraping, or sanding.

l) Finish Stair Work

Lumber shall be hardwood, select grade.

1) General

Stair work shall be fitted, and nailed together forming a strong and rigid structure without squeaks or vibrations.

2) Treads shall have a half round nosing on leading edge. Treads shall be nailed to each supporting cleat with three casing nails after installing risers, and to its riser with two casing nails.

3) Risers shall be installed before treads. Risers shall be nailed to cleats with two casing nails, and shall be toe-nailed to siding. Risers shall be nailed from the back to tread at the bottom with two common nails.

4) Newel Post shall extend through the treads to the floor, and shall be bolted to the stringer; the second riser shall be nailed to the post. The post shall be through nailed to the second tread also.

5) Balusters shall be full mortised into the treads, and toe-nailed into the cleats.

6) Handrails shall be smooth finished. Balusters shall be set-in with mortise-and-tenon blind joints glued and toe-nailed.

m) Interior Finish Cabinet Work

As far as possible nailing shall be done in concealed places and all exposed nails shall be set or counter-sunk and putty stopped. Exposed surfaces of finish work shall be dressed, smoothed and sandpapered. Joint work shall be set-up, screwed, doweled or mortised and tenoned together, and glued. No work shall be installed until concrete and plaster work have cured and will not release moisture harmful to woodwork. Woodwork shall be neatly fitted into proper position, leveled and secured as indicated. Surfaces damaged in any way shall be repaired. All woodwork shall be finished smooth on exposed surfaces, and a slight bevel on exposed edges. All work shall be of a neat appearance. All woodwork shall have natural finish. All holes shall be puttied with putty colored to match the wood, and when dry shall be slightly sanded.

n) Hardware,

Hardware, shall be carefully fitted and securely attached. Care shall be exercised not to mar existing work. Upon completion of the work, and in the presence of the Engineer, hardware shall be demonstrated to work properly. Keys shall be fitted into their respective locks. Upon acceptance of the work, keys shall be tagged and delivered to the Engineer.

1-6-12 Doors and Windows

a) Scope of Work

All doors and windows shall be furnished and installed as shown on the drawings and as herein specified. Included are the frames for doors, windows and transoms.

Wood for door frames, doors, window frames and windows shall be of sound stock, thoroughly seasoned and dried and neatly and accurately framed. All joints in windows shall be mortise and tenon joints glued with an approved type of glue. Doors shall be factory-made, rigidly framed and smoothly finished. All wood work shall be sanded, filled, resanded and painted.

Doors shall have hollow core as will adequately support the outer plywood and afford strength and stability sufficient for the use intended. Stiles shall not be less than 2 cm and rails shall not be less than 7 cm. A lock block shall be provided at the center of each stile, 45 cm long and wide enough to extend 15 cm from the edge of door to the inside of the lock block. Cross rails shall be provided at the top and bottom of the lock block, and shall be securely connected to the stiles.

b) Shop Drawings

Shop drawings showing location, size and details of construction of all doors, frames and windows shall be submitted to the Engineer for approval.

c) Window Frames, Shutters and Screens

Lumber shall be hardwood, select grade.

1) Single Type

Stops shall be rabbeted from the solid. Sills shall slope, and shall have a ploughed drip. Jambs shall rest on the sill; head shall rest on the jambs. Head and sill shall be nailed through to the jambs.

2) Shutters

Stiles and rails shall be fitted together with open mortise-and-tenon type joints. Stiles and rails shall be rabbeted to receive panels of 1.25 cm thick by 10 cm wide tongue-and-grooved boards with V-joints. Intersection of panel with frame shall have V-joints also. Screws and glue shall be used for assembly.

3) Window Screens shall be removable type, and shall have insect or expanded metal mesh, as shown. Stiles and rails shall have half lapped joints. Screen wire shall be taut.

4) Vent Screens

Frames shall be cut to match roof corrugations.

d) Wood Louver Ventilators

Lumber shall be of hardwood, select grade. Louver frame shall be routed out to receive slats of proper width to provide the edge finish shown. Joints shall be nailed and glued. Sides of frames shall rest

on the sill; top member shall cap the sides. Where shown, bird screen on the inside shall be removable; expanded steel mesh shall be of the flattened industrial type.

e) Wood Doors and Frames

Lumber shall be of hardwood, select grade.

1) Door Frames shall be of type and design shown. Frames shall be set plumb and square. Frames shall be set with finishing nails. In masonry openings, frames shall be set with double wedge blocking in back of nailing points; also at back of butts and lock strike. Frames in masonry, where no bucks are indicated or required, shall be double-rabbeted from solid stock and shall have three jamb anchors on each side.

2) Doors; Hinged shall be of type and design shown. Flush type exterior doors shall be painted with a prime coat and one finish coat of lead-oil base paint conforming to the requirements of ISO R 510, R 511. Door surfaces shall be free of dust and in proper condition to receive paint.

i) Batten Type

Battens shall be dressed-and-matched, V-jointed lumber, select grade, not less than 2 cm thick. Doors shall have two screws at top and bottom and at each horizontal cross-piece, and one screw at each diagonal brace. Corners of frame shall be half-lapped. Intersections of horizontal crosspiece, and one screw at each diagonal brace. Corners of frame shall be half-lapped. Intersections of horizontal cross-pieces with diagonals and frames shall be lapped. Diagonals shall butt tightly at corners.

ii) Panel Type

Stiles and rails shall be fitted together with open mortise-and-tenon joints, routed to receive panels. Solid wood panels shall not be glued at the edges, but shall be capable of self adjustment within the stiles and rails to prevent splitting. Type of panels shall be as shown. Panels of V-jointed lumber shall have dressed and matched

boards assembled with brass screws, two at each horizontal cross-piece, and glued. Glass panels shall be as specified under section 1-6-14 (Glass and Glazing). Stops shall be of solid wood same as used for stiles and rails, and shall be one piece units mitered at corners.

iii) Flush Type (Hollow Core)

Doors shall have hollow cores of such type as will adequately support the outer plywood and afford strength and stability sufficient for the use intended. Stiles shall be not less than 2 cm and rails shall be not less than 7 cm. A lock block shall be provided at the center of each stile, 45 cm long and wide enough to extend 15 cm from the edge of door to the inside of the lock block. Cross rails shall be provided at the top and bottom of the lock block, and shall be securely connected to the stiles. Veneers for cross banding and faces shall be plywood of two or more plies, with a combined minimum thickness of 7 mm before sanding. Face veneer shall be of hardwood, as approved. Edge strips shall be of the same hardwood as the face veneer. Edge strips shall be tongued and grooved into the stiles and rails, glued and nailed with ample size finishing nails not more than 15 cm on centers. All veneers shall be bonded with water-resistant type adhesive applied to all contact surfaces, and the whole door shall be placed in a gluing press that applies uniform pressure over the entire surface of the door.

iv) Flush (Solid Core) Type shall have solid wood cores of the stile and rail type. Veneers for cross banding and faces shall be plywood of two or more plies, with a combined minimum thickness of 7 mm before sanding. Face veneer shall be hardwood (select grade). Assembly shall be with water-resistant type adhesive applied to all contact surfaces, and the whole door shall be placed in a gluing press that applies uniform pressure over the entire surface of the door.

v) Louver Insets in doors shall be as shown. Louver frame shall have mitered joints, and shall be routed out to receive slats of

proper width to provide the edge finish shown. Joints shall be glued.

vi) Screen Doors shall be as shown. Solid stiles and rails shall be rabbeted on one side, and the insect screen wire shall be stretched tightly and secured in place. The edges of the wire shall be covered with moulding mitered at the corners.

3) Fitting

Unless otherwise shown, doors shall have 2 mm space at sides and tops and 6 mm over thresholds. Doors in openings without thresholds shall have 8 mm clearance at bottoms. Meeting stiles of double doors shall be shaped to provide the minimum practicable clearance of not less than 2 mm.

4) Hanging and Trimming

Doors shall be properly hung in accordance with clearance specified herein. Doors shall swing horizontally, and shall stand still in any position.

1-6-13 Preservative Treatment of Lumber

a) General Requirements

The work includes the providing of preservative treatments as required in other sections of the specification or as indicated.

b) Pressure Treatment shall be in accordance with Table III of U. S. Federal Specification TT-W-571g, except (a) treatment of electrical wood poles shall produce a net dry salt retention 14 per cent greater than that specified therein and (b) the minimum net retention of solid chromated copper arsenate shall be not less than 0.50 lb. per cu. ft. (8.0 kilogram per cu. m.). The following is an excerpt from Table III modified to show acceptable preservatives and retentions:

Preservative	Minimum Net Retention of Solid Preservative Kilogram per Cubic Meter
Acid copper chromate	8.0
Amonical copper arsenate	4.8
Chromated copper arsenate	8.0
Chromated zinc arsenate (including copperized form)	8.0
Chromated zinc chloride	12.0
Copperized chromated zinc chloride	12.0
Fluor-chrome arsenate phenol mixture	5.6
Sodium fluoride, sodium arsenated and sodium bichromate mixture	4.0

c) Dip Treatment

The preservative for dip treatment shall be 50% strength pentachlorophenol. The preservative solution shall be a mixture of one (1) part pentachlorophenol to nine (9) parts diesel fuel oil. The pentachlorophenol shall be added slowly to the fuel oil while vigorously stirring the mixture. All lumber to be dip treated shall be immersed in the solution for a minimum period of 3 minutes for every 2.5 cm thickness of the lumber. If the lumber is to be dipped in a bundle, each piece of lumber shall be separated from the next piece with a thin piece of lath board. After immersion, the lumber shall be allowed to drain, and excessive preservative shall be dissipated by drying.

d) Surface Treatment

After lumber has been treated, all cut, sawed, planned, and bored surfaces shall be given two heavy brush coats of the same material used in the preservative treatment. The first coat shall be allowed to penetrate and dry before the second coat is applied. Machining, cutting, trimming and drilling shall be done prior to treatment insofar as practicable.

1-6-14 Glass and Glazing

a) Glass

1) Clear sheet glass shall be not less than 5 mm thick.

2) Obscure glass, glazing quality, shall be not less than 5 mm thick, rolled figured on one surface, unpolished.

b) Putty and Glazing Compound

ISO or other equal or higher authorized standards for glazing in aluminum or metal and for glazing in wood shall apply. Compounds used for glazing aluminum units shall be the products of a recognized manufacturer. The compound shall be pigmented with aluminum powder to match the metal unit without staining or discoloring, shall be non-hardening, and shall be of a type that does not require painting.

c) Workmanship

All materials shall be installed in accordance with the approved recommendations of the manufacturer to conform with the Contract Documents. The installation shall be accomplished by workmen skilled in this type of work.

d) Installation

1) General

The sizes and proper edge clearances shall be determined by measuring the actual unit to receive the glass. Each piece of glass shall bear the manufacturer's label to identify its type, as well as thickness and quality. Labels shall not be removed until final approval is obtained. Operative sash shall move freely and properly in the frame of the unit prior to glazing. Movable items shall be securely fixed, or in a closed and locked position until putty or glazing compound has thoroughly set.

2) Clear Sheet Glass shall be used except where indicated otherwise. The glass shall be cut and installed with the visible lines or waves running with the horizontal dimensions.

3) Obscure Glass shall be used in doors and windows of toilets, dressing rooms, and elsewhere as indicated. Glass shall be installed

with the smooth side on the outside.

e) Glazing in Wood

Glass, unless otherwise specified, shall be embedded in pure linseed-oil putty conforming to ISO or equal or higher standards approved by the Engineer. The glass shall be firmly seated into the previously bedded and back-bedded rabbet and secured in place with wood beads, or flat-head wood screws, countersunk and set approximately 12.5 cm on centers. A positive seal shall be provided between the glass and the wood on both sides of the glass. Nails or screws used in beads shall be of a corrosion-resistant type.

f) Replacement and Cleaning

Upon completion of the work, all glass surfaces shall be thoroughly cleaned, with all labels, paint spots, putty, and other defacements removed. Cracked, broken, and imperfect glass shall be replaced at no additional cost to the PWD.

1-6-15 Painting

a) Scope of Work

1) It is the intent of this specification to paint all exposed structural steel, miscellaneous metal, doors, frames, louvers, piping, machinery, concrete and walls, and all other work obviously required to be painted unless otherwise specified. The omission of minor items in the schedule of work shall not relieve the Contractor of his obligation to include such items where they come within the general intent of the specifications as stated herein.

2) The following items will not be painted:

i) Floor

ii) Finish hardware

iii) Non-ferrous metals, unless specifically noted otherwise.

iv) Packing glands and other adjustable parts and name plates of mechanical equipment.

v) Submerged concrete, influent flume,
Exterior framing for the monorail.

vi) Parts of buildings not exposed to sight, unless specifically noted otherwise.

b) Materials

1) All Painting Materials shall conform to the requirements of authorized standards approved by the Engineer. .

2) All Colors shall be selected by the Engineer.

3) All Painting Materials shall be delivered to the mixing room in unbroken packages, bearing the manufacturer's brand and name. They shall be used without adulteration, mixed, thinned, and applied in strict accordance with manufacturer's directions for the applicable materials and surface and with the Engineer's approval before using.

4) Shop Priming shall be done with primers that are guaranteed by the manufacturer to be compatible with the finish paints to be used.

5) Work Areas will be designated by the Engineer for storage and mixing of all painting materials. Materials shall be in full compliance with the requirements of pertinent codes and fire regulations. Proper containers outside of the buildings shall be provided by the Contractor and used for painting waste, and no plumbing fixture shall be used for this purpose.

c) Preparation of Surfaces

All surfaces to be painted shall be prepared as specified herein and shall be dry and clean before painting.

1) Metal

All welds, blisters, etc., shall be ground and sanded smooth. All pits and dents shall be filled and all imperfections shall be corrected so as to provide a smooth surface for painting. All rust, loose scale, oil, grease and dirt shall be removed by use of approved solvents, wire brushing or sanding.

2) Concrete

Surfaces shall be left one month before painting. Surfaces shall

be free of dust, oil, curing compounds, and other foreign matter. Floors, and submerged surfaces to be painted shall be etched with a 15~20% muriatic acid solution and rinsed clean with water until a fine granular surface has been achieved.

d) Workmanship

1) General

At the request of the Engineer, samples of the finished work prepared in strict accordance with these specifications shall be furnished and all painting shall be equal in quality to the approved samples. Finished areas shall be adequate for the purpose of determining the quality of the workmanship. Experimentation with color tints shall be furnished to the satisfaction of the Engineer where standard chart colors are not satisfactory.

Protection of furniture and other moveable objects, equipment, fittings and accessories shall be provided throughout the painting operation. Canopies of lighting fixtures shall be loosened and removed from contact with surfaces, covered and protected and reset upon completion. Remove all electric plates, surface hardware, etc., before painting, protect and replace when completed. Mask all machinery name plates and all machined parts not receiving a paint finish. Dripped or spattered paint shall be promptly removed. Lay drop cloths in all areas where painting is being done to adequately protect flooring and other work from all damage during the operation and until the finished job is accepted.

On metal surfaces apply each coat of paint at the rate specified by the manufacturer to achieve the minimum dry mil thickness required. If material has thickened or must be diluted for application by spray gun, the coating shall be built up to the same film thickness achieved with undiluted material. One gallon of paint as originally furnished by the manufacturer shall not cover a greater area when applied by spray gun than when applied unthinned by brush. Deficiencies in film thickness shall be corrected by the application of an additional coat(s).

On masonry, application rates will vary according to surface texture; however, in no case shall the manufacturer's stated coverage rate be exceeded.

2) Field Priming

Structural steel, metal castings, mechanical and electrical equipment and other metals which are shop primed before delivery at the site will not require a prime coat on the job. All piping and other bare metals to be painted shall receive one coat of primer before exposure to the weather, and this prime coat shall be the first coat as specified in the painting schedule.

The equipment which is customarily shipped with a baked-on enamel finish or with a standard factory finish, shall receive a rust-preventative treatment in the manufacturer's shop before painting is applied. The manufacturers of such equipment shall submit to the Engineer for approval samples of the color and finish proposed. Unless the finish has been damaged in transit or during installation, such equipment shall not be field painted.

Surfaces that have been shop painted and have been damaged, or where the shop coat or coats of paint have deteriorated, shall be properly cleaned and retouched before any successive painting is done on them in the field. All such field painting shall match as nearly as possible the original finish.

Equipment shipped with a protective shop painting coat or coats shall be touched up to the satisfaction of the Engineer.

3) Field Painting

All painting at the site shall be designated as Field Painting and shall be under the direct and complete control of the Engineer, and only skilled painters and specialists, where required, shall be used on the work.

All paint shall be at room temperature before applying, and no painting shall be done when in dust-laden air, when rain is falling, or until all traces of moisture have completely disappeared from the surfaces to be painted.

Successive coats of paint shall be tinted so as to make each coat easily distinguishable from each other with the final undercoat tinted to the approximate shade of the finished coat.

Finish surfaces shall not show brush marks or other irregularities. Undercoats shall be thoroughly and uniformly sanded to remove defects and provide a smooth even surface. Top and bottom edges of doors shall be painted and all exterior trim shall be back-primed before installation.

Painting shall be continuous and shall be accomplished in an orderly manner so as to facilitate inspection. Materials subject to weathering shall be prime coated as quickly as possible. Surfaces of exposed members that will be inaccessible after erection shall be cleaned and painted before erection.

All materials shall be brush painted unless spray painting is specifically approved by the Engineer.

All surfaces to be painted as well as the atmosphere in which painting is to be done shall be kept dry by ventilation, if necessary, until each coat of paint has hardened. Any defective paint shall be scraped off and repainted in accordance with the Engineer's directions.

Before final acceptance of the work, all damaged surfaces of paint shall be cleaned and repainted as directed by the Engineer.

e) Cleanup

1) The Contractor shall at all times keep the premises free from accumulation of waste material and rubbish caused by his employees or work. At the completion of the painting he shall remove all of his tools, scaffolding, surplus materials, and all of his rubbish from and about the buildings and shall leave his work "broom clean" unless more exactly specified.

2) The Contractor shall also, upon completion, remove all paint where it has been spilled, splashed, or spattered on all surfaces, including floors, fixtures, equipment, furniture, etc., leaving the work ready for inspection.

1-6-16 Roofing; Asbestos-Cement

a) Scope of Work

The Contractor shall furnish all labor, materials, equipment and incidentals necessary to complete all roofing and flashing as indicated on the drawings and as specified herein. The work included herein applies to roofing materials and installation of asbestos-cement corrugated sheet roofs.

b) Materials

1) Asbestos-Cement Sheets

All sheets shall be cement gray, new standard sizes as manufactured locally, without holes, cracks or any other defects. Sheets shall be dense, tough and manufactured with the weather side relatively smooth.

i) Corrugated Type

Corrugations shall be formed with inside and outside radii the same so that all sheets shall rest snugly at laps.

ii) Roman Type

Shape shall be as shown; all sheets shall rest snugly at laps.

2) Accessories

Ridge pieces, valleys, flashings, closers, fillers, and similar items required to assure a weatherproof and watertight installation shall be used with the sheets. Accessories shall be of the same basic material as the sheets, shaped or formed as standard with and recommended by the manufacturer of the sheets.

3) Fasteners for Wood Purlins shall be galvanized metal clips furnished by the manufacturer of the asbestos-cement sheets. Clips or screw bolts shall be of the type which permits installation without drilling holes in the sheets. Fasteners for miscellaneous accessories shall be galvanized steel hooked bolts with synthetic rubber gasket, galvanized nuts and washers, supplied by the manufacturer of the asbestos-cement sheets.

4) Caulking Compound shall conform to JIS A 5751. The compound shall be slate gray in color, non-staining and suitable for gun application.

c) Installation

1) General

All sheets, with all fasteners and accessories, shall be erected and installed in accordance with the manufacturer's instructions. Sheets shall be laid with corrugations in the direction of the roof slope, starting at end of building opposite the prevailing wind direction. End laps shall be not less than 20 cm, side laps shall be not less than one corrugation.

2) Fasteners for Wood Purlins shall be attached to the purlin with two eight penny nails. Accessories shall be used as required by the manufacturer to insure a weatherproof installation. All laps and joints shall be caulked.

3) Drilling

In order to avoid cracking of corrugated panels, the use of a punch is strictly prohibited. Twist drills shall be used for all drilling. Location and size of holes shall be as recommended by the manufacturer.

4) Cutting

When asbestos-cement sheets are cut in the field, a power-driven carborundum wheel or saw properly guarded or a hand-saw for cross cutting shall be used, with templates of approved type, as recommended by the manufacturer.

5) Ridges for asbestos-cement roofing shall be formed with a ridge roll resting on panel-end closures as shown with a cement mortar filling composed of one part Portland cement and 3 parts sand and shall be caulked with a plastic sealer.

6) Valleys for asbestos-cement roofing shall be formed using a sheet metal gutter lined with asphalt felt set in a bituminous plastic cement. Where the asbestos cement roofing terminates at the valley, the openings shall be caulked using loose oakum faced with bituminous plastic cement.

7) Caulking

Ridge roll joints and spaces between overlaps of asbestos-cement roof panels shall be caulked with application of compound by a caulking gun with a continuous head from a 12.5 mm hozzle. Prior to application, joints and spaces to be caulked shall be thoroughly dry and shall be raked clean. Caulking shall be done to a depth of 20 mm.

8) Protection

The roofing units shall be protected during the erection by the use of planks for walkways. Workmen shall use proper caution in the disposition of their own weight and shall not store material on any part of the roofing after erection.

1-6-17 Calking

a) General Requirements

The work includes the providing of calking, as shown, complete, in strict accordance with the specifications and the applicable drawings, and subject to the terms and conditions of the Contract.

b) Materials

1) Calking Compound shall be composed of pigments (with or without fibers) uniformly mixed in a liquid vehicle to a plastic consistency for gun application, and shall be specially manufactured as being suitable for the use intended. The compound shall adhere tenaciously to the surface to which applied, shall not shrink excessively and shall be non-staining. Color shall be gray.

2) Sealer shall be a mixture of aluminum paste, spar phenolic resin varnish and thinner that is compatible with the varnish, mixed in the proportion of 0.9 kg of paste to not more than 3.78 liter of thinner. The materials shall be field mixed.

3) Rope Yarn shall be the raveled strands of rope fiber, free from oil or other staining elements.

c) Samples of all materials proposed for use shall be submitted to the Engineer for approval.

d) Preparation of Surfaces

1) Cutting of Grooves

Where grooves in concrete and masonry are indicated and not formed, the grooves shall be cut and cleaned out to a minimum depth of 19 mm, and ground to a minimum width of 6.35 mm without damage to adjoining work.

2) Backstop

Joints and spaces to be calked that are deeper than 15 mm shall be firmly packed with rope yarn to within 15 mm of the surface.

3) Cleaning

Joints and spaces to be calked shall be raked and cleaned out to a depth of 15 mm, and all particles of mortar, dust, and other foreign matter shall be brushed out just prior to calking.

4) Priming

Grooves in concrete, masonry, and softwood that will absorb the essential oils from the calking compound shall be primed with the sealer using a brush that will reach all parts of the grooves to be filled with compound. The primer shall be allowed to dry thoroughly, prior to calking the grooves.

e) Calking compound shall be forced into the joints with a pressure calking gun using nozzles of the proper size to fit the width of the joints. Joints shall be completely filled. Surface shall be uniformly smooth and free from wrinkles, and shall be sufficiently convex to result in a flush joint when dry. Excess material shall be removed.

f) Re-calking

Upon completion of the calking, any joints not completely filled shall be roughened and filled as specified, and the exposed surface tooled smooth.

g) Cleaning

Adjacent materials which have been soiled due to the calking operation shall be cleaned immediately and the work left in a neat, clean condition.

1-6-18 Plastering

a) General Requirements

The work includes providing all plastering on exterior and interior masonry walls and ceilings where indicated on drawings, in strict accordance with the specifications and applicable drawings, and subject to the terms and conditions of the contract.

b) Delivery and Storage of Materials

All manufactured materials shall be delivered to the job site in unbroken, original packages, containers and bundles, bearing name of the manufacturer and the brand. Building material shall be stored off the ground under watertight cover and away from sweating walls or other damp surfaces until required for use.

c) Materials

1) Cement, fine aggregate and water shall be of high quality and shall conform to the requirements specified in section 1-6-4 (Concrete and Reinforced Steel Concrete Work).

2) Lime shall be hydrated lime, conforming to JIS A 6902 or equivalent standard. The total unhydrated calcium oxide (CaO) and magnesium oxide (MgO) in the hydrated product shall not exceed 8 per cent by weight, calculated on the as-received basis.

d) Preparation

Surfaces to receive plaster shall be clean and free from defects, oil, grease, acids, organic and other injurious matter. Masonry or concrete surfaces to receive plaster shall be damp when the plaster is applied. Where plaster terminates against wood such as windows or door bucks the Contractor shall provide a wood stop before application, unless otherwise shown. Metal lath shall be applied on ceilings for plaster base, where indicated.

e) Types of Finish

Surfaces to receive plaster shall receive three coats; scratch, brown and finish coats. If plaster is to be applied to a smooth cement or other surface which does not offer bonding characteristics for plaster

a dash coat shall be required as a bonding surface.

f) Proportioning

Portland cement plaster three-coat-application shall have each coat proportioned by volume as follows:

1 part Portland cement
3 parts sand
1/10 part hydrated lime

g) Mixing

Select for mixing, aggregated of uniform moisture content to avoid bulking. Mix materials to a uniform color before water is added; then wet-mix them to the desired consistency.

h) Application

1) Scratch Coat shall be about 1 cm thick and carried the full length of the wall or to natural breaking points like doors or windows. Before the scratch coat hardens cross-scratch it to provide mechanical key for the brown coat. Keep this coat moist for not less than 24 hours and allow it to set before applying brown coat. Scratch coat shall be applied evenly and with sufficient pressure to produce full keys on the metal lath and shall not be less than 6.4 mm over the face of the lath.

2) Dash Coat shall be used to provide bond on smooth concrete or other smooth surfaces. The dash coat shall be of mushy consistency, composed of 1 part Portland cement and 1 1/2 parts sand. Apply the dash coat with a whisk broom or fiber brush, using a strong whipping motion at tight angles to the face of the wall. Scratch coat shall be applied to the dash coat after the dash coat has been kept moist for 48 hours and then allowed to dry out.

3) Finish Coat shall not be applied until the brown coat has seasoned for 7 days. Just before application of the finish coat, the brown coat shall again be wetted evenly. The finish coat shall be about 0.6 cm thick. Where cement plaster with a smooth troweled finish is specified or indicated on the drawings, the finish coat shall be first floated to a

true and even surface, then troweled in a manner that will force the sand particles down into the plaster and, with the final troweling, leave the surface burnished smooth and free from rough areas, trowel marks, checks, or other blemishes. Cement plaster in all other spaces, where a smooth finish is not specified or noted on the drawings, shall be given a sand float finish of a uniform texture, as approved. The finish coat shall be kept moist for at least 2 days, and thereafter shall be protected against rapid drying until properly and thoroughly cured.

i) Patching

Plaster containing cracks, blisters, pits, checks, or discoloration will not be acceptable. Such plaster shall be removed and replaced with approved plaster. Patching of defective work will be permitted only when approved and such patchwork shall match existing work in texture and color.

j) Clean-Up

Upon completion of the plaster work, all debris arising from the work shall be removed and all surfaces defaced during the progress of the work shall be cleaned and restored as required.

1-6-19 Tile Work: Floor and Wall

a) General Requirements

The work includes providing tile work, floor and wall, complete, in strict accordance with the Specifications and the applicable drawings, and subject to the terms and conditions of the Contract.

b) Materials

Manufacturer's original containers, bundles, or packages shall be delivered to the project site unopened, with seals unbroken and labels intact. Materials shall conform to ISO or equivalent or higher standard and other requirements stipulated below.

1) Ceramic Mosaic Floor Tile

Tile for all floor areas indicated as ceramic tile on the drawings

shall be natural clay, vitreous, non-slip type ceramic tile, 1/4 inch thick, with plain or cushion edges. The color of ceramic tile for all floor areas, shall be as shown. The tile shall contain not less than 7.5 per cent of abrasive by weight.

2) Glazed Wall Tile

Glazed tile for wainscots shall be nominal 4-1/4 in. square, approximately 3/8 in. thick and shall have a non-vitreous body, glazed surface with a high gloss finish. Wainscot shall include all stops, returns, trimmers, caps and other special shapes required for sills, jambs, and recesses or offsets to produce a complete and neatly finished installation. The color shall be as selected and approved by the Engineer.

3) Hydrated Lime

Hydrated lime shall conform to the requirements of JIS A 6902.

4) Sand for setting beds, base coats, and grout shall be clean, washed, sharp, durable particles, free from silt, loam, clay, soluble salts, and organic impurities. Sands for setting beds of floors shall be well graded, passing a No. 8 sieve, with not more than 5 per cent passing a 100-mesh screen. Sand for grout shall be screened to pass a 30-mesh sieve, with not more than 5 per cent passing a 100-mesh screen.

5) Water shall be clean and free from injurious amounts of oil, acids, soluble salts, and organic impurities.

c) Samples

The following samples of materials proposed for use shall be submitted to the Engineer for approval before proceeding with the tile work:

1) Two panels of wainscot, 4 tiles to each panel, for each color to be used, showing the two extremes in color.

2) Two pieces of each of the tile shapes to be used.

d) Installation of Floor Tiles

1) Laying Out Work

Tile shall be laid out from the centerlines of each space outward

and adjustments made along walls, partitions, and borders, if any, so as to symmetrize the pattern with a minimum of cut tiles.

2) Preparation of Setting Beds and Tiles

Surfaces to receive the various applications of materials shall be clean and free of dirt, dust, oil, grease, or other objectionable matter. Concrete fill where required, setting beds, and tile shall be installed with their respective surfaces to true planes, level or pitched to drains as required by the drawings, so that the surface of the completed flooring will be at the elevations and grades shown. Retempering of mortar will not be permitted. Joints between tiles shall be of uniform width and as specified for the tile installed. Fractional changes in dimensions without varying the uniformity of the joint width will be permitted.

Tile shall be cut with a suitable cutting tool and rough edges shall be rubbed smooth. Cut-tile misfits shall be replaced with properly cut tile. Tile shall be laid to the straight edges. Straight edges shall be accurately set to the line established and reset at suitable intervals to keep the joints parallel over the entire area.

3) Setting Beds for tile flooring shall be composed by volume of one part Portland cement to five parts dry sand, to which not more than 1/10 part hydrated lime may be added, mixed with the minimum amount of water necessary to produce a workable mass. Unless otherwise specified, only as large an area of setting bed shall be spread at one time as can be covered with tile before the mortar has obtained its initial set. Surplus mortar shall be removed, and the setting beds shall be spread, tamped to force out air pockets, and screeded to a true plane, sloped to drains or leveled as shown on the drawings. The average thickness of setting bed in any room or space shall be 2.5 cm, but not less than 2 cm or more than 3.2 cm thick.

4) Laying Ceramic Floor Tiles

The ceramic floor tile shall be laid with regular joints between the tiles. As soon as the setting bed has set sufficiently to be worked

upon, a dust coat of dry Portland cement not more than 2 mm thick shall be sprinkled over the surface and lightly worked with a steel trowel. Tile laying shall begin as soon as the moisture, not free water, has penetrated the dust coat. A thin skim coat of neat Portland cement grout shall be troweled or brushed into the backs of tiles immediately before each tile is laid. Tile shall be laid on the freshly prepared setting bed while the surface is still plastic and the tile then tamped into the mortar to insure solid bedding to the exact slope or level of finished floor surface.

5) Grouting

A thick creamy slurry of neat gray waterproofed Portland cement and a minimum amount of water shall be brushed or squeezed over the floor until all joints are thoroughly filled. The surface of the floor shall be very gently rubbed with a wood block to bring tile surfaces to true planes, excess slurry shall be removed, and the floor shall be rubbed with burlap to clean the tile and finish the joints.

e) Installation of Wainscot

1) Scratch Coat

Scratch coat for application as a foundation coat shall be not less than 6 mm thick composed of one part cement, 4 parts sand, and 1/4 part hydrated lime by volume. While still plastic, the scratch coat shall be deeply scored or scratched and cross-scratched. The scratch coat shall be protected and kept reasonably moist during the seasoning period. All mortar for scratch and float coats shall be used within one hour after mixing. The retempering of partially hardened mortar will not be permitted. The scratch coat shall be applied not less than 48 hours nor more than 54 hours before starting the setting of tile.

2) Float Coat

The float coat shall be composed of 1 part cement, 1/2 part of hydrated lime and 4 parts sand. The float coat shall be brought flush with screeds or temporary guide strips so placed as to give a true and even surface at the proper distance from the finished face of the tile.

3) Setting Wainscot

Wainscot shall be thoroughly soaked in clean water before setting. Wainscot shall be set by troweling a skim coat of neat Portland cement mortar on the float coat or applying a skim coat to the back of each tile unit and immediately floating the tile into place. Joints shall be straight, level, perpendicular, and of even width not exceeding 2 mm. Wainscots shall be built of full courses, which may extend to a greater height, but in no case more than 4 cm lower than the specified or figured height. Vertical joints shall be maintained plumb for the entire height of the tile work.

4) Grouting

All joints in wainscot shall be grouted full with plastic mix of neat white cement immediately after a suitable area of tile has been set. The joints shall be tooled slightly concave and the excess mortar shall be cut off then wiped from the face of tile. Any interstices or depressions in the mortar joints after the grout has been cleaned from the surface shall be roughened at once and filled to the line of the cushion-edge before the mortar begins to harden. All joints between wainscot and plumbing or other built-in fixtures shall be made with a light-colored calking compound.

f) Curing

Floors shall be covered with waterproofed paper with all joints lapped at least 10 cm and the laps tape-sealed or held down with planks or other weights, and allowed to damp-cure for at least 72 hours before foot traffic is permitted thereon.

g) Cleaning

Upon completion, tile shall be thoroughly cleaned in a manner as not to affect the surface.

h) Protection

Tile floors shall be covered with building paper before foot traffic is permitted over the finished floor. Damaged or defective tiles shall be replaced, at no cost to the PWD.

Chapter 2 Special Conditions

2 Special Conditions

2-1 Intake Facilities

2-1-1 Revetment Work

a) Scale of Structure

1) Piled Stonework

Method of Piling: Wet masonry

Height: 3.6 m

Length: 4.85 m

Total length: 19.0 m

Area: 92.15 m^2

2) Reinforced Concrete Fencing

Fencing shall be installed as specified below:

Fence posts: T-type concrete pile

Fencing: (1) 130 x 1000 x 2100 (mm)

Fencing: (2) 100 x 1000 x 2100 (mm)

Fence length: 19.0 m

3) Reinforced Concrete Sheet Piles

The revetment work will take all precautions to prevent flooding of the site or of the grit chamber by driving reinforced concrete sheet piles in areas of the site and the raw water intake.

Chart 2-1-1-a-3 Dimensions of Sheet Piles (unit: mm)

Sheet Pile No.	Thickness(t)	Breadth(B)	Length(L)	Notes
1	100	400	4000	
2	120	400	6000	
3	150	400	9000	
4	190	400	11000	9000~12500 (average length: 11000)
5	220	400	12500	

4) Temporary Cofferdams

Work on revetments and the raw water intake will be done during the dry season, but, in addition, temporary cofferdams shall be installed.

The method of coffering shall be as follows. A double-row of log piles shall be driven, and tied together with fagots. The space between the piles shall then be filled with earth and sand to prevent water flowing into the work area.

Wooden piles: 200 mm dia. (tip end)

Length of pile: 3.0 m (driven to 1.8 m depth)

Spacing between piles: 1.0 m (2 rows)

Width of cofferdam: 2.0 m (measured between centers of piles)

Length of cofferdam: 47.0 m

b) Scope of Work

1) Revetment Work

i) This work shall consist of the stonework, of construction of a reinforced concrete retaining wall as a revetment for the river bank, and the installment of reinforced concrete sheet piling as a breakwater.

ii) The installment of reinforced concrete sheet piling as a breakwater for the raw water intake shall be a separate construction work.

iii) Construction of stairs of stonework shall be done as a part of this construction.

iv) Concrete slabs between the stonework and the fencing shall be part of this construction.

2) Temporary Coffering

Temporary coffering shall include all work from the driving of wood piles in the stream, and filling in between them with earth, etc. until their removal.

c) Particulars of the Construction

1) Stonework

i) Stones shall be set with mortar.

ii) Stones used shall be Thai domestic stones, with approximate length of 35 cm.

iii) There shall be no definite limitations to the shape or size of stones except length, but use of very flat stones and stones with both ends pointed should be avoided.

iv) Backfilling with cobblestones shall be as indicated in pertinent drawings, except that the quantity used may require changing, depending on foundation conditions.

v) In case of weak ground foundation or for earthwork banks, backfilling shall be 60 cm near the base and 30 cm thick at the top. However, where the foundation is comparatively firm, thickness at both base and top may be 30 cm.

vi) Stonework shall be adequately consolidated together by pounding in binder concrete between the stones.

vii) The slope for stonework shall be as indicated in drawings, but where conditions at the site are such that there are unusually large amounts of earth embankment work, changes may be made after consulting and obtaining approval of the Engineer.

2) Reinforced Concrete Revetment Work

i) Shapes and dimensions shall be as indicated in the drawings.

ii) The revetment work shall use Thai-produced domestic T-type material.

iii) Fencing shall extend underground more than 50 cm below the planned river bed level (+301.400 m).

iv) Cracks between concrete-sheet piles and fencing used in cofferdams shall be rendered watertight by filling in concrete 30 cm or more over the crack.

v) Concrete sheet piles for breakwater use shall be as specified in section 2-1-1-c-3.

vi) The thickness of fencing shall be changed when earth pressures so require.

vii) Before driving piles for revetment work, test piles shall be driven to ensure that piles will not fall or sink due to their weight.

viii) When, as a result of driving test piles, it appears that piles may sink under their own weight, the Contractor must change suitably the length of the piles, after consulting and obtaining the approval of the Engineer.

3) Concrete Sheet Pile Work

i) Shape and dimensions shall be as indicated in the drawings.

ii) The sheet piles shall be of Thai domestic manufacture, and the crack moment shall be as indicated in the chart below.

Chart 2-1-1-c-3 – Concrete and Crack Moment of Sheet Piles

Sheet Pile No.	Length (mm)	Crack Moment		Notes
		tm/sheet	tm/m	
1	4000	1.00	2.50	
2	6000	1.20	3.00	
3	9000	2.40	6.00	
4	11000	3.60	9.00	9000 ~ 12500 (Average Length, 11000)
5	12500	5.20	13.00	

iii) The concrete sheet piles shall be waterproof type with trimmed edges, and fitted with guide way metal. When driving the piles, the Contractor shall exercise the utmost core that the point of the pile is not twisted, and that there is no slant.

2-1-2 Grit Chamber and Raw Water Pump Well

a) Scale of Structure

Facilities at the raw water intake site shall consist of intake gate, screen, grit chamber, pump well, intake pump room, and intake pumps, and the scale of the structures to be built during the present work are as follows:

1) Intake Gate

Construction: Reinforced concrete

Breadth: 2.0 m, 6 gates, total effective width, 12 m

Inflow depth: In dry periods, 0.2 m

Capacity: 60500 m^3/day

2) Grit Chamber

Construction: Reinforced concrete

Width: 4.5 m

Length: Effective length 15.0 m with total depth of 10.3 m

Flow velocity in chamber: V = 5.2 cm/sec.

Capacity: 30.25 m^3/day

Retention time: 5 min. / chamber

Control gates: On inflow side, 2 gates, size 1000 x 1000 mm, square.

On outflow side, 2 gates, size 1000 x 1000 mm, square.

Number of chambers: 2

3) Pump Well

Construction: Reinforced concrete

Width: 4.5 m (interior measurement)

Length: 13.0 m (interior measurement)

Depth: Effective depth, 1.5 m; total depth 10.3 m

4) Steel Sheet Piling for Revetments

Material: Steel sheet pile

Size: 400 (W) x 125 (H) x 7 (L) mm --- 87 m

400 (W) x 125 (H) x 10 (L) mm --- 19 m

b) Scope of Construction Work

1) Revetment Steel Pile Construction

i) Temporary Construction

(a) Temporary coffering in the river, as well as earth revetment work necessary for construction of facilities such as intake gates, grit chambers, and the pump well shall be part

of this work.

(b) This work shall include all temporary coffering, and earth revetment work including its removal and attending restoration after serving its function.

ii) Civil or Earth Work

(a) Excavation, refilling, disposal of excess earth, and banking shall be included in this work.

(b) Banking the site shall be done with site material to a level of +308.200 m. Above that level, earth and sand shall be spread, which will be suitable to plant trees and shrubs, to a level of +308.500 m, as a part of this work.

2) Work of Building the Grit Chamber

i) The building of the intake gate, grit chambers and pump well shall be part of this construction work.

ii) Work of installing the screens, control gates, and the headstock for opening and closing the control gates shall be included in this construction.

iii) Pump facilities and their installation shall be a separate construction work.

iv) Concrete foundations for the pumps shall be included in this present construction.

v) Instructions regarding the position for embedding pump foundation bolts shall be ascertained from those responsible for work for pump facilities, and provision of bolt holes shall be made as part of this construction.

vi) The work of building the pump room shall be a separate construction job. However, the foundation floor of the pump room shall be part of this construction.

vii) Construction above the foundation floor slab, such as laying poor concrete and building a distributing wiring pit shall be a separate construction job.

viii) Raw water main at the pumps shall be part of this construction.

ix) For this construction, raw water main of the pumps shall be that portion beyond the control valves auxiliary to the pump equipment, a distance of 6 m, which is the standard length of the 300 mm and 400 mm dia. ductile iron pipe from the raw water flow meter room.

c) Matters Concerning the Construction

1) Grit Chambers

i) The sheet piling to be installed as a breakwater along the entire face of the intake shall be done during the revetment construction (section 2-1-1). Sheet piles must be driven in straight rows so there will not be any cracks or space between.

ii) For the intake, a concrete wall shall be laid to 40 cm above the river bed to prevent the influx of sand.

iii) The wall to keep sand out of the intake mouth shall be built by laying concrete brick to a height 20 cm above the present river bed so that, as the river bed wears lower in the future, the bricks may be removed if necessary.

iv) The concrete block shall be made at the site.

v) The size and method of laying the concrete blocks shall be as follows:

Size of blocks: H. 190 mm, W. 190 mm, L. 390 mm

Blocks shall be 10 layers in width and 9 layers high, laid on the 390 mm side, in staggered layers.

vi) Pores of all concrete blocks shall be closed with mortar.

vii) The flush board installed in the intake shall be hardwood, with a thickness of 5 cm.

viii) The flush board shall be fitted with a handle to render it easy to remove.

ix) Apertures shall be made in the side wall of the grit chamber to enable inflow of underground water, to maintain balance with the weight of the grit chamber at all times, in order to prevent floating due to rises in the underground water level.

x) The apertures shall be fitted with a 200 mm dia. asbestos-cement pipe, with cobblestones and with stone and gravel around

the pipe outside the chamber wall, to prevent influx of earth or sand.

xi) Placement of the apertures and of the cobblestones and of the stone and gravel shall be as specified in the drawings.

xii) Cobblestones and gravel shall be tamped down adequately so they will not sink down.

xiii) Shape and size of the cobblestones and stone and gravel shall be as follows:

Cobblestones: about 15 ~ 20 cm

Stones and gravel: 4 ~ 6 cm

xiv) Thickness of layers: Lowest layer, stone and gravel 30 cm middle layer, cobblestone, 50 cm, upper layer to the surface for more than one m. Total length shall be 17 m.

xv) The boundary line separating (a) cobblestones plus the sand and gravel and (b) the refill earth shall be provided with a wood partition to prevent the sand and gravel from shifting position.

xvi) On the outside of the area of the apertures, steel rods of 9 mm diameter shall be installed as a mesh-like grill to prevent seepage of water or influx of cobblestones.

xvii) The area of the apertures for the flow control baffle (wall) shall have installed 150 mm asbestos-cement pipe or vinyl-chloride pipe at intervals from center to center of 50 cm. Those shall be assembled, affixed to forms.

xviii) The concrete of the base for below the control gate on the outlet side shall be as follows: Lower 90 cm, reinforced concrete of 1 : 2 : 4 mixture, upper 1 m. non-reinforced concrete of 1 : 4 : 8 mixture.

xix) The side wall of the grit chamber on the down stream side of the intake facilities shall be provided with a drain channel to dispose of sand when cleaning the grit chamber.

xx) The drain channel shall be 1 m. deep at its upper end and 2 m. at the lower end.

2) Pump Well

i) Baffle piers shall be installed for each pump to prevent unstable intake conditions, or mutual interference between pumps in the intake operation.

ii) Holes to receive bolts for metal fittings to prevent vibration of suction pipes shall be provided at the time of laying concrete for the side walls.

iii) Steps and manholes shall be provided in two places for entering the pump wells.

3) Steel Sheet Piling for Revetments

i) After laying the concrete base and the lower walls of the grit chamber, supporting timbers shall be replaced by replacement timbers inserted between the sheet piling and the walls.

ii) The replacement planks shall be spaced and inserted in the grooves of the sheet piling. About 80 cm is desirable.

iii) Replacement for the second stage strut beams shall be done when the laying of concrete for side walls is completed to just below the second stage strut beams by using inside the side walls discarded material from the 3rd stage struts.

iv) Taking out the replacement materials shall be done after laying concrete for strut beams for the upper section.

2-1-3 Metal Fabrication

a) Scale of Construction

1) Bar Screen

A scraper-type bar screen shall be installed between the grit chamber and the intake to collect foreign matter. The facility is designed with two inlet channels 4.7 m. wide but to facilitate its construction, transportation, and installation, piers shall be built in the center of the channels, and four bar screens provided.

The specifications shall be as follows:

Construction: Steel

Water channel width: 2.15 m

Height of water channel: 4.1 m (vertical measurement)

Slope installed: 75°

Width between bars: Effective width, 71 mm

Number: 4

2) Water Control Gate and Headstock

Four square type water control gates, each 1000 mm x 1000 mm, shall be installed on both sides, inflow and outflow, of the grit chamber, in order to control flow volume.

The opening and closing of these gates shall be by external screw-type manually-operated headstocks.

Type: External screw, square type, sluice gate

Dimensions: 1.0 m x 1.0 m

Maximum head: 8.0 m

Spindle: 50 mm dia.; material, SUS 50

Number: Inflow side, 4
Outflow side, 4
} Total 8

3) Hand Rail

GS pipe shall be installed as railing for the central area for walking, around the sedimentation chamber, and the screen openings.

Structure: GS pipe, 1 1/4" dia., welded

Height: 1.0 m

Distance between supporting posts: 0.5 m

Horizontal supports: 0.5 m

4) Grating

The pit for waste grit from the grit chamber (pit width, 1.0 m, length 17.2 m) shall be covered by grating.

Structure: Steel plate 4.5 x 50, welded

Dimensions: 1.00 m x 1.10 m (1 block)

Number: 17 blocks

5) Manhole Cover and Stairs

Stairs shall be provided to get in and out of the intake, the grit chamber, and the pump well. On the downstream side of the screen, manholes covered with a checker plate shall be installed for the grit chamber and for those areas with slabs of the pump well.

Stair: Round bar, 19 mm dia.

Manhole cover: Checker plate, 4.5 mm thick

b) Scope of Construction Work

1) All work in section 2-1-2 ~ including stairs, manhole covers, grating, hand rail, headstock, and water control gates, and all the bar screens for the pump wells and grit chambers ~ shall be included in this construction work.

2) The manhole cover, stairs, etc. for the drain pit and flow meter pit shall be excluded from the construction herein specified.

3) Locations of bolts, hand rail, etc. are as specified in the drawings. But the providing of imbedded holes by forms shall be included in the civil works construction. However, the work and mortar for embedding work is included in the construction work herein described.

c) Matters Concerning the Construction Work

1) Bar Screen

i) Double-screw bolts shall hold the entire screen together, being passed at right angles through the flat surface of the steel members, 95 mm by 5 mm, with distance pieces inserted at set intervals, and the whole tightened together.

ii) The width of one bar screen is to be 2.15 m, but to facilitate transportation, installation, and removal, each shall be in two sections, fastened together by connecting bolts at the time of installation.

iii) The bar screens are supported by steel forms, fastened on by bolts. The supporting steel form is fastened by both ends to the concrete walls by foundation bolts.

iv) The angle for attaching the screen shall be approximately 75°.

v) The hand-model scraper shall be fabricated at the construction site according to the drawings.

2) Sluice Gate and Operation Stand

i) The main parts of the doors of the gates, the frame, etc. shall be of good quality cast iron, of thickness adequate to withstand the maximum still water pressures, and with ribs attached, so that the gates are safe even under instantaneous shock pressures.

ii) The surfaces of the gates exposed to water pressures, including both door and frames, shall be of brass or copper sheet, firmly fixed with screws, and put together, and so finished that there is no water leakage.

iii) Both faces of the gate for retaining water, shall be provided with wedges so that they fit together well, and are water tight even at times of maximum still water pressure. Also, stop screws shall be provided to enable adjustment of the degree of contact or fit.

iv) Spindles shall be external screw type and shall be made of SUS 50. The screw thread shall be of cast bronze, BC 6 make, and shall rotate smoothly.

v) The spindle for the inflow control gate shall be protected with cast-iron pipe to prevent damage.

vi) For the protective piping for the spindle, double-flanged cast-iron pipe shall be used, with metal fittings to prevent spindle vibration midway inside the pipe.

vii) The protective pipes shall consist of two double-flanged 200 mm diameter cast iron pipes, of such length that the flanges can be connected in the middle.

viii) Bolts shall be provided, imbedded in the lower side of the top slab in which the pipes are attached, and rigidly fixed in place with mortar to prevent bending or falling.

ix) The headstock shall be manually operated, external screw type, and so made that manual closing and opening will be easy to perform even when there is maximum still water pressure on the gates.

x) The positions of the fitting bolts, etc. shall be checked by consulting drawings, and the bolt-holes shall be chiseled in the concrete, after consultation with the supervising engineer.

xi) The specifications for materials for the gate shall be as listed in the chart below.

Chart 2-1-3-c-2. Materials for the Gates

Item	Material	Quantity	Item	Material	Quantity
Anchor Bolt	SS41, 28mm dia.	12	Guide	FC 20	2 sets
Stopper Bolt	SUS 27	2	Gate	FC 20	1 set
Stud Bolt	SS 41	22	Frame	FC 20	1 set
Coupling	FCD 45	2	Frame Seat	BC 6	1 set
Spindle	SUS 50	1	Gate Seat	BC 6	1 set

3) Hand Rail

i) Holes for installing the hand rail posts shall be provided for by preparatory forms. The supporting posts shall be adequately inset using mortar (mixture of 1 : 3).

ii) Railing pipe shall be assembled by welding. Thickness shall be adequate to prevent collapse even under stress or shock.

iii) Bolt holes and other holes in the concrete shall be of the minimum size necessary for metal fittings, and after installation, all holes shall be carefully filled with mortar.

4) Grating

Steel plates 4.5 x 50 shall be used, assembled by welding, and fabricated so as not to be twisted or deformed.

5) Manhole Covers and Stairs

i) Manhole covers shall be 4.5 mm thick steel sheet, reinforced by a welded rib L - 3.5 x 3.5.

ii) Stairs shall be of 19 mm dia. round bars, set more than 10 cm into the walls.

iii) Insertion of step bars into the walls shall be provided for by holes formed during pouring of the concrete or by chiseling into the walls. After inserting the bars, the holes shall be carefully filled with mortar.

2-1-4 Piping Works

This piping is to supply water from the intake plant's water supply tank for lubricating the raw water pump facilities. 40 mm VP pipe shall be laid from the water service main of the supply tank, and connected directly with the lubricating water injection pump which shall be provided for the pump room.

a) Scale

Water for use in oiling or lubrication of the central bearing.

Method of injection: Automatic injection on outer surface

Injection pressure: 1.5 ~ 3 kg/cm^2

Injection quantity: 10 ~ 15 liter/min.

b) Scope of Work

All work including laying underground pipes and civil works required within the scope of the work to provide a water supply.

c) Matters Concerning the Construction

The provisions of 2-1-12-c apply.

2 1-5 Raw Water Pump Equipment

Raw water pumps shall be installed in a pump room to be built above the Raw Water Pump Well. Two types of pumps shall be installed in order to send water separately to the Chiang Mai Water Treatment Plant No. 1 and to the Proposed Water Treatment Plant. Installation of the pumps shall be done successively for each stage to provide the proper capacity for the volume of water required. The capacities and numbers to be installed are as follows.

	1st Stage on Completion	2nd Stage on Completion	3rd Stage on Completion	Notes
	Volume and Number of Pumps	Volume and Number of Pumps	Volume and Number of Pumps	
Chiang Mai Water Treatment Plant	7700 m^3/day	7700 m^3/day	7700 m^3/day	1 Stand-by
	5.35 m^3/min x 2 pumps	5.35 m^3/min x 2 pumps	5.35 m^3/min x 2 pumps	
Paton Water Treatment Plant	17600 m^3/day	35200 m^3/day	52800 m^3/day	1 Stand-by
	12.22 m^3/min x 2 pumps	12.22 m^3/min x 3 pumps	12.22 m^3/min x 4 pumps	

a) Specification for Pump Equipment

1) Raw Water Pump

i) Method of Operation

Independent operation for the intake plant and water treatment plant.

ii) Specification of Pumps

Item \ Place	Chiang Mai Water Treatment Plant	Paton Water Treatment Plant	Notes
Type	Motor, direct coupling Vertical axis diagonal flow pump	Motor, direct coupling Vertical axis diagonal flow pump	External Flushing Type
Diameter	ø250 mm	ø300 mm	
Capacity	5.35 m^3/min	12.22 m^3/min	
Total Lift	48 m	43 m	
Revolutions	1450 rpm	1450 rpm	
Generator Output	80 KW	150 KW	50 Hz, 380 V
Number	2 each	2 each	1 Stand-by

iii) Raw Water Pump Accessories (per unit)

Sluice Valve (manual): 1 each

Check Valve: 1 each

Compound Gauge: 1 each

Air Valve: 1 each

Suction Strainer: 1 each

Flexible Coupling: 1 set

Standard Accessories: 1 set

Other Required Items: 1 set

2) Middle Shaft Bearing Lubricating Water Pump

Middle shaft bearing lubricating water pump shall be installed in a pump room in order to feed lubricating water to the Raw Water pumps.

i) Method of Operation

Starting of the raw water pumps shall act to start in unison the lubricating water pumps.

ii) Specification

Type: Volute pump (for high lift)

Diameter: ϕ40 mm

Capacity: 0.065 m^3/min

Total Lift: 23 m

Revolutions: 1500 rpm

Generator Output: 1.5 KW (50 Hz, 380 V)

Number: 2 each (1 stand-by)

iii) Lubricating Water Supply Pump Accessories (per unit)

Sluice Valve: 2 each

Standard Accessories: 1 set

Other Required Items: 1 set

3) Grit Chamber Sand Pump

1) Specification

Type: Motor, direct coupling submerged pump (portable)

Diameter: 100 mm

Capacity: 1.4 m^3/min

Total Lift: 10 m

Revolutions: 2950 rpm

Generator Output: 5.5 KW (50 Hz, 380 V)

Number: 1 each

ii) Sand Pump Equipment Accessories

Hose Coupling: 1 set

Rubber insulated cable for motor: 50 m

Switch with safety device for motor: 1 each

Hose: 1 set

Standard Accessories: 1 set

Other Required Items: 1 set

b) Scope of Work

1) Installation of Raw Water Pumps

2) Installation of Middle Shaft Bearing Lubricating Water Pump

3) Installation of Grit Chamber Sand Pump

4) The concrete foundations and bolt holes shall be part of the pump well construction.

5) The metal fittings to prevent vibration of the suction pipe shall be installed in this work.

6) Provision of holes to install the metal fittings to prevent vibrations shall be part of the pump well construction.

7) Hoist work shall be part of the building construction.

8) Finishing of walls where pierced by the discharge pipe shall be part of the work herein detailed.

9) Piping for the raw water pump shall be provided to the wall on the inflow side of the flow meter chamber, as part of the work here described.

10) Piping for supplying lubricating water shall be laid to within 1 meter outside the wall of the raw water pump room, and all necessary piping in the pump room shall also be done as part of the construction herein described.

11) Civil and earth work, required for piping, shall be included in

this work.

12) The work of installing for the piping is excluded from the work herein described.

13) The various electric wiring necessary for the work herein described shall be done as part of the electric work.

14) An eddy preventive baffle wall shall be constructed as part of distribution pump well construction work.

c) Details of the Construction

1) General matters concerning pump equipment installation work shall comply with section 1-4-1 (b) ~ (e) and necessary documents shall be approved by the Engineer.

2) Installation of pump equipment shall be as detailed in the Drawings.

3) The Air Valve on the delivery pipe shall be 13 mm. in diameter. Place of its installation shall be as indicated in the Drawings.

4) Installation

i) During installation work of pumps and other necessary equipments, the Contractor shall take care not to cause damage to other structures constructed nearby.

ii) Before commencement of the installation work, installation detail drawings shall be submitted to the Engineer for approval. High quality liners shall be set on the foundation bed and all equipment installed accurately.

iii) When installing small diameter pipes, the inside of all pipes shall be cleaned to prevent rusting and accumulation of dust. Cocks, nipples and unions shall be used for the pipe installation work so that disassembling, inspection and maintenance can be done easily. Pipes shall be installed firmly, using metal supporting fittings.

iv) In case a hoist is used for the fabrication and installation of pump equipment, prior approval of the Engineer shall be obtained.

v) Installation shall be done in consultation with and with the approval of the Engineer.

5) Inspection and Tests (1-4-1-b and e)

Inspection and testing of pump equipment shall be done as follows in accordance with instructions of the Engineer.

i) Inspection and Testing at the Factory

(a) Performance test

(b) Pressure test

(c) Inspection for accessories, and valves

(d) Inspection of the hoist

(e) Inspection for electric equipment

ii) Inspections at the Construction Site

(a) Operation test

(b) Inspection of exterior appearance

(c) Inspection of piping

(d) Inspection of wiring

(e) Inspection of painting

(f) Other necessary inspections and tests required by applicable standards, rules, or regulations.

(g) Other inspections and tests ordered by the Engineer

2-1-6 Drain Pit

Sand and grit from the grit chamber shall be discharged into a drain channel installed in the grit chamber, using a portable pump. This waste shall be discharged from the far end of the channel into a drain pit, built in a corner of the downstream side of the intake plant, and then be discharged into the Ping River. Reinforced concrete pipe shall be used, connecting between the river, the drain pit, and the grit chamber.

a) Scale of Structure

Drain Pit: Reinforced concrete

Inside dimensions, 1.2 m x 1.2 m

Depth, 3.2 m

Checkered plate, 1459 m x 1459 m, and 4.5 mm thick

Pipe: Reinforced concrete pipe

Inner diameter, 500 mm

b) Scope of Work

1) Included are all the civil or earth work from the far end of the drain channel of the grit chamber to the pit, and from the pit to the Ping River, plus all work for construction of the pit, for operation and control facilities, and for the manhole cover, and stairs.

2) Gradient mortar at the bottom of the end of the drain channel for the grit chamber shall be included in the work herein detailed.

3) Repair of walls at the join of the drain channel and sand disposal pipe shall be included in the work herein detailed.

4) Anchor block for the discharge pipe to the Ping River shall be included in the work herein detailed.

c) Matters Concerning the Construction

1) Construction of the pit, and its piping, and the location where the piping is laid, shall be as shown in the drawings.

2) Smooth mortar gradients must be made leading to the middle of the piping, so that sand or grit will not remain in the bottom of the channel or the pit.

3) Laying of pipe from the pit to the Ping River shall be done at the same time as the revetment construction work. The stonework shall be done after the pipe has been laid.

4) The end of the discharge pipe shall be reinforced with concrete (1:4:8) to prevent slippage.

5) The manhole cover shall be made of 4.5 mm. thick steel plate, reinforced by welding steel ribs in L-shapes or cross-shapes.

6) Handles of 19 mm. diameter round bar shall be welded in two places on the sides of the manhole cover.

2-1-7 Flow Meter Chamber and Anchor Blocks

Raw water shall be sent by raw water pumps by separate mains to the water treatment plants, to the Chiang Mai Plant by a 300 mm dia. main, and to the Paton Plant by a 400 mm dia. main. An orifice meter shall be provided at the intake plant to measure the raw water flow volume.

a) Type and Main Specifications

1) Orifice Meter

Facility	Chiang Mai Water Treatment Plant	Paton Water Treatment Plant	Notes
Type	Ring Tap	Ring Tap	
Diameter	300 mm	400 mm	Data given are minimum, average, and maximums.
Flow Volume	0 ~ 320 ~ 370 m^3/hr.	0 ~ 730 ~ 900 m^3/hr.	
Pressure	0 ~ 4.8 kg/cm^2	0 ~ 4.3 kg/cm^2	
Material	Carbon or Stainless Steel	Carbon or Stainless Steel	

2) Pit

Reinforced concrete construction

Inner dimensions, 3.0 m x 2.5 m; Depth, 3.0 m

3) Pit Foundation Piling

Wooden piles: End dia., 12 cm; Length, 3.0 m

4) Protection for Deformed Pipe

Concrete (Mixture 1:4:8)

5) Piling for Protective Base of Piping

Wooden piles: End dia., 12 cm; Length, 3.0 m

b) Scope of Work

1) Included shall be all work for civil or earthwork in connection with building the flow meter pit, for construction of the pit, for providing the meter and its installation, for the work of installing piping, and for the manhole cover and stairs.

2) Installations for the work here detailed shall include those from the special pipe connecting before and after the orifice meter and the

single straight pipe on the downstream side.

3) Repairs where the pipes pass through walls shall be included.

4) The meter itself and its installation shall be included in the work here detailed; the receiver and transmitter, etc. shall be a separate different work.

5) Anchor block for the discharge pipe of the pumps and driving piles for their foundation shall be included in the work here detailed.

c) Matters Concerning the Construction

1) The upper plate for the pit shall have the surface contacting the pit wall sealed with asphalt to prevent leaking in of rain water, so the type used may be a concrete plate set on the wall, and independent of the side walls.

2) The upper plate shall be 50 cm wide and 3.0 m long, and made detachable, with joint sealed as described immediately above.

3) A manhole shall be provided in the one-piece upper plate. The manhole cover shall be of checkered plate, 4.5 mm thick.

2-1-8 Site Preparation (Intake Area)

a) Scale of Construction

The site for the intake plant is located on the right bank of the Ping River, extending about 34 m along the river bank, and about 40 m in width, approximately square in shape. The area is about 1400 m^2. The designed flood level is set at +308.000 m, while the present height of the ground is +307.660 m, so that an 80 cm earth fill or embanking to +308.500 m is designed.

Site area: about 1400 m^2

Designed flood level: +308.000 m

Designed ground level: +308.500 m

b) Scope of Work

1) Work for the construction here detailed includes the following:

i) Embanking

ii) Landscaping

iii) Building an entrance or gate

vi) Fencing

v) Building revetments

vi) Simple paving within the plant site

vii) Site drainage

viii) Replacing or dressing soil

c) Matters Concerning the Construction

1) Earth banking shall be to +308.50 m.

2) Banking shall be with excavated earth, and cobblestones and large material shall be removed and cleaned away from exposed surfaces.

3) For landscaping, good quality earth suitable for planting grass shall be spread evenly to a depth of 10 cm on top of the embanking earth.

4) The embankment along the road shall have a concrete wall.

2-1-9 Lighting Works and Water Service (Intake Area)

This construction shall include water supply to the intake plant, the entrance lighting, and outdoor lighting.

a) Scale of Construction

1) Lighting Works

Outdoor illumination: Fluorescent light, 20 W, single tube	4 each
Entrance lights: Round type, 100 W	4 each
Outdoor illumination post: H, 4.5 m, total length, 5.3 m	4 each
Cable: 600 V, EV cable	228 m

2) Water Service

Standing type faucet	2 places
Service main: 40 mm dia. vinyl chloride pipe	50 m
Road crossings: 100 mm dia. asbestos cement pipe	10 m

b) Scope of Work

1) Lighting Works

i) Work shall include all installations from the hand hole in the residential area to the entrance lights A and B, as well as the four

outdoor lights.

ii) The work here detailed shall include all portinent civil or earth work, concrete work, building of the hand hole, and laying of the trough.

2) Water Service

i) Included shall be all laying of mains from the residential area's border to the water service, faucets within the intake plant, and installation of all faucets.

ii) Construction of water service piping within buildings shall be part of the various works for constructing buildings. Included in the work here detailed are mains only to one meter outside the building walls.

2-1-10 Site Preparation (Residential Area)

a) Scale of the Construction

The residential area is located slightly upstream on the opposite side flanking the intake area and the road. The area is about 4200 m^2.

The lodging house (for workers and staff members), the generator room, the electric room, the warehouse, and the water service elevated tank, etc. shall be built in the residential area.

The designed flood water level is +308.000 m, while the present site elevation is only +307.660 m, so that about 80 cm of earthfill or banking shall be done to raise the site to its planned elevation of +308.500 m.

b) Scope of Work

1) Work for the construction here detailed shall include the following:

i) Banking or fills

ii) Lard scaping

iii) Building an entrance gate

iv) Building fencing

v) Building revetments, banks, or walls

vi) Simplified paving for inside the site

vii) Drainage for inside the site

viii) Planting trees and shrubs

ix) Replacing or dressing soil

c) Matters Concerning the Construction

Section . 2-1-8-c shall apply.

2-1-11 Lighting Works (Residential Area)

a) Scale of Construction

Lines shall be run from the electric power source for illumination lighting in the power room into the switchboard in the same room for the main facilities, from which power shall be supplied to the well pump and for outdoor lighting.

Outdoor lights: Fluorescent, 20 W, single tube	9 each
Gate light: Round, 100 W	2 each
Outdoor illumination post H, 4.5 m, total length 5.3 m	9 each
Cable: 600 V, EV cable	180 m

b) Scope of Construction

1) All work shall be included, from inside the hand hole outside of the electric power room to the two gate lights and the 9 lights in the plant site.

2) Included shall be all necessary work for civil or earth work, concrete work, trough, and laying underground cable.

3) Work for the hand hole shall not be part of the work here detailed, but shall be included in construction for the intake area.

2-1-12 Water Service (Residential Area)

To supply water to the intake area and the residential area, a deep well shall be dug, and water furnished after chlorine treatment.

Disinfecting equipment shall treat the water lifted by the pump with hypochlorine by injections made with automatic and safe disinfecting equipment directly into the discharge side of the distributing pipe.

a) Scale

1) Water Source

Type: Deep well

Well diameter: 65 mm

Depth: 25 m

Designed capacity: 50 liter/min.

2) Lift Pump

Type: Automatic deep and shallow pump

Lift capacity: 50 liter/min.

Lift: 24 m

Diameter: Suction and discharge pipe, 1 1/4"

Motor output: 0.75 KW, 3 phase, 200 V

3) Chlorine Disinfecting Equipment

Type: Automatic Hypochlorine injector

Volume of dose: 4 ~ 16 cc/min.

Maximum injection pressure: 3 kg/cm^2

Capacity of liquid chemical: 20 liters

Tank:

Number: 1 unit

4) Elevated Water Tank

Construction: Steel plate coated with polyvinyl chloride

Inner dimensions: 1.00 m x 1.00 m

Effective depth: 1.00 m

Tower structure: wood

H. W. L. : +317.95 m

L. W. L. : +316.95 m

Capacity: 1.0 m^3

b) Scope of Work

1) Digging of the deep well shall be part of the work here detailed.

2) Foundation piles shall be wooden, of 200 mm diameter, 3.0 m length, 9 piles. These are part of the work here detailed.

3) Concrete foundation work shall be part of the work herein described.

4) The pump room, a wooden structure with slate roof, is included in the work here described.

5) Work for service pipe shall be completed for outdoor water service to the faucets and for indoor water supply to within one meter of the building.

c) Matters Concerning the Construction

1) Pump lifting volumes shall be tested to ascertain that required volumes of water can be obtained from the deep well, after the well digging is completed.

2) In event the required volume of water is not obtained, the well shall be redug at a different location.

3) Testing of water quality shall be conducted, and water supplied suitable for drinking.

4) Test piles shall be driven to ensure that piles will satisfactorily support the load that the piles will bear.

5) A ladder shall be provided for the tower of the elevated tank, so that there will be no difficulty in checking the tank.

6) Surface piping for supplying or lifting water shall be GS pipe. Pipe laid underground shall be polyvinyl chloride pipe.

7) The inner surface of the elevated tank shall be coated with polyvinyl chloride.

2-2 Raw Water Main

2-2-1 General Matters Concerning The Pipe Lines

a) Calculations for the Scale of Construction included all items excepting only the bent pipe between sections; namely, the straight pipe, sluice valves, blow-off valve, air valves, and the fire hydrants. Naturally, bent pipe is also included in the construction. The items listed above are indicated in terms of lengths and number of installations. Pipelines at river crossings, water courses, and road crossings all have their lengths included in the total length of straight pipe. But, since special considerations apply to this work, they are specially shown in writing. Also, the casing pipe for the Super Highway crossing is shown as SP.

b) Scope of Construction includes connections with pipe of sectors before and after. So that the pipeline may function effectively as a main route, installation is included of fire hydrants, blow-off valve, air valve, etc. Pipeline to be installed for one sector is shown by a solid line in the design drawings.

c) Matters Concerning the Construction

1) Crossing of the Super Highway shall be done by expeditious, quick methods. Working drawings of such points of crossing and for the river crossing shall be shown without fail to the Engineer, whose approval shall be obtained before beginning the work.

2) After laying pipe, roads must be restored without fail to their original condition. Instructions from the Engineer or the concerned city office shall be complied with in doing asphalt or concrete paving.

3) Sluice valves shall be of the double-flanged type, with bolt holes on the pipeline side corresponding to the size of the valve. In case the pipeline being laid is DCIP, the flanged socket or the flange holes of the flanged spigot shall correspond in size and fit with the holes of the sluice valve. For ACP pipelines, both sides of the sluice valve shall use an ACP flanged spigot, and the connection with the pipeline shall be a Gibault joint.

4) All ACP asbestos-concrete pipeline shall have sand spread on top of the pipe, after digging ground to lay the pipe. For all road crossings except the Super Highway, sleepers shall be used. The Contractor shall be responsible for using similar supporting wood wherever variations in the ground or soil render this necessary.

5) In order to distinguish, from other sluice valves, those sluice valves dividing the two distributing systems for Chiang Mai Water Treatment Plant No. 1 and for the Proposed Water Treatment Plant during Stage 1, a distinguishing mark shall be fixed to these valves, entered on drawings, and submitted to the Engineer. Valves shall close when turned clockwise.

6) All bent pipe, 90^{o} bend, 45^{o} bend and T-bends, shall be located as shown in the design drawings, and fixed in place with anchor blocks.

d) Construction for Casing Pipe

1) General Matters

i) This work shall be done by workmen approved by the Engineer.

ii) Before beginning work, the Contractor shall consult with contractors for other distributing main construction for this project, then shall make a work plan and work schedule chart, and submit this to the Engineer for approval, ensuring that no delay or inconvenience is caused to the progress of the construction as a whole.

2) Expediting Work for the Casing Pipe

i) When driving in the pipes, the axis line and the heights shall be checked, and the work shall be so executed that deflections in the axis do not occur.

ii) If, while inserting the piping, it appears that the embanking behind is not strong enough, the Contractor shall make reinforcements with concrete.

iii) Concrete to reinforce banks shall use steel rod reinforcing, and shall be cured till it reaches a strength fully sufficient to

bear the pressure of forcing in the piping. Pressure must not be applied immediately after laying.

iv) When driving in the pipes, work shall be done so that the ground around the end of the pipe is not broken down. Earth which gets inside the pipe shall be cleaned out. Digging shall be done preparatory to driving in the piping. Work shall be done so as not to weaken the earth around the piping.

v) Pipe joints shall be sealed with a sealing compound to prevent influx of fine sand or underground water. Also, the inserted end of the piping shall have proper drainage equipment so that drainage will be completely effective.

vi) If the Engineer considers it necessary during the work of driving the pipe, sample material shall be gathered each time there appear differences in the nature of the soil. The Contractor shall then make geological maps for soil strata, and must submit them to the Engineer.

vii) The work of driving the pipe shall be, as a basic policy, done on double shifts, day and night. If special circumstances arise, the Contractor shall do as directed by the Engineer.

viii) When impediments, or water, or sliding of earth, etc. is encountered during the work, the Contractor shall report to the Engineer.

ix) The Contractor shall, in the course of the work, exercise caution at all times as to conditions around the working site so as not to affect adversely nearby buildings, and must build necessary preventative installations.

x) When crevices appear around the pipe, they shall be filled up immediately by thorough use of cement grouting.

xi) Grouting shall be done at an appropriate interval from the inner face of the pipe. The mixture shall be determined with reference to soil conditions, and the pressure at which it is injected shall be as directed by the Engineer. The Contractor shall inform the Engineer as to the plans for grouting, and per-

form the work under the Engineer's observation.

2-2-2 Raw Water Main

a) Scale of Construction

DCIP

Dia. 400 mm; length, 2998 m

ACP

Dia. 300 mm; length, 4053 m

Dia. 150 mm; length, 70 m

Dia. 75 mm; length, 48 m

SP

Dia. 800 mm; length, 20 m

Dia. 600 mm; length, 20 m

Sluice Valves

Dia. 400 mm; 1 place

Dia. 300 mm; 2 places

Dia. 150 mm; 2 places

Blow-off

Dia. 150 mm; 1 place

Dia. 75 mm; 2 places

Air Valve

Dia. 75 mm; 2 places

b) Scope of Construction

Construction for 300 mm ACP pipe shall be from the connection to the delivery pipe of the raw water pump to the connection with the existing raw water pipe for Chiang Mai Water Treatment Plant No. 1. Construction for 400 mm DCIP pipe shall be from its connection to the raw water pump delivery pipe to the entrance of the planned water treatment plant. All equipment shall be installed as necessary or desirable for the effective functioning of the mains.

c) Matters Concerning the Construction

1) Plans for the future include laying a third additional main from

the raw water intake to the Super Highway, in addition to the two lines designed for this present construction project. Therefore, the two pipelines shall be laid as closely together as possible, taking precautions for easy installation of the third pipeline in the future.

2) Excavation for both pipelines shall be done at the same time. A connecting pipe shall be provided at one spot, equipped with a valve to close the connection.

3) The pipelines cross the Super Highway at two locations. Work shall be done with due care, in accordance with the design drawings for the road crossing. Detailed drawings of the work shall be submitted to the Engineer in advance, and his approval obtained before beginning work.

4) The schedule for making connections with existing raw water main shall be determined by consulting the Engineer. All connections shall be done after checking diameter and type of the pipe to make absolutely certain there are no mistakes.

2-3 Existing Water Treatment Plant

2-3-1 Receiving Well for Water Treatment Plant No. 1

a) Construction of the Well

1) Structure and Scale

Type: Reinforced concrete

Inner dimensions: D = 5.0 m

H = 6.8 m

(Inflow well, He = 6.0 m, 1 well

Outflow well, He = 5.65 m, 2 wells)

Capacity (inflow well): 39 m^3

Number of wells: 1

2) Scope of Construction

i) Piping near or at the well shall be part of the construction, as detailed in 2-3-1-b Work for Piping around the Well.

ii) Concrete reinforcements and metal supports for the piping included as part of this construction shall also be part of this work.

3) Matters Concerning the Construction

i) Foundation shall be concrete piles, Type-B 300$^{\phi}$, and 10.0 m long. There shall be 13 piles. Work shall be preceded by driving test piles to confirm that the piles are adequately strong to bear the load of the construction resting on them.

ii) As shown in the drawings, stairs shall be installed with a foundation of two wooden piles, with a diameter of 100 mm, and a length of 3.0 m.

iii) As shown in the drawings, the stairs shall have installed a hand rail of 1 1/4" diameter GS pipe.

iv) Steps of 19 mm diameter round bar shall be installed to enable descent into the receiving well.

v) Waterproof mortar shall be applied to the inside of the well, and ordinary mortar applied to the outside walls. Details shall be as shown in the drawings.

vi) Mortar finish for the surface of the overflow notch shall be done carefully and smoothly.

b) Work for Piping Around the Well

1) Scale

Inlet Pipe	ACP (class 20)	D. 300 mm	L. 26.5 m
	Ductile cast iron pipe	D. 300 mm	L. 4.0 m
	Cut-off valve	D. 300 mm	one place
Outlet Pipe			
For No. 1:	ACP (class 15)	D. 300 mm	L. 23.0 m
	Ductile cast iron pipe	D. 300 mm	L. 3.7 m
	Cut-off valve	D. 300 mm	one place
For No. 2:	ACP (class 15)	D. 200 mm	L. 71.0 m
	Ductile cast iron pipe	D. 200 mm	L. 3.5 m
	Cut-off valve	D. 200 mm	one place
Drain and Overflow Pipe			
	ACP (class 15)	D. 200 mm	L. 73.0 m
	Ductile cast iron pipe	D. 200 mm	L. 12.4 m
	Cut-off valve	D. 200 mm	one place

2) Scope of Construction

i) Inlet Pipe

(a) For the No. 1 sedimentation facilities

The existing raw water main (ACP, D. 300 mm) shall be utilized for the receiving well inlet pipe. The location of the direct connection from the raw water main shall be as shown in the drawings.

(b) For the No. 2 sedimentation facilities

The existing raw water main (GSP, D. 150 mm) shall be also utilized as the No. 2 sedimentation inlet pipe. Location of the direct connection to the raw water main shall be as shown in the drawings.

ii) Outlet Pipe

(a) For the No. 1 sedimentation facilities

The existing raw water main (ACP, D. 300 mm) shall be also

utilized as the No. 1 sedimentation outlet pipe. Location of the direct connection to the raw water main shall be as shown in the drawings.

iii) Drain and Overflow Pipe

Existing drainage facilities shall be used as the point of disposal for the drain pipe. Drain piping shall be installed to a nearby drain pit.

3) Matters Concerning the Construction

i) All connections with existing mains shall be done only after confirming that the mains are undoubtedly those shown on the drawings by checking location laid, pipe diameter and type.

ii) Connections to existing mains must be done while water supply is stopped. Therefore, the work must be done both quickly and accurately.

iii) Connections with the existing raw water main (GSP 150 mm dia.) shall use sleeve joints.

iv) At points where the pipeline crosses the existing main, the Contractor shall check the location and depth of the existing pipeline, so that there is no interference.

v) Concrete protection shall be provided for the 90^{o} bent pipe sections and 45^{o} bends in the 300 mm diameter receiving well inlet pipe. Dimensions shall be as shown in the "Specimen Drawings for Pipe Protection."

vi) Valve boxes shall be Type-B cast iron, with dimensions as shown in "Piping in the Plant Area Detail Drawing."

vii) The upward projection of the overflow pipe shall be well fastened down with supporting metal fittings.

viii) Sections of structures through which pipes pass shall have steel reinforcement. Pipe shall be installed in its proper location before pouring concrete, and shall receive inspection by the Engineer.

2-4 Proposed Water Treatment Plant

2-4-1 Site Preparation

a) Scale

The scale and kinds of work included in site preparation shall be as follows:

1) Banking or civil work at the site

2) Construction of entrance gates

Type A (with Illumination)	2 places
Type B	2 places

3) Construction of fence for plant site

i) Silaraeng fence, H. 2000 m, (with wooden nameplate, 1200 (B) x 5400 (L) x 40 (t) mm, including illuminator)	L = 97.0 m
ii) Barbed wire fence, H. 1450 mm	L = 475.0 m
iii) Wooden fence, H. 800 mm	L = 280.0 m

4) Work for flag pole — one item

5) Work for paving of site

i) Asphalt pavement, 250 mm thick, with concrete curb,	A = 6.905 m^2
100 mm (B) x 200 mm (H)	L = 1.435 m
ii) Concrete pavement, 200 mm thick	A = 29.8 m^2

6) Work for drainage in plant site

i) Asbestos-cement drain pipe 150 (Dia.) x 3000 (Length) mm	
ii) Catch basin, 300 (B) x 250 (L) x 500 (H) mm	65 places

7) Planting and trimming shrubs — 1 set

8) Sodding work — A = 14700 m^2

9) Laying concrete slabs (around the lagoon)

b) Scope of Construction

1) Filling and Banking for Plant Site

Before beginning construction on the plant site, the ground level of the site north of the 1st Stage construction, the eastern, western and southern areas, and the road lending in from the highway – all these areas must be filled and raised to +306.0 m in height. The details shall be as shown in drawings. The ground shall not be filled for the areas occupied by the receiving well, chemical sedimentation basin, rapid sand filter, clear water reservoir, office, generator house, chemical dosing house, elevated tank, warehouse, and lodging house, but only necessary ground preparation shall be done for each construction.

2) Construction of Entrance Gates

The work shall be comprised of two Type-A front gates, and two gates for facilities within the plant sites.

Installing electric lines to the entrance gate lights shall be a separate construction job, included in the work for facilities for the electric meters.

3) Work for the Fencing for the Plant Site

There shall be constructed a sllaraeng fence along the side of the plant site with the main entrance, with a wooden name plate installed midway along the fence. Electric lines to the lighting shall be included in a separate construction job for electric meters. The rest of the plant site shall be enclosed by a barbed wire fence as shown in the drawings. Where other fences border the property, none shall be erected for the treatment plant. Water treatment facilities and operational facilities within the plant site shall be set off by their own wooden fences.

4) Work for the Flag Pole

A flag pole shall be erected in front of the office.

5) Paving Inside the Plant Site

Roads marked off by concrete curbing and auxiliary roads shall

have asphalt pavement, to the extent shown in the drawings.

The approach to the lodge, and auxiliary roads shall have concrete paving on both sides of the asphalt pavement.

6) Work for Drainage in the Plant Site

Drainage work shall be done for the asphalt pavement including installing catch basins and asbestos-cement drain pipe. Extent and details of work shall be as shown in the drawings.

7) Planting and Trimming Shrubs

Planting and trimming shrubs shall be done for the 1st Stage construction.

8) Sodding Work

This shall be done for all areas except the various buildings and roads of the 1st Stage.

9) Laying Concrete Slabs

The laying of pre-cast reinforced concrete slabs around the lagoon shall be done as part of the work herein described.

c) Matters Concerning the Construction

1) Work of Embanking and Filling the Plant Site

Sand from the Ping River shall be used to fill and embank the plant site to an elevation of +305.7 m. For embanking and filling beyond +305.7 m. up to +306.0 m., surplus earth from excavation for the lagoon and various structures shall be used. The place for gathering the earth to be brought to the site shall be designated by the Engineer.

2) Work for Entrance Gates

i) The gate shall be made of light weight steel (JIS J 3350 or equivalent), of square steel pipe (JIS J 3466 or equivalent), of round bar (SS 41 or equivalent) and of steel plate (SPHC or equivalent). Finish shall be one coat of anti-rust compound (JIS K 5621 or equivalent) and two coats of oil paint (JIS K 5515 or equivalent).

ii) The post for Gate A shall be built of sitaraeng of specified dimensions, equipped with a bronze name plate (150 x 600 x 20 mm

thick) and with lighting.

3) Work for Fencing the Plant Site

i) As shown in the drawings, the fence for the front side of the plant site shall be silaraeng stonework and wire net. Fence posts shall be of pre-stressed concrete of domestic Thai manufacture. The net shall be of vinyl-covered wire.

ii) The section of the fence for the front or entrance side of the treatment plant which bears the wooden name plate shall be reinforced concrete. The name plate shall be supported by bolts, and lighting shall be provided as shown in the drawings.

iii) Barbed-wire fence shall be built with No. 14 galvanized barb wire 2 mm in diameter and with prestressed concrete fence posts 2.100 m in height, made domestically in Thailand.

iv) The wooden fence shall be painted with three coats of oil paint (JIS K 5506 or equivalent).

4) Work for the Flag Pole

i) The flag poles shall be built of three prestressed concrete power poles produced domestically in Thailand (top 120 x 120 mm, bottom 200 x 200 mm, height 8000 mm). Metal fittings for the flag shall be provided at the top and middle of the pole.

ii) The approach to the flag pole shall be laid with brick made in Thailand.'

5) Work for Paving Within the Plant Site

i) Asphalt Pavement

The lower foundation shall be mixed gravel with a thickness of 15 cm. The upper foundation shall be two layers, each 10 cm. thick of crushed rock macadam laid with pressure. The surface layer shall be 3 cm thick permeating asphalt emulsion paving. There shall be about a 2% gradient from the center of the road toward the curb on either shoulder of the road to facilitate drainage of rain water.

ii) Concrete Curb

The standard weight formula of concrete formed into curb at the plant site shall be cement, sand, and gravel in the ratio of 1 : 3 : 6. The gutter shall be done before the road foundations and the work of paving.

iii) Concrete Pavement

The road foundation shall be mixed gravel, 10 cm thick. The concrete paving for the surface shall be 10 cm thick, and the standard mixture by weight of cement, sand, and gravel shall be in ratio of 1 : 3 : 6.

6) Work for Drainage in the Plant Site

i) This work includes providing catch basins and drain pipe for drainage water from the asphalt pavement. The catch basins shall be formed at the site using concrete made with a standard mixture by weight of cement, sand, and gravel in the ratio of 1 : 3 : 6.

The drain pipe shall be asbestos-cement drain pipe, Class-A, 150 mm in diameter and 3000 mm long per piece, and single socket. Laying shall be done at a constant gradient starting from the down-stream side, with at least a 30 cm covering of earth.

7) Planting and Trimming Shrubs

i) Trees and shrubs shall be vigorous and sound, without disease. They shall have been dug up with numerous fine roots so as to be able to survive the transplanting. The Contractor shall obtain the approval of the Engineer as to variety and quality when selecting trees and shrubs.

ii) Supporting posts shall be charred with fire or painted with creosote. Tieing wire shall be galvanized wire, 4 mm in diameter or the equivalent. Trees and supporting posts shall be bound together with hemp rope.

iii) Before landscaping, the surface soil shall be turned, and rocks and other debris removed. Soil added must be well mixed in and must be devoid of harmful objects such as rocks or gross and tree

roots, and suitable for landscape gardening. After the transplanting is finished, it shall be watered for a suitable period of time and trees and shrubs shall not be allowed to wither and die.

8) Sodding

i) Thailand-produced sod approved by the Engineer shall be used.

ii) In order that rocks and roots of weeds should not be contained in the sod, it shall be dug up and cut to approved dimensions with not less than 3 cm of dirt adhering to the roots.

iii) Sod shall be transplanted within three days after it has been removed from its original location. When unavoidable, it may be stored, taking appropriate precautions until the transplanting, providing the Engineer inspects it before transplanting.

iv) Before sodding, fertile soil shall be spread to a depth of about 10 cm. This soil shall be appropriate for landscaping, without debris such as tree and grass roots or fragments of brick or rock. After transplanting, it shall be tamped down well and fastened down with wood skewers. Also, humus shall be spread thinly on top of the sod.

9) Precast reinforced concrete slabs (500 x 600 x 50 mm) shall be laid around the lagoon as indicated on the drawings covering an area in width 4 m on the south side and 2 m to the east, west and north sides.

2-4-2 Receiving Well

a) Structure and Scale

Material: Reinforced concrete

Inner Dimensions: D. = 6.5 m, H = 6.1 m, He = 5.5 m
Outflow channel shall have an outer diameter of 9.1 m, inner diameter of 7.1 m, height of 2.1 m and He of 1.0 m.

Capacity: 53.7 m^3/basin

Number: one (1) basin

b) Scope of Construction

1) Installation of 350 mm dia. and 100 mm dia. drain pipes around structures and their pipe supports shall be excluded from the construction here detailed. This work shall be included with work for "Piping in the Plant Area" and for "Drainage System in the Plant Area."

2) But, concrete protection for the drain pipes mentioned above around the building structures shall be included in the work herein detailed.

c) Matters Concerning the Construction

1) As shown in the drawings, sand displacement shall be laid 1.40 m thick, from a level of +304.00 m to +305.40 m, before commencing foundation work. A wood retaining fence shall be built adequate to prevent this sand from sliding or moving.

2) After completing the sand layer, pile driving shall be done, consisting of 25 concrete piles, Type B, 300 mm square shape, and 10.0 m long. Before driving the piles, test piles shall be driven and tested to ensure that the piling is adequately strong to bear its load.

3) As shown in the drawings, a concrete stair shall be installed. Two wooden piles, dia. 100 mm, l. 3000 mm, shall serve as the stairs foundation.

4) As shown in the drawings, a 1 1/4" diameter GS pipe handrail shall be installed for the stairs and top of the receiving well.

5) Steps made of 19 mm diameter round bar shall be installed so that one may descend into the receiving well and its outflow channel.

6) The inner surface of the well shall be coated with waterproofing mortar, while the outer walls shall be coated with ordinary mortar. Details of this work shall be as shown in the drawings.

7) Mortar finish for the overflow notch shall be done so the surface is flat and smooth.

2-4-3 Chemical Sedimentation Basin

a) Construction at the Basin

1) Reinforced Concrete Structure and Dimensions

i) Flush Mixing Basin

Inner Dimensions: 1.90 (B) x 1.90 (L) x 3.8 m (H)

(He = 2.10 m)

Number: 2 basins

ii) Flocculation Basin

Inner Dimensions: 4.6 (B) x 9.3 (L) x 2.80 (H) m

(He = 2.40 m)

Number: 4 basins

iii) Sedimentation Basin

Inner Dimensions: 9.1 (B) x 37.10 (L) x 5.0 (H) m

(He = 4.50 m)

Number: 2 basins

2) Scope of Construction

i) Work for the inlet pipe, 400 mm dia., and for the outlet pipe, 500 mm dia., shall be included in the work for connecting mains at the plant site. The flush mixing basin drain pipe, 150 mm dia., shall be included in construction for drain pipes at the plant site.

ii) Work for the flush mixer, flocculator, flight conveyor, trough, sludge pump, sludge pipe, and lighting facilities for the sludge pump room shall all be part of the work for the machinery and equipment for the proposed water treatment plant.

iii) As shown in the drawings, the passage way shall be built to a point 1.5 m from the building structure.

3) Matters Concerning the Construction

i) For the foundation, surface soil shall be cut away to a level of +304.0 m, and replaced with sand to a height of 305.5 m. After rendering the sand layer firm and solid by wetting down with water, and using a roller, the piles shall be driven. Afterward, sand shall be filled in to the specified height. Also, before driving the piling,

test piles shall be driven and tested to ensure that the piles will have adequate strength to bear their load.

ii) When replacing or filling with sand, wood sheet piles shall be driven around the locations planned for building foundations at a distance 1.5 meters outside the lines of the foundations, in order to prevent shifting of the sand. The sludge pit will be lower than other construction; therefore, wood sheet piles shall be driven in around the boundaries as above, to ensure that crumbling or shifting of the sand layer does not endanger the construction.

iii) Holes of the baffle wall shall be accurately located at the specified places. Mortar sticking in the holes must be cleaned out carefully. Frame molding for the holes shall use 150 mm dia. ACP (asbestos-cement pipe). The pipe shall be cut to the specified length and tightly attached, so that it does not shift during the placing of the concrete.

iv) Hand rails shall be 1 1/4" GS pipe, with coating. Hand rails shall not be installed on the side of the sand filters. Hand railing for the side of the area for future expansion shall extend as far as the baffle wall on the downstream side.

v) A concrete stair to descend into the sedimentation basin shall be provided on the flush mixing basin side. A 1 1/4" GSP hand rail shall be installed.

vi) Steps of 19 mm diameter round bar shall be installed for descent into the flush mixing basin, flocculation basin, and sedimentation basin.

vii) Concrete steps shall be installed to descend into the pump room.

viii) Finish for the top edge of the submerged overflow wall at the outflow section of the flush mixing basin shall be level, flat, and smooth.

ix) The inner surface of the basin shall be coated with waterproofing mortar. The outside walls shall be coated with ordinary mortar. Details shall be as shown on the drawings.

x) The base of the flocculation basin shall have a slope provided as specified, using cement mortar, in order to facilitate drainage.

xi) A drain pit shall be built in one corner of the sludge pump room, as shown on the drawings.

xii) Grating shall be provided for three places in the outflow channel of the sedimentation basin, and for the flocculation basin, where there are installed steps. Total installations shall be in four places.

xiii) Water-stops, 300 mm in breadth, shall be installed to nullify expansion and contraction of concrete. Work shall be as shown in the drawings.

2-4-4 Chemical Sedimentation Basin Mechanical Works

Raw water shall be sent from the receiving well to the flush mixing basin, where it is treated by adding a precipitating compound and by flush mixing, then sent on to the flocculation basin. So that the floc may mature, the water is treated in the flocculator by flocculation, then is sent to the sedimentation basin. After separating out the floc, the clear water is taken out from the trough in the outflow area of the sedimentation basin. The floc from sedimentation shall be gathered into a sludge pit by sludge scrapers, and sent to a concrete open channel, by means of the sludge pump. The flush mixer, flocculator, and sludge scraper shall be operated manually from the operational board near at hand. The sludge pump shall be operable both manually from the operation board, and by a central timer control.

a) Itemization of Machinery

The specifications for the various machinery shall be as listed hereafter, but especial care shall be taken that materials used for moving parts or for parts subject to friction shall be adequately resistant to friction and corrosion. Care shall be exercised that the machinery will operate smoothly for long uninterrupted periods of time. Under water parts especially shall be coated with anti-rust compound, so that they function with fully adequate efficiency.

1) Flush Mixing Agitator

Method of Operation:	Manually turned on and off. Blades shall revolve at a fixed speed.
Quantity:	2 sets
Type:	Vertical-Type Mixing Agitator
Mixer Unit:	Rotor Impeller with Shaft and Coupling
Drive Unit:	Electric Motor with Speed Reducer (0.75 KW, 380 V, 4 P, 50 Hz)
Revolutions:	51.4 RPM
Attachments:	Walkway with Hand Rail Walkway 0.9 m x 3.2 m (steel structure) Hand rail 1 1/4" GSP

2) Flocculation Agitator

Method of Operation:	Manually turned on and off. Blades shall revolve at variable speed. Power shall be transmitted to an agitator with a speed reducer, using a V-belt and a V-pulley.
Quantity:	2 sets/Basin x 4 Units = 8 Sets
Type:	Vertical-Type Mixing Agitator
Mixer Unit:	Rotor Impeller with Shaft, Coupling and Speed Reducer
Drive Unit:	Electric Motor with Transmitter (0.75 KW, 380 V, 4 P, 50 Hz)
Revolutions:	3.14 rpm ~ 10.3 rpm
Attachments:	Walkway with Hand Rail Walkway 0.9 m x 5.0 m (steel structure) Hand Rail 1 1/4" GSP

3) Flight Conveyor (Sludge Scraper)

Method of Operation: Manually turned on and off. Speed of chain shall be variable.

Sludge Scraping Capacity: 0.264 m^3/Hr. per lane (Assuming 0.2 m/min)

Type:	Double Chain Conveyor
Unit:	2 lanes per set x 2 sets = 4 lanes
Flight Conveyor Dimension:	
	3400 mm (W) x 150 m (H) x 70 mm (t) x 3.48 m (Pitch)
	(Wood scraper treated with creosote)
Chain Speed:	0.2 m/min ~ 0.4 m/min
Drive Unit:	Electric Motor with Transmission x 2 sets (0.75 KW, 380 V, 4 P, 50 Hz, Torque 1000 kg-M)
Attachments:	Motor-Cover, and miscellaneous necessary items

Provision against Overload: Shear Pins shall be installed.

4) Trough

FRP	t = 6 mm
Dimensions:	250 mm (B) x 3400 mm (L) x 400 mm (H) x 12 items
Metal fittings:	SUS-27, 12 sets

5) Sludge Pump

i) Sludge Pump

Method of Operation:	Manually turned on and off. Also shall be operable by timer.
Type:	Horizontal axis double suction volute pump
Specifications:	200 mm (Dia.) x 3.5 (q) m^3/min x 5 m (H) x 860 rpm x 15 KW
Number:	2 pumps (including one stand-by)
Attachments:	Pressure meter, standard attachments

ii) Auxiliary Piping

Pipe:	Ductile cast iron	Dia. 150 mm, L = 12.2 m
		Dia. 200 mm, L = 33.5 m
Valves:	Sluice valve	Dia. 150 mm, 8 places
		Dia. 200 mm, 4 places

Check valve Dia. 200 mm, 2 places

Attachments: Metal straps for pipe 1 set

b) Scope of Construction

1) The work shall include the making of the flush mixing agitator, the walkways, and the attendant work of installation.

2) The making and installation of the flocculation agitator and its walkway shall be included.

3) The making and installation of the sludge collector shall be included.

4) The making and installation of the trough shall be included.

5) The making and installation of the sludge pump, and the laying of its mains shall be included.

6) The electric work and facilities for the flush mixing agitator, the flocculation agitator, sludge collector, and the sludge pump shall be part of a separate work, and shall be included in the construction of electric metering equipment and facilities.

7) The concrete foundations for the sludge pumps shall be included in the civil work for the construction here detailed.

c) Matters Concerning the Construction

1) Manufacturing at Factories

i) The construction work shall be as shown in the drawings and in the specifications herein, and shall be carefully executed in compliance with all applicable standards, codes, and regulations. Matters not clearly explained in these specifications shall be done after consulting the Engineer, and under his instructions.

ii) Workmen engaged in the manufacture or fabrication shall be experienced and skilled at the work to which they are assigned. Particularly, welders shall possess those qualifications most suitable to the type of welding required, as per the standards set forth in JIS Z 3801 or its equivalent (Examination Methods for Qualifying Skilled Welders and Grading Standards).

iii) Surfaces which move or are subject to contact shall be finished accurately and carefully, and shall fit together satisfactorily.

iv) Steel materials shall have any deformation or warping straightened out so as not to impair the quality of the material. The hammer must not be used to correct bent edges, warping or discrepancies.

v) Gears of power equipment shall all be machine cut, heat treated when necessary, with high resistance to abrasion, and adequately strong to stand the required loads.

vi) Cast items shall be of high quality. Essential parts shall be specially tested for by flaws or blowholes in the casting. Only those items which pass the test shall be used.

vii) When, during assembly, deformation or other objectionable defects are discovered, such defects shall be speedily corrected or the item replaced.

2) Painting

i) Before painting, the Contractor shall submit a plan for painting to the Engineer, and obtain his approval.

ii) Painting, as a basic practice, shall have the foundation prepared (cleaning) and one undercoat applied at the factory. The middle coat, and upper finishing coats (1 each) shall be done at the construction site.

iii) Parts to be finished shall have anti-rust oil applied and, as a general rule, shall not be painted.

iv) Specification for Various Finishes

(a) Rapid mixing agitator, flocculation agitator and sludge scraper

Under water portions

Primer coating: Tar Epoxy coating, single coating

Top coating: Tar Epoxy coating, single coating

Above water portions

Primer coating: Zinc chromate anti-rust compound, JIS K 5627 or equivalent

Middle and top coating: Butyl-acetate synthetic paint, JIS-K-5572 or equivalent

(b) Sludge pump equipment

Pipe valves: Coating shall be JWWA-G-105 or JWWA-G-106, or equivalent

Sludge pump: As a general principle, painting shall not be done at the construction site.

(c) Electric Metering Items:

As a general principle, painting shall not be done at the construction site.

3) Installation of Machinery

i) Equipment for Interior Installation

(a) Adequate care shall be exercised that no damage is done to buildings or civil structures during the work of installing the various categories of machinery. When it is necessary to tear down civil work or structure, the work shall be done with the approval of the Engineer, and restored to original condition. Special care shall be taken to insure against any leakage underwater.

(b) Before installing the various machinery, the Contractor shall submit installation foundation drawings. Under the supervision and with the approval of the Engineer, the Contractor shall install good quality liners, etc. on the foundation top, and shall accurately align the equipment and install it.

(c) The work herein detailed shall include only the installation of the various machinery. Electrical wiring and connections to the equipment shall be a separate work, included in the work for the electric metering equipment.

d) Inspection and Testing at the Construction Site

After completion of the construction herein detailed, the following listed inspection and tests shall be done, under the procedures stated in the foregoing section 1-4-1.

1) Test of capacity to treat water: 16000 m^3/day
2) Test of turbity of treated water: Less than 5 units
3) Motive power and operational tests:
   Flush mixing agitator
   Flocculation agitator
   Sludge scraper
   Sludge pump
4) Inspection of exterior appearance
5) Inspection of delivery mains and pipes
6) Inspection of electrical wiring
7) Inspection of painting, coatings, and finishes
8) Inspection for vibration
9) Other inspection or tests, required by applicable regulations
10) Inspection or tests ordered by the Engineer

2-4-5 Chemical Sedimentation Basin Lighting Works

a) Categories of Equipment

Type of Wiring:	Single phase triple line (the primary side shall be supplied separately from facilities for electric metering)		380 V/230 V
	Fluorescent lamps		230 V
	Outlets		230 V
Attachments:	Electric switchboard		one
	Fluorescent lamps, 40 W x 2 tubes (Method of turning on light shall be the rapid-start type)		26 places
	Outlets	3 P, 20 A	5 places
	Tumbler switch	1 P, 15 A	8 places
	Wiring and pipes as necessary		1 set

b) Scope of the Construction

The work herein detailed includes lights and outlets for the sludge pump room. Supply of electricity to the switchboard shall be part of the electric

meter facilities construction.

c) Matters Concerning the Construction

1) Lighting fixtures, outlets, as well as pipes and electric lines shall be included in the work herein detailed. Facilities to the terminal box shall be considered to be on the power source side of the switchboard.

2) The switchboard shall be made with the outer box of steel plate, and high quality finish. The frame shall be adequately strong. Doors shall be made of 2.3 mm to 3.2 mm thick steel, and other parts more than 1.6 mm, the whole strongly built. A card holder shall be installed inside in a place easy to see so that circuit numbers and function can be entered or written in. The construction shall be such that the whole box is easy to carry and easy to maintain. An attractive wood facing shall be used for the operating surface, with only the handles of the circuit-breaker exposed. In the lower part, there shall be installed a terminal for the neutral wire for each circuit. Construction shall be such that testing the cut-off of the circuits may be done easily and conveniently. Also there shall be built in the box a grounding terminal with an outer diameter of 8 mm or more, perfect both electrically and for the machinery.

3) Lighting fixtures shall be of good quality steel sheet with high quality finish (or of strong plastic) 0.6 mm or thicker, finished with a baked enamel coating of the specified color.

4) Outlets shall be of moisture-proof construction.

5) Fixtures shall be installed at heights as listed below.

Switch --- From the top of the bottom board: 1.2 m

Outlets --- From the top of the bottom board: 0.3 m

Switchboard --- From the top of the bottom board: 1.7 m (upper face)

6) Heavy lighting fixtures and lighting fixtures suspended from above shall be installed using fixture studs, hickeys, etc. to provide adequate strength for safe suspension.

7) Wiring shall use ethylene-propylene electric cable.

8) To facilitate maintenance, an appropriate joint box and pull box, etc. shall be installed.

d) Site Inspection and Testing

After completion of the construction here detailed, the following inspections and tests shall be conducted, in accordance with the procedures listed in the preceding Section 1-4-1.

1) Operating test

2) Inspection of outer appearance

3) Inspection of pipes and wiring

4) Inspection for vibration

5) Other inspections and tests, in accordance with applicable rules or regulation

6) Inspections and tests ordered by the Engineer

2-4-6 Clear Water Basin

a) Construction and Scale

Structure: Reinforced concrete

Inner dimensions: 4.8 m (B) x 19.8 m (L) x 2.0 m (He)

Capacity: 190 m^3/basin

Number: 2 basins

b) Scope of the Construction

The 400 mm dia. outlet pipe and the 200 mm dia. drain pipe for the clear water basin, which constitute piping around the structure, shall be excluded from this work. They shall be part of the work detailed in "Piping in the Plant Area" and "Drainage System in the Plant Area."

c) Matters Concerning the Construction

1) An inspection manhole shall be installed in the filter basin pipe gallery. Steps of 19 mm dia. round bar shall be installed within the basin to permit entering.

2) Air valves for the clear water basin shall be of steel pipe 300 mm in diameter. There shall be one per basin for each of the two basins,

as well as pipe supports. Details shall be as shown in the drawings.

3) The inner surface of the basin shall be coated with waterproof mortar, while the outer walls shall be coated with ordinary mortar.

2-4-7 Rapid Sand Filter

a) Basin Construction

1) Structure and Scale

Structure: Reinforced concrete

i) Rapid Sand Filter

Inner dimensions: 6.4 m x 5.0 m

Filter area: 32.0 m^2/chamber

Number: 6 chambers

The base of the filter basin shall be on the same foundation slab as the clear water basin, supported on pillars, standing above the bottom of the clear water basin.

ii) Pipe Gallery

Inner dimensions: 7.0 m (B) x 19.8 m (L) x 6.5 m (H)

Number: one place

2) Scale of Construction

i) The next work shall be the interior fittings of the rapid sand filter.

(a) Comprising the work of the interior fittings for the sand filters shall be the concrete supports and the metal fittings for the following - 500 mm dia. inlet main, 500 mm dia. back wash water main, 200 mm dia. clear water pipe, 150 mm dia. drain pipe, plus the 500 mm dia. drain pipe for back wash, the 250 mm dia. surface wash water main, and the 200 mm dia. overflow pipe.

(b) Surface washing equipment, trough

(c) Under drainage, filter media (sand and gravel)

ii) The drain pipe, 200 mm dia., from the drainage gallery shall be excluded from the work herein detailed. This shall be constructed as part of the work for drain pipes in the plant site.

iii) The concrete protection for the drain pipe described in the above clause (ii) shall be constructed as part of the work here described.

iv) The housing above the filter as well as its lighting equipment and the work for lighting equipment for the pipe gallery shall all be excluded from the work herein described. They shall be constructed as part of a separate work for the upper housing of the filter.

v) The passageway from the control center shall be excluded from the work herein described, and shall be built as part of the new construction for the chemical dosing house.

vi) The clear water basin under the filter basin shall not be included in the construction here detailed. Only work above the boundary set by the bottom of the filter basin shall be part of the work herein detailed.

3) Matters Concerning the Construction

i) The type of foundation shall be a concrete supported foundation. As shown in the drawings, 168 reinforced concrete piles, 300 mm square and 9.00 m in length shall be driven. Before pile driving, test piles shall be driven to ensure that the piling is of adequate strength to support its load.

ii) A concrete stairway shall be built for entrance to the pipe gallery at the west side of the filter basin. The stairs shall rest on 4 wooden piles, 100 mm in dia., and 3.0 m long.

iii) Concrete stairs shall be built to go down from the pipe gallery foundation slab. As shown in the drawings, a hand rail shall be installed of 1 1/4" dia. GS pipe.

iv) A walkway shall be installed 2.8 m from the bottom, inside the pipe gallery. Grating of steel plate and 1.62 meters in breadth shall be installed. Details of this grating shall be as shown in the drawings.

v) So that the sedimentation basin and the filter basin may be joined into one structure for ease of passage, a cantilever concrete slab shall be projected out from the top edge of the filter basin.

vi) For the drainage gallery, 200 mm dia. steel pipe shall be installed as air vents in 2 places for each of 2 chambers, totalling 4 places, along with their metal supports.

vii) The inner surface of the filter basin shall be coated with waterproof mortar, and the outer walls with ordinary mortar. Details shall be as shown in the drawings.

viii) A manhole for maintenance and checking shall be installed at the end of the drainage gallery. For entry, steps of 19 mm dia. round bar shall be installed. Also, to facilitate drainage, a 1.0% gradient shall be provided, using poor concrete.

ix) An opening covered with grating shall be provided in the slab of the pressure reduction valve for surface washing.

2-4-8 Interior Fittings for the Rapid Sand Filter

a) Scale and Details of the Equipment

1) Scale

The control of each basin of this facility depends on information provided by the flow controller, the filter resistance meter, the electrode-type water level indicator. The filter and the washing processes are all operated by manual control, so the operation of the valves of the various mains is done from the floor stand on the foundation slab of the pipe gallery. The adjustment of the filter flow volume is done by moving by hand the weight of the counter-weight type, 200 mm dia. flow controller. The scale and extent are as listed below.

Filter area: 6.4 m x 5.0 m = 32.0 m^2/chamber

Filter velocity: 100 m/day

Filter volume: 3200 m^3/day/chamber

No. of basins: 6 chambers (including 1 stand-by)

Water collection facility: Leopold-type under drain

Control of filter volume: The 200 mm dia. counter weight of the flow controller is set at a determined valve by hand.

Surface washing: Fixed-type washing equipment is used. Washing water is reduced to the specified pressure by divergence of the delivery pipe header.

Back washing: Wash water is used from an elevated tank, flowing by gravity.

2) Details of Interior Fittings

i) Delivery Pipe Facilities

Inlet pipe

Main: (Ductile cast iron pipe)	500 mm dia.	1 set
Branch: (Ductile cast iron pipe)	300 mm dia.	for 6 basins
Sluice valve: (Operation stand rod, 5.7 m long)		
	300 mm dia.	6 items

Back wash water pipe

Main: (Ductile cast iron pipe)	500 mm dia.	1 set
Branch: (Ductile cast iron pipe)	400 and 500 mm dia.	for 6 basins
Sluice valve (Operation stand rod, 4.8 m long)		
	500 mm dia.	6 items

Clear water pipe

Ductile cast iron pipe:	200 mm dia.	for 6 basins
Sluice valve: (Operation stand rod, 6.22 m long)		
	250 mm dia.	6 items
Flow controller: (Counterweight type)	200 mm dia.	for 6 basins

Waste water pipe

Ductile cast iron pipe:	150 mm dia.	for 6 basins
Sluice valve: (Operation stand rod, 6.22 m long)		
	150 mm dia.	6 items

Surface wash water pipe

Main: (Ductile cast iron pipe)	250 mm dia.	1 set
Branch: (Ductile cast iron pipe)	250 mm dia.	for 6 basins
Sluice valve: (Operation stand rod, 6.22 m long)		
	250 mm dia.	8 items

Pressure reducing valve: (Pressure reduction, 15 m)

(Secondary pressure, +327.0 m) 250 mm dia. 1 item

Strainer: Cast iron 250 mm dia. 1 item

Back wash drain pipe

Main: (Ductile cast iron pipe) 500 mm dia. 2 pipes

Branch: (Steel pipe) 500 mm dia. for 6 basins

Flat valve: (Control platform rod, 3.1 m long)

500 mm dia. 6 items

Over-flow pipe

Ductile cast iron pipe: 200 mm dia. for 6 basins

ii) Drainage Collection Equipment

Type: Perforated pipe

Main: Steel pipe 600 mm dia. x 6100 mm 6 pipes

Perforated pipe: PVC 80 mm dia. x 3100 mm 192 pipes

Metal attachments: for 6 basins

iii) Filter Media

(a) Sand: 6.4 m x 5.0 m x 0.6 m (t) for 6 basins

Standards for the filter sand shall equal or exceed the standard set for filter sand for waterworks given in "Methods of Testing Filter Sand for Waterworks Use" in Standard of the Japan Waterworks Association (JWWA-A-103). The standards of JWWA-A-103 for selecting filter sand for waterworks use are as follows:

(1) Sand shall be hard and uniform with a high content of quartz. Dirt, clay-like impurities, or flat, weak sand shall not be included in the sand.

(2) The uniformity coefficient shall be 1.70 or less.

(3) Washing turbidity shall be 30 degrees or less.

(4) Ignition loss shall not exceed 0.7%.

(5) Solubility in hydrochloric acid shall not exceed 3.5%.

(6) Specific gravity shall be between 2.55 and 2.65.

(7) Abrasion loss shall not exceed 3%.

(8) Maximum diameter shall not exceed 2.0 mm; minimum diameter shall not be less than 0.3 mm. Even in unavoidable circumstances, the % of sand exceeding the maximum or the minimum shall be 1% or less.

(b) Gravel: 6.4 m x 5.0 m x 0.5 (t) for 6 basins

(1) Sieve tests of filter gravel shall be 4 minutes for mechanical sifting and 8 minutes for hand sifting. The procedure shall equal or exceed the standards of the Japan Waterworks Association (JWWA-A-103) for methods of testing gravel.

(2) Filter gravel shall be close to globular, hard, clean and of uniform quality, and must be without dirt, and earthy or other impurities.

(3) Filter gravel shall have a minimum diameter of 2 mm and a maximum diameter of 20 mm, of four layers, each layer 50 mm thick. The total layer shall be 500 mm thick. The grain chambers for each layer are given starting with the lowest layer:

1st layer, from 12.7 mm dia. to 19.1 mm, 2nd layer, from 6.73 mm dia. to 12.7 mm, 3rd layer, 3.36 mm dia. to 6.73 mm, 4th layer, from 2.0 mm dia. to 3.36 mm.

iv) Surface Wash Equipment (Fixed type)

(a) Surface Washing Pipe

Main: (steel pipe) 150 mm dia. for 6 basins

Branch: (steel pipe) 50 mm dia.

Spray nozzle: 1" dia., 60 x 6 basins = 360 items

(b) Trough 4 x 6 basins = 24 total

Construction: FRP, t=8 mm

380 mm (B) x 5100 mm (L) x 400 mm (H)

Metal fittings (SUS 27)

b) Scope of Construction

1) The boundary defining the delivery mains for the filter basins are as set forth in the drawings. Jointing for the wash water drain pipe

shall be included in the work herein described. But, jointing for the inlet main, the backwash water main, and the surface wash water main shall be part of the work for connecting mains within the plant site.

2) Pipe for air vents for the drainage gallery and the clear water basin shall be part of the civil works construction for the rapid sand filter.

3) Concrete supporting platforms and supporting concrete shall be included in the work here described.

4) The filter resistance meter and work for the electrode-type water level indicator shall be a separate construction work, included in the work for electric metering equipment.

c) Matters Concerning the Construction

1) Pipe Facilities

i) Reinforcing steel shall be inserted in sections of structures through which pipes pass. Pipes shall be installed in their designated locations, and be inspected by the Engineer before placing the concrete.

ii) When it is not possible to install pipes before pouring the concrete, an opening shall be left adequate to insert the pipe.

iii) The opening shall be filled in with mortar so that it adheres well to both the installed pipe and the concrete, and so there is no possibility of water leakage.

iv) Pipes shall be provided with supports adequate to withstand unbalanced stresses due to water pressures.

2) Drainage Collection Equipment

i) Perforated pipe shall be installed at the designated locations, horizontally and at the same, unvarying height. The location of the perforations shall be kept accurate.

ii) Perforated pipe shall be fastened down firmly with metal supports so that there is no movement due to the pressure of backwashing water.

iii) Perforated pipe shall be cleaned before installation and provided with a temporary cover if construction is suspended or delayed during its installation.

iv) Perforations shall be cleaned after installation and cured with sheeting so that perforations will not become clogged.

3) Filter Media

i) Sand

(a) In consideration that sand will pack and shrink in volume, the sand shall be tamped down.

(b) Care shall be exercised that shock or excessive load is not placed on the surface washing equipment or on the lower water collection facilities during the tamping.

ii) Gravel

(a) So that the gravel layers shall not be uneven, gravel shall be spread evenly in careful succession of layers, from the first, lowest layer to the top.

(b) Care shall be exercised that shock or excessive load is not placed on the surface washing equipment or on the lower water collection facilities during the tamping.

4) Surface Washing Equipment (Fixed type)

i) This equipment shall be installed in the designated location, fastened firmly with metal supports so that there will not be vibration or shifting due to water pressures.

ii) The trough shall be installed correctly in its designated position, with the upper edge horizontal, and at the same unvarying height.

d) Inspection and Testing for the Plant Site

After completion of this construction work, the following inspection and tests shall be made, under procedures stated previously in article 1-4-1.

1) Test of treatment capacity for water: 3200 m^3/chamber

2) Test of quality of treated water (according to standards for water quality of the Waterworks Law of the Government of Thailand)

3) Test of filter resistance

4) Test of surface washing

5) Test of backwash

6) Inspection of exterior appearance

7) Inspection of painting finishes

8) Other inspections and tests, under pertinent rules and regulations

9) Inspections or tests ordered by the Engineer

2-4-9 Clear Water Reservoir and Distributing Pump Well

a) Structure and Capacity

1) Clear Water Reservoir

Structure: Reinforced concrete (Flat slab type)

Inner dimensions: B = 24.0 m, L = 48.0 m, H = 5.0 m

He (effective water depth) = 4.0 m

Capacity: 4610 m^3/chamber

No. of chambers: 1

Retention time: 6.9 hr.

2) Distributing Pump Well

Structure: Reinforced concrete

Inner dimensions: B = 8.0 m, L = 24.0 m, H = 6.1 m

He (effective water depth) = 4.0 m

Capacity: 770 m^3/chamber

No. of chambers: 1

Retention time: 1.15 hr.

b) Categories of Construction

1) Work for the following pipes shall be included in the construction herein described: 500 mm dia. inlet pipe for the clear water reservoir, 600 mm dia. inlet pipe for the distributing pump well, and piping around the structure for the future projected distributing pump well's 800 mm dia. inlet pipe. Also, piping below the sluice valve for the delivery side of the distributing pump and the boosting pump for the elevated backwash water tank. The following work shall be

excluded from the construction herein detailed, and done as part of the connective piping for facilities in the water treatment plant yard: the control valve floor stand and equipment, and connecting the sluice valve with the pump facilities.

2) The concrete protection for the delivery side of the distributing pump shall be done as part of the work for connective piping for facilities in the water treatment plant yard.

3) The baffle wall to prevent eddies and the foundation for the valve for the inlet pipe for the distributing pump well shall be included in the construction herein described.

4) Work for the delivery pump room shall be done as part of the delivery pump room construction. But, the metal cover for the manhole and the metal cover for the equipment transporting entrance shall be included in the construction herein described.

5) The ventilating tower for the clear water reservoir shall be included in the construction herein described.

6) Construction of pump facilities to the sluice valves shall be included in the construction herein described. Distributing board and the water level indicator (float-type) shall be included in construction for the electric meter equipment. But, the installation of the float casing pipe and the metal bracing shall be included in the construction herein described.

c) Matters Concerning the Construction

1) Before building foundations, sand displacement shall be laid for a depth of one meter between +299.90 m and +300.90 m as shown in the drawings. However, in event the gravel layer is not reachable by 1 m of sand displacement, work shall continue until the gravel layer is reached. Furthermore, in this case, banking with wooden sheeting shall be done to prevent the sand from shifting to adjacent areas.

2) As indicated in the drawings, a manhole to enable descent into the chambers shall be installed for both the clear water reservoir and distributing pump well. Also, 19 mm dia. round bars shall be install-

ed as steps into the wells.

3) An expansion joint shall be built into the bottom slab, and a sleeper foundation, 1.00 m (B) x 0.60 m (H), installed below the bottom slab, as indicated in the drawings.

4) At four places, vinyl pipe of 50 mm dia. shall be installed for air vents for the distributing pump well, and located in the upper part of the partition wall between the clear water reservoir and the distributing pump well, as shown in the drawings.

5) Vinyl pipes 50 mm in diameter shall be installed as drains at 6.00 m intervals in the parapet of the clear water reservoir.

6) A wooden louver ventilator with screen shall be installed for the ventilation hole in the ventilating tower of the clear water reservoir.

7) A pipe used to obtain stable conditions for measuring water level (ACP 400 mm dia.) for the float-type water level meter shall be installed in the location indicated in the drawings, and firmly fastened in two places by bracing metal.

8) Waterproof mortar shall be used to coat the inner walls of the chambers. The visible parts only of the outer walls shall be coated with plain mortar. Details are as shown in the drawings.

9) Turfing shall be done on the earth banking on top of the clear water reservoir.

10) Before beginning work, the various contractors for the various works involved in building the clear water reservoir and other facilities herein described shall hold mutual consultations as to the scope and the phasing of their construction. For instance, this shall be done for the civil or earth work, and the building construction work for the ventilating tower of the clean water reservoir. Also, another example shall be the various construction works for the pump facilities.

2-4-10 Distribution Pump Equipment

The distributing pump facilities shall be installed in the pump room, built above the distributing pump well. The plans for pump facilities provide that additional facilities be installed for each expansion stage, depending on the increase in capacity of the water works. The capacities in terms of volumes of water and the number of pumps to be installed are as follows:

Stage / Facility	1st Stage at Completion (Volume and Number)	2nd Stage at Completion (Volume and Number)	3rd Stage at Completion (Volume and Number)	Notes
Distribution Pump (I)	12000 m^3/day 8.4 m^3/min x 2 pumps	36000 m^3/day 8.4 m^3/min x 4 pumps	59050 m^3/day 8.4 m^3/min x 6 pumps	Including one stand-by
Distribution Pump (II)	12000 m^3/day 4.2 m^3/min x 2 pumps	12000 m^3/day 4.2 m^3/min x 2 pumps	12000 m^3/day 4.2 m^3/min x 2 pumps	

a) Specifications for Machinery (Pump Facilities)

1) Distributing Pumps (Stage I)

i) Operation System

Operation shall be by manual control, while reading the pressure gauge and flow gauge, at the pump site. Facilities shall also provide for being able to read the pressure gauge and flow gauge in the control room.

ii) Specifications of the Machinery

Type: Motor direct coupling vertical shaft mixed flow pump (water feeding type)

Bore of pump: 300 mm dia.

Discharge capacity: 8.4 m^3/min

Total head: 43 in

Revolutions: 1450 rpm

Power of electric motor: 100 KW (50 Hz, 380 V)

No. of pumps: 2 (incl. 1 stand-by)

iii) Accessories for distributing pumps (Stage I) (per pump)

Sluice valve (manual control): 1 each

Check valve: 1 each

Pressure and vacuum gauge: 1 each

Automatic air valve: 1 each

Suction strainer: 1 each

Flexible coupling: 1 set

Standard accessories: 1 set

Other necessary parts: 1 set

2) Distributing Pump (Stage II)

i) Operation System

Same as the distributing pumps for Stage I.

ii) Specifications of the Machinery

Type: Motor direct coupling vertical shaft mixed flow pump (water feeding type)

Bore of pump: 200 mm dia.

Discharge capacity: 4.2 m^3/min

Total head: 43 m

Revolutions: 1450 rpm

Power of electric motor: 55 KW

No. of pumps: 2

3) Middle Shaft Bearing Lubricating Water Pump

A middle shaft bearing lubricating water pump shall be installed in the pump room in accordance with the specifications below, for use with the distribution pumps and lift pumps.

i) Operation and Control System

This pump shall operate in unison, whenever the distribution pumps and lift pumps are operating.

ii) Specifications of the Machinery

Type: Underwater volute pump

Bore of pump: 40 mm dia.

Discharge capacity: 0.13 m^3/min

Total head: 25 m

Revolutions: 3000 rpm

Power of electric motor: 15 KW (50 Hz, 380 V)

No. of pumps: 2 (one stand-by)

iii) Accessories for the Lubricating Water Pump

Standard accessories: 1 set

Other necessary accessories: 1 set

4) Lift Pump

A lift pump to pump water to the elevated tank shall be installed in the pump room.

i) Operation and Control System

The pump shall start and stop automatically, according to the water level in the elevated tank. In addition, it shall be operable by manual control, referring to a water gauge. Gauge reading shall also be provided for in the control room.

ii) Specifications of the Machinery

Type: Motor direct coupling vertical centrifugal pump (external flushing)

Bore of pump: 125 mm

Discharge capacity: 2 m^3/min

Total head: 19 m

Revolutions: 1450 rpm

Power of electric motor: 15 KW (50 Hz, 380 V)

No. of pumps: 2 (incl. 1 stand-by)

iii) Accessories for the Lift Pumps (per pump)

Sluice valve (manual control): 1

Check valve: 1

Connecting meter: 1

90^0 bend pipe: 1 set

Flexible coupling: 1 set

Standard accessories: 1 set

Other necessary accessories: 1 set

5) Distributing Basin Drain Pump (Drain Pump No. 1)

i) Specifications of the Machinery

Type: Electric motor direct coupling underwater pump (portable)

Bore of pump: 100 mm dia.

Discharge capacity: 14 m^3/min

Total head: 10 m

Revolutions: 2950 rpm

Power of electric motor: 5.5 KW

No. of pumps: 1

ii) Accessories for Drain Pump

Hose coupling: 1 set

Rubber insulated cable for motor: 20 m

Magnetic switch with motor protecting device: 1

Hose: 1 set

Standard accessories: 1 set

Other necessary accessories: 1 set

b) Scope of the Construction

1) Installation of the distributing pumps shall be part of this construction.

2) Installation of the middle shaft bearing lubricating water pump shall be part of this construction.

3) Installation of the lift pump shall be part of this construction herein described.

4) The pump concrete foundation and bolt holes shall be done as part of the pump well construction.

5) The hoist work shall be done as part of the building construction.

6) Repair or finishing of walls where pierced by the outlet pipe shall be part of this construction.

7) Piping for the distributing pumps and the lift pump, as far as the sluice valve, shall be part of this construction. The jointing shall be done as part of the connection piping work for the plant yard.

8) Piping work for supplying lubricating water shall all be done as a

part of this construction herein described.

9) Pipe protection concrete work shall be done as part of the piping work for the plant yard.

10) The various electric lines shall be installed as part of the electric work.

11) The eddy preventative baffle wall shall be done as part of the pump well work.

c) Matters Concerning the Construction

1) Pump facilities shall be done in compliance with the provisions previously stated in section 2-1-4 (Raw Water Pump Equipment).

2) Arrangement of the pump facilities shall be as indicated in the drawings.

3) During the actual work, all the related contractors for civil or earth works, for building construction, etc. shall all consult together adequately to ensure smooth progress of the various works.

2-4-11 Aluminium Sulphate Feeder Equipment

a) Scale and Facilities

1) Scale

Coagulant: Solid alum, JIS K 1450 or equivalent, used as a 5% solution of Al_2O_3.

Feeding system: Manual stroke control feeding pump

Quantity of treated water: 16000 m^3/day (1st Stage)

Feeding ratio:	Min.,	7.5 ppm
$(Al_2(SO_4)_3 \cdot 18H_2O)$	Mean,	42 ppm
	Max.,	72 ppm
Quantity of feed:	Min.,	0.216 liter/min.
(5% solution Al_2O_3)	Mean,	1.21 liter/min.
	Max.,	2.1 liter/min.

(flow volume ratio Min. : Max. = 1 : 10)

Service water: Branched from 100 mm dia. service pipe in the plant area.

2) Kind of Facilities

All equipment shall be chemical proof.

i) Solution Tank

Type: Inner dimensions 1.3 m x 1.3 m x 1.5 m height (effective water height = 1.03 m)

Quality: SS 41 or equivalent (finished with 3 coats of tar-epoxy rasin paint), 6 mm thick.

Capacity: 1745 liter/tank (daily average injection volume)

Number: 2 tanks

Accessories: Agitator, stand, elevated steps (2 in one place), level gauge (with protecting pipe), anchor bolts, inlet, outlet, drain, inlet of return pipe, solid alum holder

ii) Agitator

Quality: SUS-32 or equivalent

Number: 2

Power output: 0.75 KW

iii) Injection Pump

Type: Plunger pump

Quality: SUS-32 or equivalent

Specifications: 2.1 liter/min. x 20 m (H) x 0.75 KW

Number: 2 pumps (incl. 1 stand-by)

Accessories: Vacuum gauge, pressure gauge, and standard accessories

Flow range: 1 : 10 (0.21 liter/min. ~ 2.1 liter/min.)

iv) Other Piping

Type of pipe: PVC D-Plast pressure pipe (TIS) Type 5

Valves

Angle seat valve: Polyvinyl chloride resin

Diaphragm valve: Vinyl chloride

Relief valve: SUS 32, or equivalent

Strainer (Type Y): SUS 32, or equivalent

v) Other Necessary Items

b) Scope of Construction

1) Making and installation of the solution tank are part of the construction herein described.

2) Making and installation of the agitator are part of the construction herein described.

3) Making and installation of the injection pump are part of the construction herein described.

4) Piping work for the sampling pump (branch piping from the 400 mm dia. raw water main) shall be part of the construction herein described. But the work for the sampling pump itself shall be included in work for the electric metering facilities.

5) Tap water service piping (branch piping from the 100 mm dia. supply pipe for the plant site) shall be part of the construction herein described.

6) Piping for alum feeding shall be part of the construction herein described.

7) Laying of drain pipe to the joining point for the alum drain pipe shall be part of the construction herein described. The connections, however, shall be part of the installation work for the lime soda feeder equipment work.

8) The foundations for the various machinery as well as the interior piping pits, and its covers shall be separate work, included in the construction of the chemical dosing house.

c) Matters Concerning the Construction

1) Manufacture at the Factory

i) The work for this construction shall be done carefully, in accordance with the specifications and drawings, and so as to comply with all applicable standards, laws and ordinances. The Engineer shall be consulted and his instructions followed where instructions in the specifications are not clear.

ii) Workmen experienced and skilled in their particular jobs shall be used for all the processes of the manufacturing. Particularly, welders shall be selected so they are best fitted for the particular type of welding used, on the basis of JIS Z 3801 (Standard Qualification Procedure for Welding Technique), or the equivalent.

iii) Sliding and contacting surfaces shall be carefully finished, and fitted tightly.

iv) Steel materials shall be straightened perfectly by methods not harmful to their quality. Burrs, deformations, or staggering must not be pounded out by hammer.

v) Running gears shall all be machine cut, and tempered when necessary. They shall be highly resistant to abrasion, and of adequate strength.

vi) Castings shall be of good quality, inspected for honey-comb cracks in important places, must pass all inspections, and be without defect.

vii) When deformation, or strains or other undesirable defects are discovered in parts during assembly, such parts shall immediately be repaired or replaced.

2) Painting

i) Before painting, the Contractor shall make a schedule or plan for the work, submit it to the Engineer, and obtain his approval.

ii) As a basic rule, painting shall include a backing treatment, and a prime coating done at the factory, and the second coating and finish coatings done at the construction site.

iii) Parts to be finished shall, as a basic rule, be coated with anti-rust oil, but shall not be painted.

iv) Specifications for the various painting

(a) Machinery

Primary coat: tar-epoxy resin painting

Second and finish coats: epoxy-resin painting (color as specified by Engineer)

(b) Electric instrumentation

As a basic rule, painting shall not be done at the work site.

(c) Electric conduit pipe

Specifications shall be given separately, elsewhere.

3) Installation of Facilities

i) Kinds of Facilities

(a) Adequate care shall be exercised not to damage buildings, or earth works while installing machinery or related facilities. When necessary to tear down structures, the Engineer's prior approval shall be obtained, and the structure carefully rebuilt afterward.

(b) Prior to installing the various machinery and facilities, the Contractors shall submit installation plan drawings to the Engineer, and shall obtain his approval. The Contractor shall install good quality liners, etc. on the bases, and shall carefully center the equipment and make the installation.

(c) Before installing piping, the pipe shall be carefully cleaned so dirt does not remain inside. Appropriate cocks, nipples, and union joints shall be used for ease in overhauling, inspection, and maintenance. At required places, the pipe shall be firmly supported by metal braces.

d) Field Inspection and Examination

After completion of the construction herein described, the following inspections and tests shall be done, in accordance with section 1-4-1.

1) Dosing test
2) Operation test (manual)
3) Visual inspection
4) Inspection of piping
5) Inspection of electric wiring
6) Inspection of painting and coating
7) Instrumentation, relay, and unit body tests

8) Other inspections or examinations required by applicable regulations or standards.

9) Inspections or tests ordered by the Engineer

2-4-12 Lime Soda Feeder Equipment

a) Capacity and Kind of Facilities

1) Capacity

Alkaline chemical: Soda ash (JWWA-K-108) or equivalent as a 20% (W/V%) solution

Dosing method: A feeding pump shall be operated continuously by manual adjustment of the delivery pipe valve before the raw water flow gauge well, so that dosing is effected into the receiving well.

Place of dosing: Receiving well

Quantity of treated water: 48000 m^3/day (including to the 3rd Stage)

Feeding ratio: 34 ppm

Feeding quantity (20 W/V% Solution):

1st Stage	1.9 liter/min.
2nd Stage	3.8 liter/min.
3rd Stage	5.7 liter/min.

Service water: Branched from 100 mm dia. supply pipe for the plant yard

2) Kinds of Facilities

The various machinery and equipment shall be chemical proof.

i) Solution Tank

Type: Inner dimensions 1.3 m x 1.3 m x 2.0 m (H) (effective water height, 1.5 m)

Quality of materials: SS 41 or equivalent (with 3 coatings of tar-epoxy resin coating), 6 mm thick

Capacity: 2500 liter/tank

Number: 2 tanks

Accessories: Agitator stands, lift step
(2 tanks in 1 place)
Level gauge (with protective pipe), anchor bolt, inlet, outlet, drain, return inlet from gauging well to the receiving well site.

ii) Agitator

Material: SUS-27, or equivalent

No. of agitators: 2

Output power: 0.75 KW

iii) Chemical feeding pump

Type: Centrifugal process pump

Quality of material: SUS-27, or equivalent

Specifications: 30 liter/min. x 20 m height x 0.75 KW

Number: 2 (including 1 Stand-by)

Accessories: Pressure gauge, standard accessories.

iv) Gauging well

Type:

Inner dimensions 500 mm (B) x 1000 mm (L) x 800 mm (H) (with cover)

Materials: SS 41 or equivalent (with 3 coats of tar-epoxy paint), t = 6 mm

Number: 1 well

Accessories: 30^{o} weir, weir gauge (with protective pipe), inlet, outlet, drain, anchor bolts

v) Accessory piping

Pipes: PVC, D-Plast pressure pipe (TIS) Type 5

Valves:

Angle seat valve: PVC

Diaphragm valve: Polyvinyl chloride resin

Check valve: FC

vi) Other necessary equipment

b) Scope of Construction

1) The following works shall be included in the construction herein described.

i) Manufacture and installation of the solution tank

ii) Manufacture and installation of the agitator

iii) Manufacture and installation of the injection pump

iv) Manufacture and installation of the gauging well

v) Branch piping work for service water, taken from the 100 mm dia. supply pipe for the plant yard

vi) Piping for the lime soda dosing

vii) Drain pipe work (jointing of drain pipes for aluminium sulfate, to the catch basin in the plant yard)

2) The bases for the various equipment, the pit for interior piping, and its cover shall be part of a separate construction, namely the work for the chemical dosing house.

c) Matters Concerning the Construction

The foregoing section 2-4-11 on Aluminium Sulphate Feeder Equipment shall apply.

d) Field Inspection and Examination

This shall be as described above in section 2-4-11 for Aluminium Sulphate Feeder Equipment.

2-4-13 Chlorination Equipment

a) Capacity and Facilities

1) Capacity

Dosing system: Use of pressure pumps for operation of chlorinator, manually setting the flow meter to inject adequate chlorine solution (about 3000 ppm)

Dosing point: At inlet of clean water reservoir

Dosing rate: 5 ppm max.

Quantity of treated water: 16000 m^3/day (1st Stage)

Max. chlorine capacity: 3.3 kg/hour

Stopping dosing: Close the valve for the ejector, after stopping the pressure pump

Service water: Branch piping from the 100 mm dia. supply pipe for the plant yard

2) Kind of Facilities

i) Water Pressure Pump

Type: Centrifugal pump

Material: FC

Specification: 20 liter/min. x 40 m (H) x 0.75 KW

No. of pumps: 2 (including one stand-by)

Accessories: Pressure gauge, standard fittings

ii) Chlorinator

Type: Dry vacuum chlorinator, stand type

Capacity: 10 kg/hour max.

Weighing method: Flow meter (rotor meter type)

Operation method: Manual

Pressure (water supplied to injector): 4.0 kg/m^2

Emergency alarm: Red lamp

Pressure gauge: Pressure gauge for chlorine container, water pressure gauge

Safety device to prevent backflow:

Excessive pressure, excessive vacuum double safety device to prevent backflow

iii) Chlorine Container

100 Kg container	8 items
Valve for container (brass), 8 mm dia.	8 items

iv) Lifting Hoist for Chlorine Container

Hoist rail: 150 mm (H) x 75 mm (B) x 5.5 m (t) x 16.9 m (L) (minimum radius of curve = 1.0 m)

Hoist: Manual trolley type, 250 Kg. hoist

Lifting height: 6 m

Lift motor: 0.5 KW x 50 Hz x 4 P

Control method: Push button

v) Connecting Pipings

Header pipe for chlorine container, 100 mm dia.: for 8 cylinders

Copper pipe for chlorine, 8 mm dia.: for 8 cylinders

Chlorine feeding distribution device for clear water reservoir: 1 place

Service water, chlorine, and chlorine water solution piping

Pipe: PVC, D-Plast pressure pipe (TIS), Type 5

Valve:

Angle seat valve: PVC

Diaphragm valve: Vinyl chloride pipe

Check valve: FC

Strainer (Type Y): FC

vi) Other Necessary Accessories

b) Scope of the Construction

1) The following works shall be included in the construction herein described.

i) Manufacture and installation of the water pressure pump

ii) Manufacture and installation of the chlorinator

iii) Water service piping, consisting of branch pipes from the 100 mm dia. service main for the plant yard

iv) Chlorine pipe work

v) The chlorine water pipe work and installation of the chlorine water distribution device at the clean water reservoir

vi) Installation of metal supports for the 100 kg chlorine container

vii) Installation of the hoist rail and of the 250 kg hoist

2) Foundations or bases of all the equipment shall be done separately, included in the building work for the chemical dosing house.

c) Matters Concerning the Construction

The provisions of section 2-4-11 on Aluminium Sulphate Feeder Equipment, shall also apply here.

d) Field Inspections and Examinations

The provisions of section 2-4-11 on Aluminium Sulphate Feeder Equipment shall also apply here.

2-4-14 Chlorine Neutralization Equipment

a) Contents and Itemization of Facilities

1) Contents

Neutralizer: 15% thick solution of caustic soda, JIS-K-1203, or equivalent

Neutralizing method: After verifying from the control center that the alarm for detection of chlorine gas leakage is accurate, the blower, the caustic soda circulating pump, and the neutralizer apparatus shall be set in operation manually by pushing buttons on the field control panel. This will cause the chlorine gas and caustic soda to react and neutralize, the product then being blown from the room outdoors.

Neutralizing capacity: 100 kg/hr.

2) Kind of Facilities

All facilities shall be made of anti-corrosive material.

i) Neutralization Equipment

Neutralizing capacity; 100 kg/hr. x 7.5 KW x 50 Hz

Blower capacity: 20 m^3/min. x 40 mm Aq x 0.75 KW x 50 Hz (Assuming density of leaking gas to be about 5 to 6%)

Number: 1 item

ii) Caustic Soda Storage Tank

Size: 1.0 m (W) x 2.5 m (L) x 0.4 m (He)

Storage capacity: 1.0 m^3

No. of storage tanks: 1

Accessories: Level gauge with protective pipe, anchor bolt, caustic soda inlet, outlet, and drain

iii) Caustic Soda Circulating Pump

Type: Process circulating pump

Material: SUS-27, or equivalent

Specifications: 200 liter/min. x 5.0 m (H) x 0.4 KW x 50 Hz x 4 P

No. of pumps: 1

Accessories: Pressure gauge, standard accessories

iv) Chlorine Gas Leakage Detector

Detecting method: Electrical conductivity due to chemical reaction method

Detecting range: 0 -- 5 ppm

Alarm point: Manual control adjustable setting

Retention period of reaction liquid: 50 days or more

Output power: 200 W x 50 Hz

No. of detectors: 2 (1 each for chlorinator room and chlorine cylinder room)

v) Accessories

Chlorinator gas leakage detector pipe, ventilation pipe, pipe for caustic soda, and drain pipe.

Pipe: PVC, D-Plast pressure pipe (TIS), Type 5

Valves:

Angle seat valve: PVC

Damper: Vinyl chloride

Check valve: FC

Strainer: SUS-32, or equivalent

vi) Other Necessary Items

b) Scope of the Work

1) The following shall be included in the work herein described.

I) Installation of the neutralizing apparatus

ii) Installation of the caustic soda storage tank

iii) Installation of the caustic soda circulating pump

iv) Installation of the chlorine gas leakage detector

v) Piping installations and work for the chlorine gas leakage detector, ventilation, and for the caustic soda piping

2) Construction of foundations for the machines and equipment shall be done separately, as part of the building work for the chemical dosing house.

c) Matters Concerning the Construction

The provisions of section 2-4-11 on Aluminium Sulphate Feeder Equipment shall also apply for the work herein described.

d) Field Inspections and Examinations

The provisions of section 2-4-11 on Aluminium Sulphate Feeder Equipment shall also apply here for the chlorine neutralization equipment work.

2-4-15 Electrical Works for Chemical Feeder Equipment

This construction consists of the electric installations required to operate the aluminium sulphate feeder equipment, the lime soda equipment, the chlorination equipment and the chlorine neutralization equipment. As part of the work, a field control panel shall be installed in the chemical dosing room, and electric wires provided for the measuring instruments. From this panel, power and control wiring shall be installed to handle every load.

a) Kind of Facilities

1) Electrical System

For power: 3 phase 4 W 380/230V

For controls: Single phase 2W 230 V

2) Control Method

Manual controls, with a field control panel.

Emergency indication shall be provided independent for each facility in the field, with provision for a comprehensive indication in the

central control room. Sending and receiving signals shall be a function of the field control panel.

3) Standards

Standards shall conform to Water Treatment Plant Electric Metering Facilities code, 2-8.

4) Wiring Materials

Standards shall conform to Water Treatment Plant Electric Metering Facilities code, 2-8.

5) Field Control Panel

The field control panel shall be a double panel, one for the aluminium sulphate feeder equipment and the other for the lime soda equipment, the chlorination equipment, and the chlorine neutralization equipment. Specifications are as follows.

No. of panels: 2

Use: For furnishing power, and for supplying electricity to controls (including machinery and equipment to be installed in the future)

Type: Indoor, standing type

Size: To be determined by referring to the attached blueprints, then making and submitting drawings for approval to the Engineer.

Fittings: Other necessary items as shown in the drawings

b) Scope of Construction

1) The work herein described shall include the primary side of the field control panel as far as the terminal board, and the various equipment for the secondary side.

2) Only the conduit shall be provided for equipment to be installed in future expansion.

3) Electricity for the sampling pump shall be supplied from the power panel of the chemical feeder equipment according to the skeleton drawing. The work shall be included in the scope of the electric metering equipment construction work.

c) Matters Concerning the Construction

Work shall comply with the provisions of section 2-8 on Electric Metering Facilities for the Water Treatment Plant.

d) Field Inspections and Tests

After completing the works herein described the following inspections and tests shall be done, according to procedures given above in section 1-4-1.

1) Operation test
2) Visual inspection
3) Piping and wiring inspection
4) Coating or painting inspection
5) Individual tests for all meters and relays
6) Other inspections and examinations required by applicable regulations or standards
7) Inspections or examinations ordered by the Engineer

2-4-16 Connective Piping Work Between the Various Facilities in the Water Treatment Plant Yard

a) Scale of the Work

1) Connective Piping

Terminal of raw water main -- receiving well

Ductile cast-iron pipe:	400 mm dia., L = 66.7 m
	500 mm dia., L = 8.2 m
Butterfly valve:	400 mm dia., 1 place
	500 mm dia., 1 place

Raw water flow meter chamber

Inner dimensions: 3.5 m (B) x 2.5 m (L) x 2.0 m (H)

1 room

Receiving well -- flush mixing basin

Ductile cast-iron pipe:	400 mm dia., L = 25.0 m
	500 mm dia., L = 21.5 m
	700 mm dia., L = 1.0 m

Butterfly valve:	400 mm dia., 2 places
	500 mm dia., 1 place

Chemical sedimentation basin -- rapid sand filter

Ductile cast-iron pipe:	500 mm dia., L = 6.30 m

Clear water basin -- clear water reservoir

Ductile cast-iron pipe:	400 mm dia., L = 21.0 m
	500 mm dia., L = 29.0 m
Butterfly valve:	400 mm dia., 2 places
	500 mm dia., 1 place

Connective piping for clean water reservoir

Ductile cast-iron pipe:	600 mm dia., L = 1.0 m
	800 mm dia., L = 1.0 m
Butterfly valve:	600 mm dia., 1 place (with control stand)
	800 mm dia., 1 place (with control stand)

Distributing pump -- starting point of distributing main

Ductile cast-iron pipe:	200 mm dia., L = 3.0 m
	300 mm dia., L = 3.0 m
	500 mm dia., L = 29.0 m
	600 mm dia., L = 112.0 m
	800 mm dia., L = 1810 m
Steel pipe:	800 mm dia., L = 10.00 m
Air valve:	13 mm dia., 4 places
Butterfly valve:	600 mm dia., 1 place
	800 mm dia., 1 place

Distribution flow meter room

Inner dimensions: 3.5 m (B) x 2.5 m (L) x 2.7 m (H)

1 room

Lift pump for elevated tank -- wash water main tank

Ductile cast-iron pipe:	125 mm dia., L = 9,634 m
	250 mm dia., L = 94,915 m

Steel pipe:	250 mm dia., 3.00 m
Air valve:	13 mm dia., 2 places
Gate valve;	250 mm dia., 1 place

Distribution pump header -- Surface wash water main

Ductile cast-iron pipe:	250 mm dia., L = 14820 m
Gate valve:	250 mm dia., 2 places

Elevated tank -- Rapid sand filter

Ductile cast-iron pipe:	500 mm dia., L = 69664 m
Butterfly valve:	500 mm dia., 2 places
Wash water flow meter chamber:	2.0m(B) x 2.2m(L) x 2.0m(H) 1 room

2) Service Pipe for Plant Yard

Ductile cast iron pipe	100 mm dia., L = 6.26 m
PVC, D-Plast pressure pipe	100 mm dia., L = 289891 m
(Thai Industrial Standard), Type 5:	35 mm dia., L = 28119 m
	25 mm dia., L = 35.00 m
	15 mm dia., L = 55.00 m
Gate valve:	100 mm dia., 3 places
Angle seat valve:	100 mm dia., 1 place
	35 mm dia., 1 place
	16 mm dia., 1 place
	15 mm dia., 2 places (with valve box)
Hydrant double hose:	100 mm dia., 2 places

b) Scope of Construction

1) The scope of construction for the work herein described is as shown in the drawings, but the connections with other separate works shall be included in the scope of the present construction,

2) Installation of flow meters for raw water flow, for the flow in the distributing mains, and for backwash water shall be done as part of a separate construction work, namely the work for the Electric Metering Facilities.

3) Overflow pipes and drain pipes for the various structures shall be a separate work, namely part of the work for drain piping in the water treatment plant yard.

4) Concrete protective piping for pipes around structures for facilities herein described shall be a separate work, part of the construction of the various structures. Installation of metal bracing or supports, however, shall be part of the work herein described.

c) Matters Concerning the Construction

1) Piping from the Terminal of the Raw Water Main to the Receiving Well

i) The 400 mm dia. inlet pipe from the terminal of the raw water mains to the receiving well, and the installation of the facilities necessary to bring the 500 mm dia. inlet pipe for Stages 2 and 3 into the receiving well shall be part of the work herein described. The 500 mm dia. inlet pipe shall be stopped off with a butterfly valve, with a blind cap.

ii) The raw water flow meter room shall be built large enough to install meters for the 2nd and 3rd Stages.

2) Piping from the Receiving Well to the Flush Mixing Basin

i) Piping shall be installed from the receiving well to the flush mixing basin for the 1st Stage only. For facilities of the 2nd and 3rd Stages, a 700 mm dia. special, short, ductile cast-iron pipe shall be installed projecting from the outlet channel with a blind cap at the end.

3) Piping from the Chemical Sedimentation Basin to the Rapid Sand Filter

The construction shall include piping from the chemical sedimentation basin's outlet channel to the rapid sand filter's inlet main.

4) Piping from the Clear Water Basin to the Clear Water Reservoir

The installations shall include piping from the clear water basin's 400 mm dia. outlet pipe to the 500 mm dia. inlet for the clear water reservoir.

5) Piping at the Clean Water Reservoir

600 mm dia. pump well connecting piping shall be installed for the 1st Stage facilities. For the 2nd and 3rd Stages 800 mm pipe shall be installed at the inlet. A butterfly valve, operated from the operation stand, shall be installed in the pump well. For the 2nd and 3rd Stages, a blind cap shall stop off the piping just below the 800 mm dia. butterfly valves. The installation of the control stand shall be part of the construction herein described. But, construction of the foundations of the operation stand and the valves shall be separate work, part of the clean water reservoir construction.

6) Piping from the Distributing Pump to the Distributing Main

i) A 600 mm dia. distributing main shall be installed from the sluice valve on the delivery side of the distributing pump to the starting point of the distributing main. For the 2nd and 3rd Stages, a 600 mm dia. branch pipe shall be installed, stopped off by a butterfly valve provided with a blind cap.

ii) The check valve and sluice valve on the delivery side shall be part of separate construction; namely, the installation of the pumps.

iii) The distribution flow meter room shall be constructed large enough to house meters required for the 2nd and 3rd Stages.

iv) Before the downward bend of the pump's delivery pipe, each pipe shall be fitted with a screw-type single orifice air valve 13 mm in diameter, as the details of which are shown in the drawings.

v) An 800 mm dia. steel pipe shall be laid for the pump's header pipe. For the boundary of the 2nd and 3rd Stages, a butterfly valve, covered with a blind cap, shall stop off the pipe.

vi) Strong concrete protections shall be constructed so that the lower side of the vertical bends of the pump's outflow pipe and the header pipe will withstand irregular water pressures.

vii) Concrete protection shall be provided for 45° and $22\ 1/2^{\circ}$ bends in the pipe on the pump's delivery side. Details are shown

in the drawings (Specimen Drawings for Pipe Protection).

7) Piping from the Lift Pump for the Elevated Tank to the Backwash Water Main under the Filter Bed

i) 250 mm dia. pipe shall be installed as part of the construction herein described from the sluice valve on the delivery side of the lift pump for the elevated tank to the backwash main for the rapid sand filter. But the check valve and sluice valve for the delivery side of the pump shall be part of the construction for the pump facilities.

ii) Air valves of 13 mm dia. for venting air shall be installed for each delivery pipe, just before the vertical bend downward on the delivery side of the pump. Details shall be as shown in the drawings.

iii) The delivery header pipe shall be installed for the pump using 250 mm dia. steel pipe, and connections for the 2nd and 3rd Stages provided with a blind cap.

iv) Concrete protections shall be provided for 90° and 45° bends, the details and dimensions to be as shown in the drawings (Specimen Drawings for Pipe Protection).

8) Piping from the Elevated Tank to the Rapid Sand Filter

i) A wash water main 500 mm in dia. shall be installed from the elevated tank to the sand filter's wash water main. Connections with pipe for the 2nd and 3rd Stages shall be closed off by a butterfly valve with a blind cap.

ii) Pipe protection around the elevated tank shall be provided as part of the work herein described, details to be as shown in the drawings.

iii) Concrete protections shall be provided for 45° and $22\ 1/2^{\circ}$ bends and J-shapes. Dimensions shall be as shown in the drawings (Specimen Drawings for Pipe Protection).

iv) A back wash flow meter room shall be built as part of the work herein described.

9) Piping from the Distribution Pump Header to the Surface Wash Water Main

i) A main shall be installed 250 mm in dia. branching off from the 800 mm dia. distribution pump header and extending to the rapid sand filter's surface wash water main. Connections with the 2nd and 3rd Stages piping shall be closed off by a gate valve with a blind cap.

ii) Concrete protection shall be provided for 90° bends and T-pipes, the dimensions to be as shown in the drawings (Specimen Drawings for Pipe Protection).

10) Service Water Pipe in the Water Treatment Plant Area

i) A service water pipe shall be installed, branched from the lift main between the backwash water main and the lift pump for the elevated tank. This service water pipe shall furnish water for the following: tap water for the buildings and miscellaneous water in the area, injection water for the chemical dosing plant and chlorinator, cooling water for the diesel engine generator, sedimentation basin washing water, fire fighting water, and other miscellaneous uses. All interior piping for buildings and service piping from curb cock to buildings shall be part of the construction works of the various buildings. Only service piping for the plant generator shall be done as part of the works here described.

ii) Washing pipe for the sedimentation basin shall be solidly held in place by metal supports so as to withstand external forces. Connections for the 2nd and 3rd Stages shall be closed off by an angle seat valve with a blind cap.

iii) Two miscellaneous service faucets shall be installed in a Thai domestic-made concrete Pilaster Block (C8-13) valve box as shown in the drawings.

iv) Double orifice hydrants shall be installed in two locations in the plant area.

11) Miscellaneous

i) Flow Meter Chamber

(a) This shall be constructed of reinforced concrete, supported by 4 wood piles, each 4 inches in dia., and 3.00 meters in length. The inner walls shall be coated with waterproof mortar.

(b) Slabs shall not be constructed as one body with the wall, and asphalt filler shall be used between slab and wall, and also between the crevices of slab and slab to prevent water leaking in.

(c) A meter inspection manhole shall be installed, with 19 mm dia. round bars as steps to descend into the chamber.

(d) Concrete bases for the meters shall also be included in the construction herein detailed.

ii) Valve Box

Valve boxes shall be provided for the valves installed as part of the work herein described. The valve boxes shall be two kinds, both cast iron, Type A and Type B. Type B shall be constructed so the depth is adjustable between 0.55 m and 1.0 m. Details, including the type of box for each valve, shall be as shown in the drawings.

iii) Installation of Pipes which Penetrate Structures

(a) Places in buildings where pipes penetrate the structure shall be adequately reinforced by inserting steel bars, and the pipes shall be set in their proper places, and inspected by the Engineer, all before placing the concrete.

(b) When it is not possible to set pipe in location before placing the concrete, an opening shall be provided adequate to allow insertion of the pipe or of the flange. Openings shall be filled with mortar for close adherence to the pipe and the concrete, and so there will be no leakage.

(c) Installation of piping around structures shall be done after fully consulting the contractors for related or affected work.

2-4-17 Drainage Pipe in the Water Treatment Plant Area

a) Scale and Structure

From Receiving Well to No. 1 Manhole (Overflow pipe)

DCIP	Dia. 500 mm, L = 7.061 m
ACP	Dia. 500 mm, L = 7.639 m

From Receiving Well to No. 1 Manhole (Drain pipe)

DCIP	Dia. 350 mm, L = 4.408 m
ACP	Dia. 400 mm, L = 7.612 m
Gate Valve	Dia. 350 mm, 1 place

From No. 1 Manhole to Canal

ACP	Dia. 500 mm, L = 9.400 m

From Receiving Well to Canal

DCIP	Dia. 100 mm, L = 5.100 m
ACP	Dia. 100 mm, L = 13.953 m
Gate Valve	Dia. 100 mm, 1 place

From Flush Mixing Basin to No. 1 Manhole

DCIP	Dia. 150 mm, L = 7.600 m
ACP	Dia. 150 mm, L = 34.195 m
Gate Valve	Dia. 150 mm, 2 places
No. 1 Manhole	Inner dimensions: 1.20 x 1.20 x 1.05 (H) m

From Elevated Tank (Overflow pipe)

DCIP	Dia. 150 mm, L = 12.148 m
ACP	Dia. 150 mm, L = 5.697 m

From Elevated Tank to Canal (Drain pipe)

DCIP	Dia. 150 mm, L = 8.148 m
ACP	Dia. 150 mm, L = 50.372 m
Gate Valve	Dia. 150 mm, 1 place

From Clear Water Basin to Pump Well

DCIP	Dia. 200 mm, L = 9.796 m
ACP	Dia. 200 mm, L = 77.762 m
Gate Valve	Dia. 200 mm, 4 places

	Pump Well	Inner dimensions:
		2.00 x 2.00 x 3.35 (H) m

From Pump Well to Manhole No. 5

ACP	Dia. 75 mm, L = 1,146 m
ACP	Dia. 100 mm, L = 2,983 m

From Rapid Sand Filter to Manhole No. 5

ACP	Dia. 500 mm, L = 4,700 m
ACP	Dia. 600 mm, L = 69.000 m

From No. 2 Manhole to Manhole No. 5

ACP	Dia. 200 mm, L = 109.250 m
No. 2 Manhole	Inner dimensions:
	1.20 m x 1.20 m x 0.50 (H) m

From Sedimentation Basin to No. 3 Manhole

ACP	Dia. 200 mm, L = 1.880 m
ACP	Dia. 300 mm, L = 68.090 m
No. 3 Manhole	Inner dimensions:
	1.20 x 1.20 x 0.55 (H) m

From No. 3 Manhole to No. 5 Manhole

Open Channel (Concrete)	Inner dimensions:
	0.50 (B) x 0.735 (mean depth) m
	L = 82.276 m
Manhole	Inner dimensions:
	1.50 x 2.00 x 1.10 (H) m

From No. 5 Manhole to No. 4 Manhole

Open Channel (Concrete)	Inner dimensions:
	0.80 (B) x 1.22 (mean depth) m
	L = 147.250 m
No. 4 Manhole	Inner dimensions:
	1.20 x 1.20 x 1.20 (H) m

From No. 4 Manhole to Lagoon

ACP	Dia. 600 mm, L = 8.459 m

From Pump Well (Lagoon) to Ping River

ACP	Dia. 100 mm, L = 1,039 m
ACP	Dia. 150 mm, L = 608.52 m

b) Scope of the Construction

1) The scope of the construction work herein described shall be as shown in the drawings. But connections with other construction works for this entire project shall be included as part of the work herein described. As an exception, the wash water drain pipe shall be done as part of the filter construction works.

2) Drainage pipe for the lagoon and pump well shall be excluded from the work herein described. Pipes for the pumps on the downflow side from the sluice valve of the delivery pipe shall be done as part of the work herein described.

3) Concrete protection for the piping around the elevated tank shall be part of the work herein described.

4) Metal supports for the piping shall be part of the work herein described.

c) Matters Concerning the Work

Refer to 2-4-17 regarding materials, type and quantities of pipe.

1) Overflow Pipe from the Receiving Well to the No. 1 Manhole

i) An overflow pipe shall be installed from the receiving well to the No. 1 manhole.

ii) The overflow pipe shall be firmly supported by metal fittings to prevent vibration.

2) Drain Pipe from the Receiving Well to the No. 1 Manhole

i) A drain pipe shall be laid from the receiving well to the No. 1 manhole.

3) Pipe from the No. 1 Manhole to the Watercourse

i) A pipe shall be laid from the No. 1 manhole, which collects overflow water and drainage water from the receiving well in back of the flush mixing basin, to the watercourse.

ii) The center of the outlet pipe from the No. 1 manhole is at a

level of +305.15 m. Therefore, a slight gradient, which is possible in relation to the water level of the watercourse, shall be made in laying the pipe, so as to prevent accumulation in the pipe of dirt or sand.

iii) The pipe shall be laid so that the end projects appropriately into the watercourse.

4) Pipes from the Receiving Well to the Watercourse

i) Pipe shall be laid from the receiving well to the watercourse to drain the receiving well channel.

ii) The pipe shall be laid so the end projects slightly into the watercourse.

5) Pipe from the Flush Mixing Basin to the No. 1 Manhole

i) A pipe shall be laid from the flush mixing basin to the No. 1 manhole as a drain pipe for the flush mixing basin.

ii) The drain pipe for the flush mixing basin shall be connected in a level position, and the confluent drain pipe shall be laid on an appropriate gradient to No. 1 manhole.

iii) In order to facilitate the outflow of water, inside of the manhole shall have invert shaping.

iv) A ladder, with steps of 19 mm dia. round bar, shall be installed in the manhole to enable descent.

6) Overflow Pipe for the Elevated Tank

i) A pipe shall be installed from the elevated tank to a point connecting to the drain pipe for the elevated tank, to serve as an overflow pipe.

ii) Concrete protection shall be provided for the 90° bend at the lower part of the overflow pipe. Details shall be as shown in the drawings.

iii) The overflow pipe shall be firmly supported by metal fittings.

7) Drain Pipe from the Elevated Tank to the Watercourse

i) To serve as drain pipe for the elevated tank, piping shall be installed from the elevated tank to the watercourse.

ii) Concrete protection shall be provided for the 90^{o} bend at the lower part of the drain pipe. Details shall be as shown in the drawings.

iii) The pipe shall be laid so the end projects slightly into the watercourse.

8) Pipe from the Clear Water Basin and Sand Filter to the Pump Well

i) A pipe shall be laid from the rapid sand filter to the pump well to dispose of waste water from the rapid sand filter and drain water from the clear water basin, which is also connected in.

ii) For use in the 2nd and 3rd Stages, a branch-off shall be installed midway, closed off by a blind flange cap or a plug.

iii) An inspection manhole shall be installed in the pump well, with steps of 19 mm dia. round bar to enable descent.

iv) A drain pump shall be installed to pump waste water from the rapid sand filter and drain water from the clear water basin.

9) Piping from the Pump Well to No. 5 Manhole

i) Pipe shall be laid from the pump well to manhole No. 5 to send water to the lagoon from the pump well.

ii) Connection will be made to the delivery side of the pump. Therefore the laying of the pipe shall be done only after adequate consultation with the Contractor for the pump facilities installation work.

10) Piping from the Rapid Sand Filter to No. 5 Manhole

i) Piping shall be laid from the rapid sand filters to manhole No. 5 to carry washing waste water from the rapid sand filters.

ii) For use in the 2nd and 3rd Stages, a pipe branch shall be installed, closed off by a blind flange.

11) Piping from No. 2 Manhole to No. 5 Manhole

i) Pipe shall be installed from No. 2 manhole to the connecting manhole leading to the lagoon for use as a drain water pipe for the clear water reservoir. (Pumps will send water from the reservoir to No. 2 manhole.)

ii) For use in the 2nd and 3rd Stages, a branch shall be installed midway in the above pipe, closed off with a blind flange.

iii) In order to facilitate the outflow of water, the bottom of the inside of the manhole shall be invert.

iv) An inspection manhole shall be provided in the manhole, with steps of 19 mm dia. round bar to enable descent.

12) Piping from the Sedimentation Basin to the No. 3 Manhole

i) A pipe shall be laid to carry waste water from the sedimentation basin to the No. 3 manhole.

ii) For use in the 2nd Stage, a branch shall be installed, closed off with a blind flange. But, this waste water from the 3rd Stage facility shall be discharged directly into No. 3 manhole.

iii) The pipe here described is the delivery pipe for the pump removing sludge from the sedimentation basin. Therefore, the Contractor shall investigate the site carefully, and lay the waste water pipe to fit the center height +305.55 m at the inlet of No. 3 manhole.

iv) In order to facilitate the outflow of water, the bottom of the inside of the manhole shall be invert.

v) An inspection manhole shall be provided in the manhole, with steps of 19 mm dia. round bar for descending.

13) Open Channel from No. 3 Manhole to No. 5 Manhole

(Concrete, B = 500 mm, Average depth = 735 mm)

i) This channel shall be provided from No. 3 manhole to No. 5 manhole transit to the lagoon, in order to discharge waste water from the sedimentation basin.

ii) The inner surfaces of the channel shall be constructed and finished carefully so that water will flow well.

iii) At specified intervals, as shown in the drawings, construction joints shall be installed, their mortar joints to be approximately 10 mm thick.

iv) In order to facilitate the outflow of water, the bottom of the

inside of the manhole shall be invert.

v) An inspection manhole shall be provided in the manhole to enable descent, fitted with steps of 19 mm dia. round bar.

14) Open Channel from No. 5 Manhole to No. 4 Manhole

(Concrete, B = 800 mm, average depth = 1220 mm)

i) Piping shall be laid from a junction manhole, No. 5 to No. 4 transit manhole in order to carry waste water from the sedimentation basin, backwashing waste water from the rapid sand filters, waste water from the clear water basin, and waste water from the clear water reservoir.

ii) The inner surfaces of the channel shall be constructed and finished carefully so that water will flow well.

iii) At specified intervals, as shown in the drawings, construction joints shall be installed, their mortar joints to be approximately 10 mm thick.

iv) In order to facilitate the outflow of water, the bottom of the inside of the manhole shall be invert.

v) An inspection manhole shall be provided in the manhole to enable descent, fitted with steps of 19 mm dia. round bar.

15) Piping from the No. 4 Manhole to the Lagoon

i) In order to discharge into the lagoon, waste water from all the various facilities, pipe shall be laid from the transitional No. 4 manhole to the lagoon.

ii) The pipe shall be laid so that its end projects slightly out into the lagoon.

16) Piping from the Lagoon Pump Well to the Ping River

i) Pipe shall be installed from the lagoon pump well to the Ping River to discharge the upper layer of clear water of the lagoon's waste waters.

ii) The pipe will be connected to the discharge side of the pump. Therefore, the contractor shall consult adequately, before being the connection, with the Contractor for the work of the pump installation.

iii) The pipe shall be laid so that its end projects slightly out into the lagoon.

17) Miscellaneous

i) Valve Box

The valve boxes to house valves of this work shall be cast iron of 2 types, Type A and Type B. Type B shall be so made that its depth is adjustable between 0.55 m and 1.0 m. Details and the type of box for each valve shall be as shown in the drawings.

ii) Installation of pipes which penetrate structures.

Places in buildings where pipes penetrate the structure shall be adequately reinforced by inserting steel bars, and the pipes shall be set in their proper places, and inspected by the Engineer, all before placing the concrete.

iii) When it is not possible to set pipe in location before placing the concrete, an opening shall be provided adequate to allow insertion of the pipe or of the flange. Openings shall be filled with mortar so as to adhere closely to the pipe and the nearby concrete, and so there will be no leakage.

iv) Installation of piping around structures shall be done after fully consulting the contractors for related or affected work.

2-4-18 Lagoon

a) Structure and Capacity

1) Lagoon

Excavated depth (without timbering): 2.0 m (inclination of circumferential slope = 2 : 1)

Bottom area: 3265 m^2

Water depth: 1.5 m

Pond capacity: 5463 m^3

2) Pump Well

Structure: Reinforced concrete

Inner dimensions: 2.0 m (B) x 3.8 m (L) x 1.85 m (H)

Number: 1 well

b) Scope of the Installation Work for Drainage Pumps

1) The installation of the 600 mm dia. inlet pipe for the lagoon shall be part of the work for drainage pipe in the treatment plant area.

2) The works for installation of pumps shall be part of the mechanical works.

3) Installation of pipe for the delivery side of the pumps, as far as the sluice valves, shall be part of the construction herein described. Piping beyond that point shall be part of the construction for drain pipes in the treatment plant area.

4) Stairs descending from the foundation at +306.00 m to +304.55 m, which is the height of the precast reinforced concrete slab pavement, shall be done as part of the construction, herein described.

5) The precast reinforced concrete slab paving for the lagoon shall be done as part of the site preparation work.

6) Pump foundations and valve foundations shall be done as part of the construction herein described.

c) Matters Concerning the Construction

1) The location of the lagoon is a place where there is an underground natural water table. Therefore, the inclination of the lagoon walls is set at 2 : 1. Care shall be exercised that the slope surfaces do not collapse.

2) Concrete shall be placed to protect the top of the slopes, as shown in the drawings.

3) The surface of the concrete slabs is on a slope descending from the top surface of the embanking at +306.00 m to +304.55 m. Therefore, stairs 1 m. wide shall be installed at two places, made of concrete, with a 15 cm wide hard vail, as shown in the drawings.

4) Concrete to protect the slope shall be placed on the slope, on both sides of the pump well as shown in the drawings. Bamboo 1 1/2 in. dia. drain pipe shall be inserted at 1 meter intervals.

5) Foundation concrete shall be placed at the bottom of the concrete to protect the slope, as shown in the drawings.

6) As shown in the drawings, the pump well shall have a channel on both sides of the walls, constructed with a flash board, to drain by pump the top water in the lagoon. Construction shall be carefully done, so the corners of the channel will not crumble.

7) The flash board shall be made of wood highly resistant to water, and to dimensions as shown in the drawings. A hook of 13 mm dia. round bar shall be installed in the place indicated in the drawings, so that stop log can be drawn up from the top of the slab of the pump well.

8) A hand rail for safety, made of 1 1/4 inch steel pipe, shall be installed around the slab for the pump well, and coated with oil paint.

9) An inspection manhole shall be installed in the pump well to enable descent inside, fitted with steps of 19 mm dia. round bar.

10) The Contractor shall discuss the phasing of the work for the pump facilities adequately with contractors for related works, before beginning the work.

2-4-19 Drain Pump Equipment

a) Specifications

1) Lagoon Drainage Pump No. 2

This pump shall discharge surface waters of the lagoon into the Ping River.

i) Operation and Control System

Manual control at the pump location.

ii) Pump Specifications

Type: Motor direct coupling vertical centrifugal pump
(Middle shaft bearing oil lubrication type)

Pump bore: Dia. 100 mm

Discharge capacity: 0.87 m^3/min.

Total head: 10 m

Revolutions: 1450 rpm

Motor output: 3.7 KW (50 Hz, 380 V)

No. of pumps: 1 pump

iii) Accessories for Drain Pump

Sluice valve (manual):	1 item
Check valve:	1 item
Combined gauge:	1 item
90^{o} bend:	1 set
Flexible coupling:	1 set
Standard accessories:	1 set
Other required items:	1 set

2) Drain Pump No. 3

This pump shall be installed at the side of No. 5 manhole to discharge drain water from the filter into the drainage channel.

i) Operation and Control System

Manual control at the pump location.

ii) Specifications

Type: Motor direct coupling vertical centrifugal pump (Middle shaft bearing oil lubrication type)

Pump bore: Dia. 80 mm

Discharge capacity: 0.7 m^3/min.

Total head: 6 m

Revolutions: 1450 rpm

Motor output: 2.2 KW (50 Hz, 380 V)

No. of pumps: 1 pump

iii) Accessories for Drain Pump

Sluice valve (manual):	1 item
Check valve:	1 item
Combined gauge:	1 item
90^{o} Bend:	1 set
Flexible coupling:	1 set
Standard accessories:	1 set

Other required items: 1 set

b) Scope of Construction

1) Installation work for drain pumps shall be included.

2) Concrete foundations and bolt hole shall be done as part of the civil works.

3) Piping around the pumps to the sluice valve shall be included in the work here detailed for installation of the drainage pumps. Piping connecting from the sluice valve to the drainage manhole shall be part of the drainage pipe work for the water treatment plant area.

4) All electric wiring work shall be part of a separate construction work; namely, the electrical work.

c) Matters Concerning the Construction

1) Pump equipment shall be as indicated in section 2-1-4 (Raw Water Pump Equipment).

2) Pump equipment shall be arranged as indicated in the blueprints.

3) Before starting actual work, contractors for related works, as for example civil work and electrical work, shall consult together adequately to ensure correct progress of the work.

2-5 Distribution Mains

2-5-1 Distribution Main No. 26* to No. 29*

a) Contents of the Work

Straight pipe line includes

ACP, 250 mm dia.	L = 1018.5 m
ACP, 200 mm dia.	L = 1370.0 m
Fire hydrant, 100 mm dia.	3 places
Air valve, 75 mm dia.	1 place
Blow-off, 100 mm dia.	2 places

River crossing

GSP, 250 mm dia.	L = 9.5 m
GSP, 200 mm dia.	L = 6.0 m

Note: Lengths of straight pipe line, above, include the length of pipe crossing the river.

b) Scope of the Construction

Work is comprised of the mains from the connecting point with the existing main in front of the Rincome Hotel to the existing clear water well at Chiang Mai University. The works shall include all installations of fire hydrants, sluice valves, air valves, blow-offs, and other necessary works to provide effective functioning of the distribution pipe line. The above applies correspondingly to all pipe lines to be constructed.

c) Matters Concerning the Construction

1) The connection with the existing main in front of the Rincome Hotel shall be made by installing a reducing tee for 300 mm ~ 250 mm dia., jointed with Gibault coupling.

2) GSP pipe, 250 mm dia., shall be used at the crossing of the irrigation canal. Both ends of the pipe at the crossing shall be supported with concrete block to provide beam action against external loads. A blow-off of ACP 100 mm in diameter shall be installed on the Rincome Hotel side.

3) Crossing of the spillway at Chiang Mai University shall be as described in (2) directly above, and as indicated in the drawings,

* Refer to the Distribution Main General Plan regarding these points.

using GSP pipe of 200 mm diameter.

4) Insertion of the pipe through the walls of the clear water well requires careful work. The insertion shall be done so as not to interfere with the operation of the existing facilities, and the wall adequately restored so there will be no future leakage. The Contractor shall consult with the Engineer and the head of the Chiang Mai University Water Treatment Plant as to timing of the work and the method used, and shall obtain their approval before beginning the work.

5) A 75 mm dia. air valve shall be installed at Chiang Mai, the standard for which shall be JIS B 2063 or equivalent. Air valves of all the mains described below shall meet the same standard.

6) A 100 mm dia. double orifice fire hydrant shall be installed. Details shall be as shown in the drawings "Specimen Drawings for Fire Hydrant and Sluice Valve." Hydrants of all the mains described below shall be as shown in the same drawings.

7) An open cut will be dug in the left side of the auto road going to Chiang Mai University. To avoid inconveniencing traffic, half the breadth or more shall be maintained for passage. Similarly, a temporary bridge shall be provided while laying the main across the road.

8) The discharge point for the blow-off shall be determined after obtaining the Engineer's approval.

9) The sluice valves shall close by turning in a clockwise direction. The Contractor, before making the connection with the existing pipe line, shall verify the positions of the bolt holes, under direction of the Engineer. Similarly, it shall be verified that the flange on the valve side and the flange on the pipe line side are the same size.

2-5-2 Boosting Pump Equipment

a) Scale and Construction

1) Area of site: 10 m x 10 m

2) Specifications of Concrete Box

Material: Reinforced concrete

Inner dimensions: 3.0 m x 2.2 m x 1.485 m (H)

3) Piping

ACP, 250 mm dia.:	L = 28.2 m
ACP, 125 mm dia.:	L = 6.4 m
GSP, 125 mm dia.:	L = 3.8 m

4) Boosting Pump

i) Operation and Control System

The pump shall start and stop automatically depending on the water level in the clear water reservoir on the Chiang Mai University campus. Also, the pump shall be operable manually at the pump site.

ii) Specifications of the Pump

Type: Vertical multi-stage suspended type submerged motor pump

Bore of pump: 125 mm dia.

Discharge capacity: 1.85 m^3/min.

Total head: 10 m

Revolutions: 3000 rpm

Motor output: 7.5 KW (50 Hz, 380 V)

No. of pumps: 2 (including 1 stand-by)

iii) Accessories for Boosting Pumps (for each pump)

Sluice valve (manual):	2 items
Check valve:	1 item
Discharge bent pipe:	1 item
90^o bend:	2 items
Automatic air valve:	2 items
Combined gauge:	2 items

Standard accessories:	1 set
Other required items:	1 set

b) Scope of Construction

1) All work beyond the T-shape branching from the distribution main to the boosting pump station shall be within the scope of the construction herein described. But, the connective fittings shall be part of the work for the distribution mains.

2) Work other than laying pipes, if it be within the plant site, shall all be included in the construction herein described.

3) Civil works and works related to the pumps shall be part of the works herein described, with the sluice valve as their boundary limit. The flange connections for the valves shall be separate, included in the civil works.

4) The installation of the boosting pump shall be within the scope of the works herein described.

5) Wiring work from the pump to the local operation panel, work of installation of the local operation panel, shall be excluded from the scope of this construction and shall be part of the electric meter equipment.

c) Matters Concerning the Construction

1) Asbestos pipe, 500 mm dia., shall be installed to protect the submerged pump. A certain amount of space shall be left open at the bottom, even when the pump has been placed, and made solid with concrete. Due to the relation with the installation of the pump, the Engineer's directions shall be followed in regard to the space left open and the installation of asbestos cement pipe.

2) An inspection manhole shall be installed for the concrete box, provided with steps of 19 mm dia. round bars for descent. Details shall be as shown in the drawings.

3) In order to bring in the pump and other equipment, an opening shall be provided in the location shown in the drawings.

4) The freight opening shall have a cover in three sections with plates

welded to one side so that water will not leak in. The cover shall be so constructed as to fit tightly. Details shall be as shown in the drawings.

2-5-3 Distribution Main No. 5 – Paton Water Treatment Plant – No. 1

a) Scale of Construction

Straight pipe lines include:

DCIP, 600 mm dia.	L = 73 m
DCIP, 500 mm dia.	L = 19 m
DCIP, 450 mm dia.	L = 202 m
DCIP, 350 mm dia.	L = 1776 m
DCIP, 100 mm dia.	L = 55 m
ACP, 200 mm dia.	L = 97 m
ACP, 150 mm dia.	L = 21 m
Sluice valve, 450 mm dia.	2 places
Sluice valve, 350 mm dia.	1 place
Sluice valve, 200 mm dia.	1 place
Sluice valve, 150 mm dia.	2 places
Sluice valve, 100 mm dia.	3 places
Fire hydrant, 100 mm dia.	1 place
Blow-off, 200 mm dia.	2 places
Blow-off, 150 mm dia.	1 place
Air valve, 75 mm dia.	1 place
Sluice valve, 75 mm dia. (for air valve)	1 place

River crossing:

DCIP, 450 mm dia.	L = 10.5 m
DCIP, 350 mm dia.	L = 56.0 m
DCIP, 100 mm dia.	L = 55.0 m

Road crossing:

DCIP, 450 mm dia.	L = 25.0 m
DCIP, 350 mm dia.	L = 14.0 m

b) Scope of the Construction

1) Pipe shall be laid from point No. 1, as shown in the drawing "Distribution Main General Plan," paralleling the highway, passing in front of the planned water treatment plant, and continuing to the front of the aqueduct across the Ping River.

2) At point No. 1, provision shall be made for a branch, using DCIP 500 mm dia. with a blind flange cap, to enable future expansion of the distribution mains.

3) The distribution trunks for the city area are as shown in the drawings.

4) The distribution pipe, DCIP of 450 mm dia. shall be finished with a flange just above the Ping River aqueduct.

5) Service branch piping shall be installed to the office building in the water treatment plant yard, as shown on the drawings.

c) Matters Concerning the Construction

1) The Super Highway, along which the water main pipe line is to be laid, is intended to be broadened in the future. Therefore, the pipe shall be laid 14 to 15 meters distant from the highway center line, as shown in the drawings. This position shall be approved by the Highway Department.

2) Branch pipes, DCIP 100 mm dia., shall be laid to cross the road at suitable intervals in preparation for supplying water services in the area across the highway in the future. Work shall be done by the shielding method, as shown in the design drawing "Distribution Main Road Crossing."

3) Mains laid below the irrigation ditch shall be provided with wooden sheet pile cofferdams, and laid in an open cut. If work is done during the irrigation season, care shall be used that adequate water continues to flow to down stream areas. The vertical section of the main laying shall be as shown in the drawings.

4) Earth coverings are shown as depths from the ground level. That the earth coverings are deep is unavoidable because of the future planned expansion of the Super Highway.

2-5-4 Aqueduct

a) Contents of the Construction Work

1) Scale of the Construction

Loading distribution pipe	SP 450 mm dia.	L = 142.005 m
Total length of girder	Steel girder	L = 132.800 m
Four spans		
Side span		L = 36.4 m
Middle span		L = 30.0 m
Middle span		L = 30.0 m
Side span		L = 36.4 m
Abutment	Reinforced concrete	Both bank sides
Pier	Reinforced concrete	3 piers in river

2) Scope of Construction

This work shall consist of building a 4-span aqueduct and installing on it a distributing main 450 mm in diameter. Connections with the distribution mains on either bank of the aqueduct shall be in the scope of a different construction work; namely, the distribution main installation work.

3) Matters Concerning the Construction

i) Before building the aqueduct crossing the Ping River, the Contractor shall consult the Engineer, shall submit working drawings to concerned government offices, and obtain their approvals.

ii) Since the water level is much higher in the rainy season than the dry season, foundations shall be completed during the favorable dry season.

b) Fabrication and Materials

1) General

This chapter applies to the making of the aqueduct crossing the Ping River. Only the most important matters are included. Matters not referred to here shall meet the standards contained in Road Bridge Specifications (Japan Road Association, March 1972), or standards recognized as equivalent or better.

2) Steel

i) Materials

(a) Materials shall be of SS 41 or equivalent functional quality.

(b) Steel pipe for mains shall be JIS G 3443 or material of equivalent quality.

(c) Rivets

Diameter: 22 mm

Material: SV 34 standard or of equivalent mechanical character

ii) Care shall be exercised so that steel materials do not rust unduly or suffer damage during storage for construction.

iii) The tolerable limit in variation of thickness of steel plate shall comply with standards in JIS G 3193 "Shapes, Sizes, Weight, and Tolerances for Band Steel and Hot Rolled Steel Plate" in Chart No. 4, and the tolerable (permitted) limit for (-) side shall be with 5% by nominal measurement.

iv) Repair of surface faults shall be done only after carefully considering the type of defects and the best way to correct it. Thickness of the place after repair must be within the tolerable limit for variation in thickness, as stated above.

3) Fabrication at the Factory

i) Full-size Drawings

Before beginning fabrication, the Contractor shall make necessary full-size drawings, and verify there are no defects in the engineering or in the design drawings.

ii) Fabrication

(a) Dividing Steel Plate

Dividing main members for the framework shall, as a basic rule, be done so that the trajectory of principal stress accords with the direction of rolling for the plate.

(b) Marking-off Guide Lines

As a general rule, cold chisel or punch marks shall be made

in places that will remain even after completion of the work.

(c) Cutting

Main steel members for the framework shall be cut with automatic gas cutting apparatus. The quality standards for gas cut sections or developed sections done by use of gas cutting apparatus shall be superior to those indicated in the chart which follows.

Section steel, gusset plate, reinforcements, etc. may be cut by shearing. In case shearing causes shoulder drops, burrs, or unevenness, the edges shall be trimmed till the defects are removed, or finishing shall be done to a smooth finish by grinding. In such cases, the finished surface shall be superior to the indicated quality valve in Chart 1.

Quality of Gas Cut Surfaces

Category	Main Structural Steel	Secondary Material
Surface roughness(1)	50 S or less	100 S or less
Notch depth(2)	Notch not permittable	Notch 1 mm or less
Slag	Attached pieces of slag shall be easy to clean off, without leaving scars.	
Melting of upper edge	May be slightly rounded; must be smooth	

(1) Surface roughness is shown in JIS Standard B 0601, 50 S expressing roughness of 50/1000 mm.

(2) Depth of notch is measured from the top edge to the bottom of the trough.

(d) Cutting

Surface roughness of the cut faces of steel material shall be 50 S or less.

(e) Drilling

Holes shall be made with a drill, or by joint use of a drill and reamer. Templates shall be used if drilling to the indicated

diameters is done in advance of the shop assembly work. Secondary memebers for the fabrication may have holes made to the prescribed diameter by punching. Burrs, etc. due to drilling or punching must be cleaned away.

iii) Welding

(a) Welding Fabrication

All welding shall be done only after checking the following matters carefully to ensure adequate joint strength.

(1) Type and special characteristics of the steel.

(2) Type and special characteristics of the welding method, groove, and welding rod.

(3) Dryness and cleanness of the area to be welded, and the fit of the joint of pieces to be welded together.

(4) Dryness of the welding material.

(5) Conditions and order for welding

Factory welding shall be done inside or under equivalent conditions.

(b) Welder

Welders shall have passed the test most applicable to the work (or a test equivalent or more severe) among the various tests established under JIS Z 3801 (Standard Qualification Procedure for Welding Technique).

(c) Welding Test

It shall be a fundamental rule that welders be tested. The welding testing shall be as specified by the Engineer.

Covered electrode arc welding (manual weld only), excepting submerged arc welding, shall be tested under the following conditions:

(1) The test piece of steel plate shall present the worst welding conditions likely to be encountered with that type of material.

(2) Welding conditions shall be the same as for the actual work, and the position of the welder while doing the test welding shall

be the most unfavorable likely to be encountered.

(3) Groove welding tests with different kinds of steel material shall use comparatively hard types of steel as test material. When conducting tests for welds of two different thicknesses of the same kind of steel, comparatively thin steel plates shall be used as test materials.

(4) For a second test or retest, twice the number of tests shall be conducted as for the first time.

(d) Assembling

When assembling parts for welding, a supplementary welding jig shall be used and conditions shall be arranged so that temporary welds are made with the parts in natural, unforced positions. Welding of temporary braces, supports, or backing shall be avoided where possible. When it is necessary to use such devices, and a member is damaged, repair shall be made after careful studying of how the repair should be made. Road Bridges Specifications, P. 127, Table 15-3-10, Japan Road Association, March 1972, will be of valuable reference for repairing defects.

(e) Welding Materials

Covered electrodes for mild steel shall be used.

(f) Miscellaneous

The Contractor shall do the various work necessary for welding such as ensuring accuracy in joining of steel members, tack welding, testing of weld, etc. in accordance with work method sheets, which he shall submit to the Engineer for approval before beginning the work.

4) Suspension

When methods of manufacture or the order of the process of manufacture are different than those of the design work, the Contractor shall restudy stresses and possibility of deformation when suspending the aqueduct structure in place, and shall ensure that the work is safely done.

When steel members are temporarily left at the site, care shall be taken that the members do not touch the ground. The Contractor shall adequately guard that the members are not liable to damage from contact with other materials, or from falling off their temporary storage stands.

When the temporary storage is for a long time, the Contractor shall take adequate measures to prevent corrosion or damage.

Assembly shall be done accurately in the specified order, and assembly number. Care shall be taken that materials being assembled are not damaged. The total number of temporary bolts and drift pins shall be, as a standard, about one-half of the total. The number of drift pins shall be limited only to those necessary to align the holes, while the number of bolts shall be maximized.

A sufficient number of rivets shall be made ready for use that there will be an allowance for replacement and so forth. The rivet, after being hammered, shall fill the rivet hole completely, and the head shall hold its required shape. Contacting surfaces of the steel members being joined together shall, as a fundamental rule, be coated with primer. Riveting done at the work site shall be inspected soon after being completed. After defective rivets have been cut out, riveting shall be redone. Loose rivets shall be caulked or tightened after cooling by after-hammering. Defective rivets shall be carefully removed so that there will be no danger of damaging the steel members, or that other adjacent rivets will be loosened.

5) Protective Covering for Steel Pipe

i) General Requirements

Steel pipe for water mains shall meet the standards of JIS G 3443 or equivalent, requiring for the inner surface one epoxy-tar coating 0.3 mm thick and for the outer surface one coating of asphalt over two layers of vinylon cloth. The former shall comply with the JWWA Standards (Methods of Epoxy Tar Painting or Coating for Waterworks). The outer surface coating shall meet the standard

of JIS 8491 (Asphalt Protective Coatings for Steel Water Pipe). Or equivalent or superior standards may apply, if approved by the Engineer.

ii) Inspection

(a) When receiving inspection, necessary equipment shall be readied including a Holiday detector, electromagnetic micro-thickness gauge, test hammer, surface temperature thermometer, etc.

(b) Procedural Order

(1) Before the primer coating, inspection shall be made of cleanliness of the steel surface, presence or absence of moisture, and temperature of the pipe.

(2) Immediately before the main coating, inspection shall be made of the primer, condition of the surface to be coated, presence or absence of moisture, and temperature of the pipe.

(3) Inner Surface Coating

(3)-1 Visual Inspection

The coating shall adhere well to its surface, be smooth, and be free of injurious scabs, dents, creases, drips, projections, foreign matter, pinholes, or unpainted places.

(3)-2 Pin Holes and Unpainted Places

The entire membranous surface shall be checked with a Holiday Detector. Blisters shall not be created. Voltage shall be as follows:

Asphalt:	8000 ~ 10000 V
Epoxy-tar:	1200 ~ 1500 V

(3)-3 Thickness

Measurement of length shall be done at 4 arbitrarily-selected points around 3 random selected areas, using an electromagnetic microthickness gauge.

(3)-4 Adhesion

A hammering inspection shall be done with a steel hammer of 250 mm handle length and weighing 0.1 Kg. The paint mem-

brane shall be tapped lightly to test wehther or not it peels. Moreover, a stripping inspection shall be made if the Engineer so orders.

(4) Outer Coating

(4)-1 Inspections after the first coating shall be as in (3) above.

(4)-2 Visual Inspection

This inspection shall be for the smoothness of the surface, and whether there is exposure of the surface below.

(4)-3 Voltage for the pinhole examination shall be 10000 ~ 12000 V.

(4)-4 Adhesion

Same as for (3)-4 above.

iii) Later Adjustment or Correction

The coating membrane in areas which have failed inspection shall be carefully removed by knife or chisel. Work shall be redone, starting with the steel surface, which shall be inspected anew. However, if defects are limited to the surface only, the Contractor may take such measures as are ordered by the Engineer.

But, when the defect is due to the occurrence of hydrogen gas, except for very light cases, coating shall be redone from the surface of the steel.

2-5-5 Distribution Main No. 5 ~ No. 8 ~ No. 9

a) Contents of the Work

Straight pipe line includes:

GSP	350 mm dia.	L = 10 m
DCIP	450 mm dia.	L = 84 m
	400 mm dia.	L = 1682.5 m
	350 mm dia.	L = 582 m
	300 mm dia.	L = 25 m
	150 mm dia.	L = 14.4 m
	100 mm dia.	L = 54 m

ACP	300 mm dia.	L = 23 m
	150 mm dia.	L = 21 m
Sluice Valve	450 mm dia.	2 places
	400 mm dia.	1 place
	350 mm dia.	1 place
	300 mm dia.	2 places
	250 mm dia.	1 place
	200 mm dia.	2 places
	150 mm dia.	3 places
	100 mm dia.	5 places
Blow off	150 mm dia.	2 places
Fire hydrant	100 mm dia.	3 places
Air valve	75 mm dia.	1 place
Sluice valve (for air valve)	75 mm dia.	1 place
Road crossing		
GSP	350 mm dia.	L = 10.0 m
DCIP	250 mm dia.	L = 20.0 m
	150 mm dia.	L = 14.4 m
	100 mm dia.	L = 32.0 m
SP	600 mm dia.	L = 40.0 m

b) Scope of the Construction

1) The scope of this construction includes the distribution mains from the point of connection with the aqueduct to point No.9 on the design drawings. For the exact route, reference shall be made to the drawing, "Distribution Main 5 ~ 9 (Super Highway)."

2) The work shall include crossings of the river, road crossings, and installation of sluice valves, air valve, blow offs, fire hydrants, and other miscellaneous work to make the distribution main function effectively.

c) Execution of the Construction Works

1) The same detail design drawings shall be followed in work for river and road crossings as are cited for the distribution main in

b)-1) above.

However, detail design drawings shall be submitted for approval to all concerned public organizations before suspending the 100 mm dia. DCIP main within the box culvert for irrigation where it crosses the Super Highway in certain places. If the Contractor is not able to obtain these approvals, he shall lay the pipe by shielding to the point outside the boundary of the planned expanded zone for the Super Highway. If the Contractor does obtain the approvals, he shall present detail drawings of the work to the Engineer for his approval before commencing work.

2) The area where there will be future expansion along the Super Highway, at point No. 8 on the "Distribution Main General Plan" drawing shall be as shown in the detail drawings. The connection with the planned expansion shall be sealed with a blind flange cap.

3) The connections where the new main crosses the existing 200 mm dia. ACP main near point No. 9 shall be made only after rechecking the position and type of the existing pipe.

4) The blow-off shall be discharged into the water channel crossing the highway. The Contractor shall consult the Engineer and, if required, submit detail drawings to the Highway Department for prior approval.

2-5-6 Distribution Main No. 9 ~ No. 53 ~ No. 51

a) Content of the Construction

Straight pipe line includes:

GSP	300 mm dia.	L = 12 m
	250 mm dia.	L = 26 m
ACP	300 mm dia.	L = 1802 m
	250 mm dia.	L = 151 m
	75 mm dia.	L = 4 m
Sluice valve	250 mm dia.	1 place
	200 mm dia.	2 places

Sluice valve	150 mm dia.	1 place
	100 mm dia.	1 place
	75 mm dia.	1 place
Fire hydrant	100 mm dia.	1 place
Blow off	75 mm dia.	1 place
Road crossing		
GSP	300 mm dia.	L = 12 m
	250 mm dia.	L = 22 m

b) Scope of the Construction

The scope shall be installation of the distribution main from point No. 9 to No. 51 on the Distribution Main General Plan. Boundaries with other construction works shall be as shown in the detail drawings.

c) Instructions for Execution of the Construction Work

1) Between points No. 9 and No. 53, there is an existing main of GSP pipe, 50 mm in diameter, so that care is necessary not to damage it while laying the new main.

2) There is one place near point No. 53 where the main crosses the road. This corssing shall be laid by making an open cut, and care shall be taken not to impede the passage of traffic.

3) Where the new main crosses or follows the existing main, the location of the existing main shall be verified, and the new distribution main so laid that there will be an interval of 30 cm or more between, as a fundamental rule.

There are also places where the new distribution main will cross or come close to culvert pipe or drains. Care shall be used not to impair the effectiveness of existing facilities in the work of laying the new distribution main.

2-5-7 Distribution Main No. 51 ~ No. 58

a) Content of the Construction

Straight pipe line includes:

GSP	250 mm dia.	L = 41 m
	200 mm dia.	L = 181 m

ACP	250 mm dia.	L = 2208 m
	200 mm dia.	L = 1383 m
	75 mm dia.	L = 46.2 m
Sluice valve	250 mm dia.	2 places
	200 mm dia.	2 places
	150 mm dia.	2 places
	100 mm dia.	6 places
Fire hydrant	100 mm dia.	6 places
Blow off	75 mm dia.	4 places
Air valve	75 mm dia.	3 places
Sluice valve (for air valve)	75 mm dia.	2 places
River crossing		
GSP	200 mm dia.	L = 163 m
Road crossing		
GSP	250 mm dia.	L = 41 m
	200 mm dia.	L = 18 m

b) Scope of the Construction

1) The scope shall be installation of the distribution main from point No. 51 in front of the railway station, connecting to the ACP pipe 250 mm in diameter to the reducer from 250 to 200 mm diameter at point No. 58 as shown on the Distribution Main General Plan.

2) Work of suspending the pipe lines to the highway bridge at two places shall be part of the scope of this construction.

c) Execution of the Construction Work

1) The crossing with the H. P. 800 mm dia. culvert pipe in front of the army camp shall be made, using care not to damage the H. P. pipe.

2) The attachment of the main to the bridge, between points No. 56 and No. 57 as well as the attachment to the bridge between points No. 57 and No. 58 on the Ping River, in which GSP 200 mm dia. pipe shall be used, shall be done after making detailed work drawings with reference to the design drawings, and presenting them for

approval to the Engineer. Also, the Contractor shall obtain prior approval of concerned government or official organizations.

3) Between points No. 56 and No. 57 there are large trees immediately beside the course for laying the main. Care shall be exercised not to damage the roots of these trees during the work.

2-5-8 Distribution Main No. 73 ~ No. 58

a) Content of the Construction

Straight line pipe includes:

GSP	250 mm dia.	L = 26 m
ACP	250 mm dia.	L = 1924 m
Sluice valve	250 mm dia.	1 place
Fire hydrant	100 mm dia.	1 place
Road crossing		
GSP	250 mm dia.	L = 26 m

b) Scope of the Construction

The scope of this work shall be installation of the distribution main from point No. 73 to point No. 58 as shown in the Distribution Main General Plan. Connections of this sector of the main to the sectors on either end shall be part of the construction work of the two adjacent sectors.

c) Instructions for Execution of the Construction Work

1) This main shall cross another road at one point, which crossing shall be an open cut. There is also one place where the main crosses a culvert pipe, and the work at this point shall be done carefully after verifying the location of the culvert pipe. GSP 250 mm in diameter shall be used.

2) At other points where the main crosses pipe culverts, the earth covering shall be as shown in the design drawings.

2-5-9 Distribution Main No. 16 (Chiang Mai W. T. P. No. 1) ~ No. 73

a) Content of the Construction

Straight line pipe includes:

GSP	300 mm dia.	L = 30.0 m
	250 mm dia.	L = 39.0 m
	200 mm dia.	L = 38.0 m
	75 mm dia.	L = 13.0 m
ACP	300 mm dia.	L = 791.5 m
	250 mm dia.	L = 17.5 m
	200 mm dia.	L = 1348.5 m
	75 mm dia.	L = 2.0 m
Sluice valve	300 mm dia.	3 places
	250 mm dia.	1 place
	200 mm dia.	5 places
Blow off	75 mm dia.	2 places
Air valve	75 mm dia.	1 place
Sluice valve (for air valve)	75 mm dia.	1 place
Road crossing		
GSP	300 mm dia.	L = 7.0 m
	250 mm dia.	L = 39.0 m
	200 mm dia.	L = 38.0 m
	75 mm dia.	L = 13.0 m

b) Scope of Construction

1) The scope of the work shall be the installation of the connection between the ACP 300 mm dia. existing distribution main at point No. 16 and the distribution main at point No. 73.

c) Instructions for Execution of the Construction Work

1) Regarding the jointing of existing distribution mains and the proposed mains, the Contractor shall consult with the Engineer concerning the method to joint without stopping the flow.

2) This sector of distribution main will pass through the center of the town, so that conditions may adversely influence the work of

laying the main. So, careful planning should precede beginning the work.

3) Traffic on the streets will be heavy. So, the Contractor shall consult adequately with traffic authorities in the city offices, and obtain prior approval if it is necessary to stop traffic or set up detours. The Contractor shall endeavor to complete the construction speedily and shall post necessary traffic signs so that traffic will flow smoothly along the detours, etc., and shall plan the construction schedule so as to minimize traffic jams.

4) Since there are numerous crossings and connections with existing mains in this sector, the locations of existing piping shall be verified, after which work shall be done as shown in the design drawings.

5) A blow-off shall be installed just before point No. 73. The design drawings indicate that this water be discharged into a nearby sewerage channel. But the Contractor shall do this work only after consulting concerned public offices and obtaining their prior approval.

6) Crossing of all other roads shall be done by open cut, which shall be done so as not to obstruct traffic.

7) When traffic signals are used for detours or closing of roads, the Contractor shall do such work at his own expense.

2-5-10 Distribution Main No. 1 ~ No. 23

a) Content of the Construction

The straight pipe line includes:

GSP	200 mm dia.	L = 9.5 m
DCIP	500 mm dia.	L = 1738.0 m
	350 mm dia.	L = 531.0 m
ACP	200 mm dia.	L = 3.0 m
	150 mm dia.	L = 8.0 m
Sluice valve	350 mm dia.	1 place
	250 mm dia.	3 places
	150 mm dia.	1 place

Blow off	200 mm dia.	1 place
	150 mm dia.	1 place
Air valve	75 mm dia.	2 places
Sluice valve (for air valve)	75 mm dia.	2 places
River crossing		
DCIP	500 mm dia.	L = 3.5 m
Road crossing		
GSP	350 mm dia.	L = 30 m
	200 mm dia.	L = 7.5 m

b) Scope of the Construction

The scope of this work comprises installation of the distribution main from point No. 1 on the Super Highway running through the center of the city, and extending westward along the north side of the city walls to the library at point No. 23 as shown on the "Distribution Main General Plan" drawing. Connections with the mains at either end of this sector shall be part of the scope of this construction. The scope is shown in detail by the full line on the design drawing.

c) Instructions for Execution of the Construction Work

1) Like the sector between point No. 16 and point No. 73, traffic is heavy in the sector herein described, so the Contractor shall take special precautions not to disturb traffic while doing the work. Depending on circumstances, the Contractor may unavoidably be forced to do the work at night, and should have ready for use illumination and other night work equipment.

2) The road is not very wide, and the Contractor must be careful not to damage electric poles, trees, etc. while doing the work.

2-5-11 Distribution Main No. 23 ~ No. 70

a) Content of the Construction

Straight line pipe includes:

GSP	200 mm dia.	L = 165.0 m
	75 mm dia.	L = 4.0 m
DCIP	350 mm dia.	L = 770.0 m
ACP	200 mm dia.	L = 2359.0 m
	100 mm dia.	L = 4.0 m
	75 mm dia.	L = 14.0 m
Sluice Valve	350 mm dia.	1 place
	300 mm dia.	1 place
	200 mm dia.	6 places
	100 mm dia.	2 places
	75 mm dia.	2 places
Fire hydrant	100 mm dia.	1 place
Blow off	75 mm dia.	2 places
River crossing		
GSP	200 mm dia.	L = 8.0 m
Road crossing		
GSP	200 mm dia.	L = 88.0 m

b) Scope of the Construction

The scope of the work shall be the installation of the distribution main from point No. 23 to point No. 70 on the "Distribution Main General Plan" drawing. At point No. 23, connection shall be made with the pipe running west along the north side of the walled city. Future extension of the main from point No. 70 is planned. Therefore, a blind flange cap shall be installed at point No. 70.

c) Instructions for Execution of the Construction Work

1) There are many existing pipes laid in this sector. The Contractor shall do the work after making a survey, and adequately verifying the locations of all underground pipes and installations.

2) Future plans are to lay several pipes in the sector between point

No. 69 and point No. 70. The Contractor shall establish the distribution pipe route for the present work with due allowance for these future plans.

3) Places where the new distribution main crosses existing pipe lines, work shall be done carefully as shown in the design drawings.

4) Connections with the ACP 300 mm dia. distribution main shall be made so as not to stop the water service.

5) The distribution main crosses a culvert pipe for ditch near point No. 69. The main shall be laid by open cut or by shielding after checking the underground position and condition of the culvert. The Engineer shall be consulted in planning this work.

6) The river crossing just before point No. 70 shall be done with GSP 200 mm dia. pipe. The pipe beam used for the crossing shall be firmly anchored in place by concrete block on both banks. The Contractor shall present a detailed work drawing to the Engineer for prior approval before beginning work.

2-5-12 Distribution Main No. 34 ~ No. 88 ~ No. 69

a) Content of the Construction

Straight line pipe includes:

ACP	200 mm dia.	L = 1170.0 m

b) Scope of the Construction

The scope of this work shall be the installation of the distribution main on the "Distribution Main General Plan" drawing running south from point No. 34, then extending eastward from the southeast corner of the walled city, and including connection at point No. 69 with the pipe going southward. Also included shall be the connection at point No. 34 with the existing ACP 300 mm dia. main.

c) Instructions for Execution of the Construction Work

1) The Contractor shall verify anew the underground location of the existing main at point No. 34, and make the connection with this main so that water service will not be interrupted.

2) At point No. 69, the Contractor shall install a sluice valve just before the connection with the 200 mm dia. ACP pipe, and shut it off.

2-6 Architectural Works

2-6-1 Scope of the Architectural Works

a) Raw Water Intake Area

1) Raw Water Pump Room
2) Generator Room
3) Lodging House (staff quarters)
4) Warehouse

b) Water Treatment Plant

1) Office
2) Chemical Dosing Room
3) Generator Room
4) Rapid Sand Filter Control Room
5) Lodging House (staff quarters)
6) Warehouse
7) Distribution Pump Room
8) Elevated Tank

c) Installation of equipment for the above-listed architectural structures include the following service installations:

1) Plumbing Works Installation
2) Water Service Works Installation
3) Drainage Apparatus Installation
4) Gas Apparatus Installation
5) Ventilation Apparatus Installations

2-6-2 Separate Installation Works

a) Exterior water service piping shall be done as part of the works of section 2-6-1, as shown on the Drawings.

b) Pipe shafts and inspection holes shall be done as part of the building construction works.

c) Electric installations shall be done as part of the electric installation works.

d) Kitchen equipment and utensils shall not be part of the Contractor's responsibility.

e) Propane gas cylinders shall be furnished or lent by the gas company.

Regarding architectural works described in 2-6-1 (Scope of the Architectural Works), sections a) and b), specifications for materials, etc. are shown on the drawings. Therefore excepting for works described in section 2-6 (Architectural Works) and in section 2-7 (Electrical System for Architectural Works), and also excepting works described in the Special Conditions, all work shall be done in accordance with the Drawings. In case of doubt, the Contractor shall consult the Engineer and follow his instructions.

2-6-3 Outline of the Work

a) The Contractor shall consult the Engineer regarding the details of finishing interiors, etc. before installing sanitary fixtures and cocks. Installation shall be orderly and secure.

b) Service Water Facilities

The Contractor shall make installations to supply service water, by the head in the service main, to each of the service cocks as shown in the Drawings. This work shall comply with the standards and regulations of concerned government and public bodies.

c) Drain Facilities

The Contractor shall make installations to discharge by gravity flow into a terminal permeation pit the drainage water from all the various equipment producing drainage water.

d) Gas Equipment

The construction work shall include installations to regulate the pressure of gas from propane gas cylinders, then send it by piping as far as the gas cock, as shown in the Drawing.

e) Ventilation Equipment

A ventilating fan shall be installed in the place shown in the Drawing to provide a forced exhaust.

2-6-4 Special Specifications

a) Instructions for Equipment and Materials

1) Sanitary Fixtures and Water Cocks

Sanitary porcelain fixtures and their metal accessories shall be first class items. Visible parts of the metal fixtures shall be chrome plated.

2) Drain Metal Fittings

The water seal depth of the traps for drains shall be 50 mm or more. Effective area of the drainage holes in strainers shall be equal to or greater than the cross-sectional area of the drain pipe.

i) Floor drain traps shall have cast-iron bodies, with brass strainers, finished with chrome plate. In case a waterproof layer is installed, a B-type waterproof layer shall be used; otherwise, Type-A shall be used.

ii) Sink traps shall have cast-iron bodies, with a brass basket inside. Strainers shall be brass finished with chrome plating.

iii) The floor cleaning outlet shall be a screw-in type of brass finished with chrome plating. When a waterproof layer is installed, the plate shall be Type B; otherwise, Type A shall be used.

3) Permeation Pit

The tank shall be concrete, finished inside with waterproof mortar. The bottom shall have invert shaping appropriate for the pipe diameter. A cover shall be provided to prevent odor.

4) Ventilating Fan

The ventilating fan shall be regulated by a balancing machine, so that its static and moving balances are good, and there is little vibration or noise during operation. Capacity shall be as specified. Also, the electric motors shall conform to the rules, regulations and requirements of the Provincial Electrical Authority.

5) Piping Materials

Materials for pipe and joints shall be as listed below:

Item	Material of Pipe	Joints
Service Water Pipe	Galvanized steel pipe for waterworks use	Screw-type forged cast-iron joints (galvanized) Screw-type steel pipe joints (galvanized)
Drainage and Ventilation Pipes	Carbon steel pipe for mains Polyvinyl chloride pipe Lead pipe for drain use Centrifugal reinforced concrete pipe	Screw-type drainage pipe joints Vinyl pipe joints
Gas Pipe	Carbon steel service main pipe Jointless copper pipe	Screw-type forged cast-iron joints (galvanized) Screw-type steel pipe joints (galvanized)

6) Valves

Valves shall pass the requirements of the concerned waterworks department.

b) Instructions for Execution of the Construction Work

1) Installation of the Sanitary Fixtures

When wall fixtures are fastened to a concrete wall, expansion bolts shall be used. When the fixtures are attached to wood or brick walls, the fixtures shall be treated with antiseptic chemicals, then firmly attached to the wall.

When part of a porcelain fixture is embedded in a concrete wall, the contacting areas of the porcelain and concrete shall be covered with a 3 mm or more coating of asphalt.

i) The toilet fixture shall be placed accurately, with respect to levelness and height, in the specified location for installing it on the floor, then fastened down firmly. The joining of the toilet fixture and its lead drain pipe shall be done by first placing wax or non-dessicant sealing material to an appropriate thickness on the

mouth of the drain pipe, then inserting the outlet of the toilet fixture so that it is not tilted. More filler material shall be used on the upper edge of the joining until the crack is completely sealed, and there is a thick layer of sealing material on top. The flushing pipe for the toilet fixture shall be connected by means of a spout fitting to a lead pipe so that there will be no leakage. The spout fitting shall be coated with asphalt and the lead pipe shall have a waterproof linen wrapping.

ii) The urinal shall be installed accurately in the specified place. The socket of the drainage fitting for the urinal and the open end of the lead drain pipe in the floor shall be solidly connected by soldering. The urinal shall be installed in its specified place, and the crack between the urinal and the drain fittings shall be filled adequately with non-desiccant seal or wax, and made tight.

iii) The wash basin and hand basin shall be set in their specified places; brackets or backhangers shall be firmly attached, and the basins shall be fixed in place, immovable, level, and without incline. The cracks between the basins and the drain fittings shall be adequately sealed with wax so there will be no leakage, and made tight.

iv) As a basic rule, the heights at which equipment shall be installed are as follows:

Equipment	Installed Height(mm)	Notes
Urinal	530	From floor to top of front edge
Wash Basin	720	(same as above)
Hand Basin	760	(same as above)
High Tank for Wash Water, Automatic	2200	From floor to the lower edge of the tank
High Tank for Wash Water, Manual	1800	(same as above)
Low Tank for Washing	500	(same as above)
Cock, Sink	300	From sink floor to the mouth of the faucet
Cock, Hand Basin	150	To the top of the front edge

2) Piping Work

The pipes shall all be cut vertically to the long axis, and the edges of the cut finished smooth, using tools which will not reduce the diameter at the mouth.

The Contractor shall check the interiors of all pipes before making connections, making sure there is no foreign matter inside, and adequately cleaning the pipe. If the work is temporarily halted, the pipe shall be taken care of so that foreign materials do not get inside.

i) Connecting screw for steel pipes shall be male tapor screws. When necessary, red lead shall be dissolved in vegetable oil, and a small amount applied.

ii) In connecting cast-iron drain pipe, the spigot shall be inserted till it rests against the end of the socket. Then yarn shall be wedged in evenly to a depth of 25 mm from the lip of the socket, and melted lead flowed in. This shall be perfectly caulked.

iii) Connections for lead pipe shall be done by soldering.

iv) Vinyl pipe connections shall be made by cold-working. Connections shall be made so that ridges are not created to interfere with flow in the pipe.

v) Connections of concrete pipe shall be done by bringing both ends close together at the centers of the collar, and fixing the ends in place so there is no unevenness in the seam, then filling in with stiff mortar (1 : 1 mixture).

3) Service Piping

Before the actual installation of the service piping, the Contractor shall check in detail instructions and specifications for the various related equipment and its piping, shall plan the gradients, and verify the locations. As the building construction progresses, he shall without delay install fittings and imbed sleeves required for the service pipe. Piping without an anti-moisture protective covering shall have installed metal supports for contacting parts where the pipe passes

through walls, floors or ceilings. Where steel or lead pipes pass through the ground, the pipe shall have two coatings of coal tar. Where concrete pipe is used, it shall have a linen waterproof wrapping.

i) As a basic rule, gradients of drain pipes shall be 1/50 for pipe with diameters of 75 mm or less, and 1/100 for pipes over 75 mm in diameter.

ii) As a basic rule, the support intervals for horizontally laid pipe shall be as follows.

Type of Pipe	Maximum Support Interval (meters)
Steel Pipe	
20 mm or less	1.8 m
21~40 mm or less	2.0 m
41~80 mm or less	3.0 m
81~150 mm or less	4.0 m
Cast iron pipe drain use	1.6 m
Lead pipe drain use	1.0 m
Vinyl chloride pipe	
40 mm or less	1.2 m
41 mm or more	1.5 m

4) Service Pipe Tests

Tests shall be made for piping during the installation, before concealment, or before doing the covering after installation.

i) A full water test of the piping shall be made of the piping during the installation, or before concealing underground, and before putting on the covering after completing the work of installation.

5) Ventilation Installations

The frame for the fan shall be imbedded in place and fastened down so it is adequately solid. A weather cover shall be installed in the air outlet to prevent rain leaking in, and an insect screen shall be provided.

2-7 Electrical System for the Architectural Works

2-7-1 General Conditions

These specifications are for illumination and other miscellaneous electric equipment and the installation of electrical wiring and conduits required for the buildings of the new water treatment plant.

2-7-2 Scope of Installation of the Electrical System

The work for the power source shall be included in other, separate construction work. Electric wiring work from the cabinet panel to the illumination circuits and also to the plug socket circuits shall be part of the work described herein in section 2-7.

The wirings shall be installed as follows:

Illumination	Single phase	three-wire system	380V/220V
Fluorescent Lamp	"	"	220 Volt
Incandescent Lamp	"	"	220 Volt
Plug Socket	"	"	220 Volt
Ceiling Fan	"	"	220 Volt

The scope of the electric apparatus installation work shall include all the illumination equipment, plug socket equipment, and their wirings including conduits and also including telephone conduits. The Contractor shall attend to field testing at the time of installations. The main power trunk and wiring work shall not be included in the work of this section, excepting for the special sector shown on design drawings.

2-7-3 Illumination Equipment

a) Illumination and plug socket equipment for the building construction as well as all wirings with their conduits for power distribution from the cabinet panel to the various electric equipment shall be executed as a part of the work of the installation of electrical equipment for the buildings.

b) General Specifications for Fixtures

1) Illumination fixtures should be manufactured of high grade finished

steel plate (or reinforced plastic) 0.6 mm in thickness or more, and finished with baked enamel coating, the color of which shall be specified by the Engineer. Fixtures specially indicated shall be of water-proof construction.

2) General Fluorescent Fixtures

Rated voltage: 230 volt

Lighting system: rapid start system 40 W or larger
glow switch system 30 W or smaller

Power factor: high power factor, as a general rule

Lamp fixtures and installation shall be as indicated in the design drawings.

3) Incandescent Lamps

Rated voltage: 230 volt

Durability: 1000 hours or more

4) Cabinet Panel for Illumination

i) The Contractor shall make this cabinet of high grade finished steel plate with a frame to provide sufficient strength.

ii) The metal for the door of the cabinet shall be 2.3 ~ 3.2 mm thick and the other faces shall be 1.6 mm or thicker, and strongly built.

The door handle of the cabinet shall be fitted with a lock and door hinges shall be invisible.

The card holder shall be attached at a prominent place inside of the cabinet for posting the number of circuits and their functions to facilitate operation.

iii) The operational panel of the cabinet shall be of attractive appearance, so arranged that only the handles of the switches project from the surface. The neutral conductor terminals shall be located under the switch handles on the operational panel.

This arrangement on the operational panel shall be such that inspection and insulation testing of circuits is easy. The grounding terminal shall be installed in the cabinet, using 8 mm diameter or

larger wire, so that the grounding is electrically and mechanically complete.

5) Installation of Fixtures

The installed height above the floor of switches and plug sockets shall be as shown below, unless otherwise indicated on the drawings.

Switch (height from floor):	1200 mm
Plug socket (height from floor):	300 mm
Cabinet panel (height of upper edge of panel from floor):	1800 mm

6) Miscellaneous

Heavy illumination fixtures and suspended illumination fixtures shall be installed with fixture studs and hickies to ensure adequately secure and safe installation.

2-8 Electrical Works

2-8-1 General Conditions

a) Outline

These general conditions apply ideatically to this installation of instrumentation for both the raw water pump plant and the water treatment plant, unless otherwise specified. The Contractor shall conform to all laws, regulations, and standards, and shall perform the work in accordance with the Specification and with the instructions of the Engineer. Matters not determined by the Specifications or Contract Drawings shall be subject to instruction from the Engineer. All details which follow are as shown in the Specifications or Contract Drawings.

1) The Construction Work

Even though the item may not be specified in these specifications or the attached drawings, the Contractor shall provide or complete, at his own expense and as directed by the PWD, any item which is normally required, as a matter of course, for the construction or facilities.

2) Contractor's Field Agent

The Contractor shall appoint a contractor's representative or superintendent and a technical foreman, notifying the PWD in writing, and obtaining their approval of these appointees.

3) Tests

On completion of this work, the Contractor shall conduct tests of insulation strength, and insulation resistance,

in the presence of the Engineer and other concerned parties. Following the successful passing of those tests, the Contractor shall similarly conduct operational testing.

h) Required Documents

Contractors for this work shall submit the specified number of copies of the following documents, as directed, and at his own expense.

i) Construction Schedule

ii) Approval Drawings

The Contractor shall send, without delay after concluding the Contract, the engineer or technician supervising the work to the PWD for detailed consultation, based on the Specifications and the Contract Drawings regarding making the following drawings.

(1) Three wire connection diagram.

(2) External drawings of the various equipment, detailed drawings, and wiring connection drawings.

(3) Drawings of connective wiring between the various equipment and drawings showing types of wiring, diameters, number of core wires, and number of cables or wires.

(4) General arrangement diagram for the equipment.

(5) Drawings of foundations for equipment.

(6) Detail drawings of pipe lines and systematic drawings.

(7) Other drawings as ordered by the Engineer.

iii) Finalized Drawings

The Contractor shall submit finalized drawings within (14) days after return to the Contractor of the approval drawings.

iv) Miscellaneous

(1) Operational manuals necessary for operation and maintenance

(2) Manuals for handling the various equipment.

(3) Charts of test results for the various equipment.

(4) Completion drawing for all facilities.

(5) Charts measuring grouding and resistance.

(6) Chart of test results of insulation of the various circuits.

5) Basic Standards

i) ISO

ii) IEC

6) Period of Guarantee

The Contractor shall guarantee the work herein performed for one year after completion and delivery. In event failure occurs during this period for reasons which are the responsibility of the Contractor, the Contractor shall speedily, without recompense, rebuild or repair the faulty work within the period specified by the PWD. Or the Contractor may be required to replace the faulty material with new equipment.

b) Scope of Construction Work

1) Outline

The construction herein described shall cover all the work for instrumentation for both the raw water pump plant and the water treatment plant, unless otherwise specified. Contractors shall refer to the Contract Drawings for details of the work, shall consult with the Engineer, and submit to him detailed work drawings. The Contractor shall follow instructions of the Engineer with regard to work in places where future expansion is planned, and shall exercise care that future expansion is not made difficult.

2) Division of Work

Raw-Water Intake		Water Treatment Plant	
i)	Sub station facilities	i)	Sub-station facilities
ii)	Plant generator equipment	ii)	Plant generator equipment
iii)	Installation of main electric lines	iii)	Installation of main electric lines
iv)	Power equipment for raw water pump	iv)	Distribution pump power equipment
v)	Instrumentation	v)	Power equipment for the sedimentation
		vi)	Instrumentation
		vii)	Installation of outdoor illumination

3) Materials Used

1) Electric wire

(1) 600V polyethylene insulated vinyl sheathed cable (EV)

(2) Control vinyl insulated vinyl sheathed cable (CVV)

(3) Same as above shielded (CVVS)

(4) 600V vinyl-covered wire (IV)

(5) Other special cable for special use with the equipment

ii) Conduit Tube

Pipe for wires and cables shall basically be conduit tube, namely vinyl-covered flexible conduits from the projections of the terminals of the equipment, to protect the cables.

2-8-2 Raw Water Intake Plant

a) Sub-Station Facilities

1) Outline

This work as shown in the Contract Drawings, shall be constructed outdoors near the generator room, installing a single aerial circuit wire of 3Ø 3 W 11 KV 50HZ from the main trunk line to a transformer where the power is coverted to 3Ø 4 W 380V/220V and delivered to the loads as their power source.

The outdoor steel contruction and foundations for the equipment shall also be included in the work herein described.

2) Installations and Equipment

i)	Single pole disconnecting switch:	6 units
ii)	Oil circuit breaker:	1 unit
iii)	Lightning arrester:	3 units
iv)	Current transformer:	3 units
v)	Main transformer:	1 unit
vi)	Instrument transformer:	1 unit
vii)	Transformer secondary panel:	1 panel
viii)	Feeder panel:	1 panel
ix)	Bus bar panel:	1 panel
x)	DC panel:	1 panel

3) Scope of the Construction

i) Installation of the equipment listed in (2) directly above.

ii) Construction of foundations and suspended platforms as necessary for equipment listed in (2) directly above.

iii) Installation and assembly of the outdoor steel frame work.

iv) Installation of special high bus bar and overhead ground wire.

v) Installing and connecting wiring, power cables and control cables.

vi) Construction of troughs and manholes for the work listed above.

vii) Grounding work

viii) Construction of a fence for the outdoor receiving transformer station.

ix) Other miscellaneous work.

4) Works Included with Other Construction

i) Construction of a pit for wiring.

ii) Boring holes in walls for wiring.

iii) Installation of meter and MOF.

5) Specifications of the Equipment

i) Single pole disconnecting switch 6 units

Outdoor, single pole, single throw, vertical,

Single point breaking, 12 KV, 600A or more, operated by a hook pole

Short interval current 18.1 KA or more

ii) Oil circuit breaker 1 unit

Outside insulator type oil circuit breaker, 12 KV, 600A or more

Breaking capacity, 1000 MVA or more; breaking interval, 8 cycles or less

Rated throwing current: 131,3 KA or more

Operation system: Solenoid-operated, operating voltage DC 100 V

iii) Lightning arrestor, outdoor type 3 units

Rated voltage 14 KV, discharging current 10 KA, shock starting voltage, 50 KV

iv) Current transformer

Outside-type, automatic oil cooled, frequency 50 Hz

Output: Three-phase 500 KVA continuous

Connection: △ - Y Three-phase, 4 line type

Primary voltage: 11.5/11/10.5/9.5 KV

Secondary voltage: 380/220V

% impedance: 5%

Accessaries: Name plate, no voltage tap transition stand, suspension straps, ground terminals, thermometer, protection equipment, fittings, maintenance items, neutral point current transformer, ground over load current relay

vi) Three phase instrument transformer

Outside, oil-sealed type, 11000 ÷ 110, rated load 2x200VA

Error class, 1.0

Accessories: primary fuse for disconnecting switch

vii) Secondary panel for transformer

(1) Type: Metal, indoor starding closed type

(2) Size: Submit approval drawing to Engineer, based on the attached drawings, for his decision

(3) Internal equipment:

(a) Single pole disconnecting switch: 4 unit

Single pole double throw: 600V 1200A or more, hook pole

Short time current: 30 KA or more

(b) Current transformer: 3 units

Molded type, 420V, 100 ~ 5A, error class 1.0

Rated load, 40 VA; over current intensity, 30 or more

(c) Three phase instrument transformer 1 unit

Molded type 400 ~ 100V, error class 1.0

Rated load 2 x 50 VA, with primary fuse

(4) Installations for the Panel

(a)	AC ampere meter	3 each
(b)	AC voltmeter	1 each
(c)	Switches for (1) and (2)	1 each
(d)	3-phase wattmeter	1 each
(e)	3-phase power factor meter	1 each
(f)	Three phase KWH meter	1 each
(g)	Frequency meter	1 each
(h)	Signal lamp	1 each
(i)	Over current relay	3 each
(j)	Ratio differential realy	3 each

viii) Feeder panel 1 panel

(1) Type Metal indoor standing, closed type

(2) Size Submit approval drawing, based on the attached drawings, to the Engineer for his decision.

(3) Internal equipment

(a) Three phase distributing circuit breaker

420V, breaking current, 30 or more

Rated current and quantity shall be as shown in the attached drawings

(b) Neutral line knife switch

Single pole single throw 420V Quantiting as shown in contract Drawings

(b) Current transformer 2 items

Molded type, 420V 1000 - 5A, error class, 1.0,

Rated load = 40VA, over current intensity, 30 or more

(c) Current transformer for neutral point of main transformer and knife switch 1 set

Accessories for main transformer

(4) Installations on panel

(a) AC Ampere meter 1 each

(b) Switch for above 1 each

(c) AC voltmeter 1 each

(d) Switch for above 1 each

(e) Ground over load current relay 1 each

(accessary for main transformer)

ix) Bus bar connection board 1 panel

(1) Type: Metal indoor standing closed type

(2) Size: Submit approval drawings, based on the Contract Drawings, to the Engineer for his decision

(3) Internal Equipment

(a) Single pole disconnecting switch 4 each

Single pole, single throw, vertical, one point cut contact, 600V, 1200A or more, hook pole operated; short time current, 30 or more

x) DC panel 1 panel

(1) Type: Metal, indoor standing, closed type, battery, rectifier

(2) Size: Submit approval drawings, based on the Contract Drawings, to the Engineer for his decision

(3) Internal equipment:

(a) Silicon rectifier 1 set

Rectifying system:	Three-phase, all wave
Cooling system:	Self-cooling
Rating:	Continuous
Input:	3 Ø 380V 50 Hz
Output:	113.6 V ±3% (floating)
	121.6 V ±3% (mean)
	90 ~ 140 V
Output current:	10 A

(b) Pocket-type alkali battery: 1 set

Rated capacity:	40 AH/5hr
Rated voltage:	96 V
No. of single cell batteries:	80 each

(c)	Automatic constant voltage equipment	1 set
(d)	Three-phase distribution circuit breaker	1 unit
(e)	Transformer	1 unit
(f)	Resistance box	1 unit
(g)	Control circuit	1 unit
(h)	Distribution device	1 unit
(i)	Relays	1 unit
(j)	Other necessary items	1 unit

(4) Accessories for panel

(a)	DC ampermeter	2 each
(b)	DC voltmeter	1 each
(c)	Switch	1 each
(d)	Voltage out put regulator	1 each
(e)	Indicator lamp	1 unit

6) Accessories

i)	Maintenance equipment foroil circuit breaker	1 unit
ii)	Inspection light (with cord)	1 unit
iii)	Maintenance items for the transformer secondary panel	1 unit
iv)	Maintenance items for the DC panel	1 unit

7) Spare Parts

Fuses, signal lamps	Amount for actual operation plus a 2 year operation supply

b) Plant Generator Equipment

1) Summary

This equipment shall be installed in the generator room as an emergency power source when there is a stoppage of electric current supervision and control of the facilities shall be within the generator room.

2) Installations and Equipment

i) Diesel engine

ii) Three phase induction generator

iii) Generator starting panel

3) Scope of the Works

i) Installation and adjustment of the equipment listed in (2) directly above

ii) Installation of power source and wiring and connection for control cable

iii) Installation, piping and wiring for auxiliary equipment

iv) Other works necessary in relation to the works listed above

4) Works Included with Other Construction

i) Construction of the foundation for the diesel engine

ii) Construction of a pit for wiring

iii) Boring holes in walls for wiring

5) Specifications of the Equipment

1) Diesel engine 1 set

(1)	Type:	4 cycle vertical type
(2)	Output	600 HP, or more
(3)	Revolutions	1000 rpm
(4)	Fuel Oil	A-type heavy oil
(5)	Cooling system	Radiator system
(6)	Lubricating system	Pressure lubrication
(7)	Starting system	Compressed air

(8) Accessories

(a) Engine accessories

Cooling water pump	1 set
Lubricating oil pump	1 set
Fuel oil pump	1 set
Lubricating oil cooler	1 set
Lubricating oil filter	1 set
Fuel oil filter	1 set
Governor	1 set
Tachometer	1 set
Various pressure meters	1 set
Various thermometers	1 set
Supercharger	1 set
Air cooler	1 set
Radiator	1 set

Other necessary items

(b) Engine turning bar 1 set

(c) Engine assembly tools 1 set

(d) Starting air compressor (with motor) 1 item

(e) Compressed air tank, accessories 1 set

(f) Silencer 1 set

(g) Fuel service tank (with flame),3-hour supply 1 set

(h) Cooling water service tank (with flame),1000 liter 1 set

(i) Anchor bolts and nuts 1 set

(j) Vibration-proof bed 1 set

(k) Fuel oil gear pump (with motor) 1 item

(l) Fuel oil wing pump 1 set

(m) Assorted gauges 1 set

(9) Spare parts

(a) Pistonring and oilring 1 set

(b) Air valve and spring 1 set

(c) Assorted pipes for maintenance 1 set

(d) Assorted springs, packing, and pins 1 set

ii) Three Phase Induction Generator

(1) Type: Open-guarded, self-cooling type with rotating salient field

(2) Output: 500 KVA, continuous

(3) Voltage: 3 ϕ 4 W 420V/242V

(4) Frequency: 50 Hz

(5) Power factor: 80% lagging

(6) Revolutions: 1000 rpm

(7) Poles: 6 poles

(8) Exciting system: Self-excitation by static exciter

(9) Overload: The generator shall be capable of running one hour continuously with a load of 110% rated output

(10) Overspeed: The generator shall withstand the mechanical forces of 110% rated speed of revolution for one minute under conditions of no load.

(11) Voltage regulation: Assuming the speed fluctuation ratio to be 3.5% the regulated voltage, when the load is varied from zero load to full load, shall be within ± 1.5% of rated voltage at all points.

(12) Instantaneous voltage fluctuation ratio: When a circuit breaks while the generator is operating under full load, the voltage fluctuation ratio shall be within 20% and shall be within ± 1.5% of rated voltage within five seconds after the circuit break.

(13) Efficiency: Total efficiency under full load, with the power factor 80% or higher, shall be 90% or more.

(14) Accessories

(a) Speed reduction switch: 1 set

(b) Coupling: 1 set

(c) Bolts and nuts: 1 set

iii) Generator Starting Panel 1 item

(1) Type: Metal, indoor, closed type

(2) Size: Submit approval drawing to Engineer based on the design drawings

(3) Internal equipment:

(a) Three phase distributing circuit breaker: 1 unit
440V, 1000A, breaking current more than 30 KA

(b) Neutral line knife switch: 1 unit
Single pole, single throw, 440V

(c) Three phase instrument transformer: 1 set
Molded type, 440 - 110V, error class 1.0 rated load 2 x 50 KVA, with primary

(d) Current transformer: 2 units
Molded type, 440V, 1000:5A
Error class; 1.0, rotating head, 40 VA

(e) Static exciter: 1 set

(f) Automatic constant voltage device: 1 set

(g) Auxiliary relay: 1 set

(h) Auxiliary materials and operating equipment 1 set

(i) Bell, buzzer for alarm: 1 set

(4) Fixtures for panel

(a) AC ammeter: 1 item

(b) Ammeter switch: 1 item

(c) AC voltmeter: 1 item

(d) Voltmeter switch: 1 item

(e) Three phase KW meter: 1 item

(f) Three phase power factor meter: 1 item

(g) Three phase KWH meter: 1 item

(h) Frequency meter: 1 item

(i) Various signal lamps: 1 set

(j) Various switches: 1 set

(k) Over current relay: 2 items

(l) Over voltage relay: 1 item

(m) Failure indicator: 1 set

(5) Spare parts

(1) Various lamps: Number of actual use

(2) Various fuses: Number of actual use

6) Protection of Equipment

i) If failures listed below occur when starting or during operation, a failure indicator shall operate, and an alarm bell shall be sounded, simultaneously, the diesel engine shall stop, and the generator circuit breaker shall automatically open.

(1) Engine overspeed failure

(2) Loss of lubricating oil pressure

(3) Cooling water stoppage

(4) Excess voltage

(5) Delay or failure in starting

ii) When failure listed below occurs during operation, and indicator and alarm shall be set into operation, and the generator circuit breaker shall automatically open.

(1) Over current

iii) When the failures listed below occur during operation, a failure indicator and a buzzer alarm shall be set into operation.

(1) Oil level falls below minimum in the fuel oil service tank

(2) Temperature of cooling water rises above critical point

(3) Temperature of lubricating oil rises above critical point

c) Installation of Main Electric Lines

1) Summary

The works herein described include electric cable wiring from the secondary panel of the transformer at the sub-station to the control center and also to the distributing board for the illumation system in the various rooms. Also, the wiring and related works for the control cable from the instrumentation panel to the control center shall be part of this work.

2) Scope of the Works

i) Installation of electric cable wiring from the secondary panel of the transformer to the control center installed in the raw water pump room, and also to each of the distribution boards for the various illumination systems.

ii) Wiring work for the control cable from the instrumentation panel to the raw water pump room.

iii) Laying underground troughs, asbestos cement, pipe, and installing man-holes and hand-holes for the works listed directly above.

iv) Installation of power poles and the aerial cable at the road crossing.

v) Laying of troughs and asbestos cement pipe for instrumentation equipment and outdoor lamps shall be part of the scope of this work insofar as they are along the main electric line route.

vi) Other miscellaneous works related to those listed above.

3) Instructions for the Work

i) The contractor shall make detailed work drawings for the wiring route, with reference to the Contract Drawings, as directed by the Engineer and submit them for approval.

ii) Drip holes shall be installed at the bottoms of manholes and hand holes.

d) Power Equipment for Raw Water Pump

1) This work shall install a control center in the raw water pump room to supervise and control the raw water pump and auxiliary equipment. The power source shall be 3 ϕ 4 W, 380V/220V supplied from the previously described extra-high voltage sub-station.

2) Installation and Equipment

Control center: 1 set

3) Scope of Construction

i) Installation of the equipment listed directly above

ii) Wiring for power line and the control-cable

iii) Wiring for an electric cable for the previously listed

iv) Groundings

v) Other work necessary for the above listed works

4) Work Included with Other Construction

Construction of a cable pit

5) Specifications of the Equipment

i) Control center: 1 set

(1) Type: Metal indoor closed type

(2) Size: Contractor shall submit approval drawings (made with reference to the Contract Drawings) to the Enginner for his decision.

(3) Rating:

(a)	Rated Voltage:	Main circuit, 440V
		Control circuit, AC 220V
(b)	Rated current:	Horizontal bus 800A
		Vertical bus 400A
(c)	Rated short internal current:	25KA (per second) or more
(d)	Rated breaking capacity:	25 KA or more
(e)	Protective relay:	terminal type, or 2E type

6) Auxiliary Items and Spare Parts

i) Test cable: 1 set

ii) Spare parts for operation: 2-year supply

o) Instrumentation Equipment

1) Summary

The function of these instrumentations is to measure and indicate the water level for the raw water pump well and the raw water flow is the intake area. Power for the meters shall be supplied from the power source specially installed for the instrumentation panel. Installations at the instrumentation panel shall include, beside the meters, the emergency indicators for the sub-station, the generator and the pumps.

2) Equipment

i) Water level meter for the suction well: 1 set

ii) Raw water flow meter 2 sets

iii) Instrumentation panel: 1 unit

3) Scope of the Work

The scope of the work herein described is:

i) Installation and adjustment of the equipment listed in paragraph 2 directly above.

ii) Wiring for the power source and the signal cable.

iii) Laying the asbests cement pipe required for the raw water flow meters and the level meter for the suction well.

iv) Other miscellaneous works required for the equipment listed in paragraph 2 above.

4) Work Excluded from the Scope of the Instrumentation

1) Opening the hole in the floor for installation of the water level meter.

ii) Installation of the orifice meter

5) Specifications for the Equipment

i) Level meter for the Suction Well: 1 set

(1) Structure

(a) Float-type level oscillator 1 item

(Range of measuring shall be as instructed by the Engineer)

Output: 3-wire potentio resistor signal

Accuracy: ± 1.0% or better

Quality: Float, weight, and tape, all SUS 304

Type: Drip-proof type

(b) Signal convertor 1 set

Input: 3-wire potentio resistor signal

Output: 4 - 20 mA DC

Accuracy: ± 1.0% or better

Power source: AC 100V or 50 Hz

(c) Alarm setting device 1 item

Input: 4 - 20 mA DC

Output: 2a, ab contact point capacity AC 100V 1A or more

Setting: Upper limit, lower limit

Power source: AC 100V 50 Hz

(d) Indicator 1 item

Type: Movable coil type

Input: 4 - 20 mA DC

Indication method: horizontal pointer

Accuracy: ± 1.5% (within)

(2) Note

(a) The above-mentioned signal convertor, alarm setting device, and indicator shall be installed on the instrumentation panel.

(b) The water level measuring pipe for the float shall be part of the scope of this construction. Before installation, the Contractor shall consult adequately with other contractors.

ii) Raw Water Flow Meter

(1) Structure (quantities are for 1 set)

(a) Variable pressure transmitter 1 item

Output:	4 ~ 20 mA DC
Accuracy:	± 0.5% (within)
Material:	flange, manion, and diaphrag m, SUS 316
Type:	Moisture proof construction
Power source:	DC 24 V (from power box specially installed)
Accessories:	Manifold set, specially installed power box, fitted to the instrument panel

(b) Differential convertor 1 item

Input, output:	4 ~ 20 mA DC
Accuracy:	± 0.5% (within)
Power source:	AC 100V 50 Hz

(c) Indicating recorder 1 item

Type:	automatic balance type
Input:	4 - 20 mA
Accuracy:	± 0.5% (within)
Method of recording:	one per type
Power source:	AC 100V 50 Hz

(d) Integrator 1 item

Input: 4 - 20 mA

No. of digits: 6 digits, manual reset

Accuracy: 0.5% (within)

Power Source: AC 100V 50 Hz

(2) Instructions

(a) The above-mentioned differential convertor, indicating recorder, and integrator shall be installed in the instrumentation panel.

(b) Installation of the orifice meter shall be part of a separate work.

iii) Instrument Panel

(1) Type: Metal, indoor, standing, closed type

(2) Size: To be determined by submitting to the Engineer an approval drawing, based on the attached drawings

(3) Items to be installed

Equipment for the level meter for the suction well and for the raw water flow meter as described above in paragraph 5 (1) and 5 (2), and also the exclusive or special power source for the meters.

6) Fittings and Auxiliary Equipment

i)	Set of tools for meters	1 set
ii)	Meter maintenance parts set	1 set
iii)	Recording paper, ink, and miscellaneous	2 year supply

2-8-3 Water Treatment Plant

a) Sub-Station Facilities

1) Outline

This work as shown in the Contract Drawings, shall be constructed outdoors near the generator room, installing a single aerial circuit wire of 3Ø 3W 11 KV 50Hz from the main trunk line to a transformer where the power is coverted to 3Ø 4 W 380V/220V and delivered to the various loads as their power source.

The outdoor steel contruction and foundations for the equipment shall also be included in the work herein described.

2) Installations and Equipment

i)	Single pole disconnecting switch:	6 units
ii)	Oil circuit breaker:	1 unit
iii)	Lightning arrester:	3 units
iv)	Current transformer:	3 units
v)	Main transformer:	1 unit
vi)	Instrument transformer:	1 unit
vii)	Transformer secondary panel:	1 panel
viii)	Feeder panel:	1 panel
ix)	Bus bar panel:	1 panel
x)	DC panel	1 panel

3) Scope of the Construction

i) Installation of the equipment listed in (2) directly above.

ii) Construction of foundations and suspended platforms as necessary for equipment listed in (2) directly above.

iii) Installation and assembly of the outdoor steel frame work.

iv) Installation of special high bus bar and overhead ground wire.

v) Installing and connecting wiring, power cables and control cables.

vi) Construction of troughs and manholes for the work listed above.

vii) Grounding work

viii) Construction of a fence for the outdoor receiving transformer station.

ix) Other miscellaneous work.

4) Works Included with Other Construction

i) Construction of a pit for wiring.

ii) Boring holes in walls for wiring.

iii) Installation of meter and MOF.

5) Specifications of the Equipment

i) Single pole disconnecting switch 6 units

Outdoor, single pole, single throw, vertical,

Single point breaking, 12 KV, 600A or more, operated by a hook pole

Short interval current 48.1 KA or more

ii) Oil circuit breaker 1 unit

Outside insulator type oil circuit breaker, 12 KV, 600A or more

Breaking capacity, 1000 MVA or more; breaking interval,

8 cycles or less

Rated throwing current: 131.3 KA or more

Operation system: Solenoid-operated, operating voltage DC 100 V

iii) Lightning arrestor, outdoor type 3 units

Rated voltage 14 KV, discharging current 10 KA, shock starting voltage, 50 KV

iv) Current transformer

Outside-type, automatic oil cooled, frequency 50 Hz

Output: Three-phase 500 KVA continuous

Connection: △ - Y Three-phase, 4 line type

Primary voltage: 11.5/11/10.5/9.5 KV

Secondary voltage: 380/220V

% impedance: 5%

Accessaries: Name plate, no voltage tap transition stand, suspension straps, ground terminals, thermometer, protection equipment, fittings, maintenance items, neutral point current transformer, ground over load current relay

vi) Three phase instrument transformer

Outside, oil-sealed type, 11000 = 110, rated load 2x200VA

Error class, 1.0

Accessories: primary fuse for disconnecting switch

vii) Secondary panel for transformer

(1) Type: Metal, indoor starding closed type

(2) Size: Submit approval drawing to Engineer, based on the attached drawings, for his decision

(3) Internal equipment:

(a) Single pole disconnecting switch: 4 unit

Single pole double throw: 600V 1200A or more, hook pole

Short time current: 30 KA or more

(b) Current transformer: 3 units

Molded type, 420V, 100 * 5A, error class 1.0

Rated load, 40 VA; over current intensity, 30 or more

(c) Three phase instrument transformer 1 unit

Molded type 400 = 100V, error class 1.0

Rated load 2 x 50 VA, with primary fuse

(4) Installations for the Panel

(a)	AC ampere meter	3 each
(b)	AC voltmeter	1 each
(c)	Switches for (1) and (2)	1 each
(d)	3-phase wattmeter	1 each
(e)	3-phase power factor meter	1 each
(f)	Three phase KWH meter	1 each
(g)	Frequency meter	1 each
(h)	Signal lamp	1 each
(i)	Over current relay	3 each
(j)	Ratio differential realy	3 each

viii) Feeder panel 1 panel

(1) Type Metal indoor standing, closed type

(2) Size Submit approval drawing, based on the attached drawings, to the Engineer for his decision.

(3) Internal equipment

(a) Three phase distributing circuit breaker

420V, breaking current, 30 or more

Rated current and quantity shall be as shown in the attached drawings

(b) Neutral line knife switch

Single pole single throw 420V Quantiting as shown in contract Drawings

(b) Current transformer 2 items

Molded type, 420V 1000 ~ 5A, error class, 1.0,

Rated load = 40VA, over current intensity, 30 or more

(c) Current transformer for neutral point of main transformer and knife switch 1 set

Accessories for main transformer

(4) Installations on panel

(a) AC Ampere meter 1 each

(b) Switch for above 1 each

(c) AC voltmeter 1 each

(d) Switch for above 1 each

(e) Ground over load current relay (accessary for main transformer) 1 each

ix) Bus bar connection board 1 panel

(1) Type: Metal indoor standing closed type

(2) Size: Submit approval drawings, based on the Contract Drawings, to the Engineer for his decision

(3) Internal Equipment

(a) Single pole disconnecting switch 4 each

Single pole, single throw, vertical, one point cut contact, 600V, 1200A or more, hook pole operated; short time current, 30 or more

x) DC panel 1 panel

(1) Type: Metal, indoor standing, closed type, battery, rectifier

(2) Size: Submit approval drawings, based on the Contract Drawings, to the Engineer for his decision

(3) Internal equipment:

(a) Silicon rectifier 1 set

Rectifying system:	Three-phase, all wave
Cooling system:	Self-cooling
Rating:	Continuous
Input:	3 ϕ 380V 50 Hz
Output:	113.6 V ±3% (floating)
	121.6 V ±3% (mean)
	90 ~ 140 V
Output current:	10 A

(b) Pocket-type alkali battery: 1 set

Rated capacity:	40 AH/5hr
Rated voltage:	96 V
No. of single cell batteries:	80 each

(c)	Automatic constant voltage equipment	1 set
(d)	Three-phase distribution circuit breaker	1 unit
(e)	Transformer	1 unit
(f)	Resistance box	1 unit
(g)	Control circuit	1 unit
(h)	Distribution device	1 unit
(i)	Relays	1 unit
(j)	Other necessary items	1 unit

(4) Accessories for panel

(a)	DC ampermeter	2 each
(b)	DC voltmeter	1 each
(c)	Switch	1 each
(d)	Voltage out put regulator	1 each
(e)	Indicator lamp	1 unit

6) Accessories

i)	Maintenance equipment foroil circuit breaker	1 unit
ii)	Inspection light (with cord)	1 unit
iii)	Maintenance items for the transformer secondary panel	1 unit
iv)	Maintenance items for the DC panel	1 unit

7) Spare Parts

Fuses, signal lamps Amount for actual operation plus a 2 year operation supply

b) Plant Generator Equipment

1) Summary

This equipment shall be installed in the generator room as an emergency power source when there is a stoppage of electric current supervision and control of the facilities shall be within the generator room.

2) Installations and Equipment

i) Diesel engine

ii) Three phase induction generator

iii) Generator starting panel

3) Scope of the Works

i) Installation and adjustment of the equipment listed in (2) directly above

ii) Installation of power source and wiring and connection for control cable

iii) Installation, piping and wiring for auxiliary equipment

iv) Other works necessary in relation to the works listed above

4) Works Included with Other Construction

i) Construction of the foundation for the diesel engine

ii) Construction of a pit for wiring

iii) Boring holes in walls for wiring

5) Specifications of the Equipment

i) Diesel engine 1 set

(1)	Type:	4 cycle vertical type
(2)	Output	600 HP, or more
(3)	Revolutions	1000 rpm
(4)	Fuel Oil	A-type heavy oil
(5)	Cooling system	Water cooling system
(6)	Lubricating system	Pressure lubrication
(7)	Starting system	Compressed air

(8) Accessories

(a) Engine accessories

Cooling water pump	1 set
Lubricating oil pump	1 set
Fuel oil pump	1 set
Lubricating oil cooler	1 set
Lubricating oil filter	1 set
Fuel oil filter	1 set
Governor	1 set
Tachometer	1 set
Various pressure meters	1 set
Various thermometers	1 set
Supercharger	1 set
Air cooler	1 set

Other necessary items

(b) Engine turning bar 1 set

(c) Engine assembly tools 1 set

(d) Starting air compressor (with motor) 1 item

(e) Compressed air tank, accessories 1 set

(f) Silencer 1 set

(g) Fuel service tank (with flame),3-hour supply 1 set

(h) Cooling water service tank (with flame),1000 liter 1 set

(i) Anchor bolts and nuts 1 set

(j) Vibration-proof bed 1 set

(k) Fuel oil gear pump (with motor) 1 item

(l) Fuel oil wing pump 1 set

(m) Assorted gauges 1 set

(9) Spare parts

(a) Pistonring and oilring 1 set

(b) Air valve and spring 1 set

(c) Assorted pipes for maintenance 1 set

(d) Assorted springs, packing, and pins 1 set

ii) Three Phase Induction Generator

(1) Type: Open-guarded, self-cooling type with rotating salient field

(2) Output: 500 KVA, continuous

(3) Voltage: 3 ϕ 4 W 420V/242V

(4) Frequency: 50 Hz

(5) Power factor: 80% lagging

(6) Revolutions: 1000 rpm

(7) Poles: 6 poles

(8) Exciting system: Self-excitation by static exciter

(9) Overload: The generator shall be capable of running one hour continuously with a load of 110% rated output

(10) Overspeed: The generator shall withstand the mechanical forces of 110% rated speed of revolution for one minute under conditions of no load.

(11) Voltage regulation: Assuming the speed fluctuation ratio to be 3.5% the regulated voltage, when the load is varied from zero load to full load, shall be within± 1.5% of rated voltage at all points.

(12) Instantaneous voltage fluctuation ratio: When a circuit breaks while the generator is operating under full load, the voltage fluctuation ratio shall be within 20% and shall be within ± 1.5% of rated voltage within five seconds after the circuit break.

(13) Efficiency: Total efficiency under full load, with the power factor 80% or higher, shall be 90% or more.

(14) Accessories

(a) Speed reduction switch: 1 set

(b) Coupling: 1 set

(c) Bolts and nuts: 1 set

iii) Generator Starting Panel 1 item

(1) Type: Metal, indoor, closed type

(2) Size: Submit approval drawing to Engineer based on the design drawings

(3) Internal equipment:

(a) Three phase distributing circuit breaker: 1 unit
440V, 1000A, breaking current more than 30 KA

(b) Neutral line knife switch: 1 unit
Single pole, single throw, 440V

(c) Three phase instrument transformer: 1 set
Molded type, 440 - 110V, error class 1.0 rated load 2 x 50 KVA, with primary

(d) Current transformer: 2 units
Molded type, 440V, 1000:5A
Error class; 1.0, rotating head, 40 VA

(e) Static exciter: 1 set

(f) Automatic constant voltage device: 1 set

(g) Auxiliary relay: 1 set

(h) Auxiliary materials and operating equipment 1 set

(i) Bell, buzzer for alarm: 1 set

(4) Fixtures for panel

(a) AC ammeter: 1 item

(b) Ammeter switch: 1 item

(c) AC voltmeter: 1 item

(d) Voltmeter switch: 1 item

(e) Three phase KW meter: 1 item

(f) Three phase power factor meter: 1 item

(g) Three phase KWH meter: 1 item

(h) Frequency meter: 1 item

(i) Various signal lamps: 1 set

(j) Various switches: 1 set

(k) Over current relay: 2 items

(l) Over voltage relay: 1 item

(m) Failure indicator: 1 set

(5) Spare parts

(1) Various lamps: Number of actual use

(2) Various fuses: Number of actual use

6) Protection of Equipment

i) If failures listed below occur when starting or during operation, a failure indicator shall operate, and an alarm bell shall be sounded, simultaneously, the diesel engine shall stop, and the generator circuit breaker shall automatically open.

(1) Engine overspeed failure

(2) Loss of lubricating oil pressure

(3) Cooling water stoppage

(4) Excess voltage

(5) Delay or failure in starting

ii) When failure listed below occurs during operation, and indicator and alarm shall be set into operation, and the generator circuit breaker shall automatically open.

(1) Over current

iii) When the failures listed below occur during operation, a failure indicator and a buzzer alarm shall be set into operation.

(1) Oil level falls below minimum in the fuel oil service tank

(2) Temperature of cooling water rises above critical point

(3) Temperature of lubricating oil rises above critical point

c) Installation of Main Electric Lines

1) Summary

The works herein described include electric wire cabling from the secondary panel of the transformer at the extra-high voltage sub-station to the control center and to the distributing board for the illumination system in the various facilities. Also the wiring and related works for the contrl cable from the graphic panel to the extra-high voltage sub-station shall be part of this work.

2) Scope of the Works

i) Installation of electric power cable from the secondary panel of the transformer to the control center installed in the distribution pump room and to the control center for the chemical feeder room and to each of the distribution boards for the various illumination systems.

ii) Wiring work for the control cable from the semi-graphic panel to the extra-high voltage sub-station to the generator, and to the various control centers.

iii) Laying underground trough, asbestos cement pipe, and installing manholes and hand holes for the works listed directly above.

iv) Laying of troughs and asbestos cement pipe for the instrumentation equipment and for the power equipment shall be part of the scope of this work, provided they are in the route of the main electric line.

v) Other miscellaneous works related to those listed above.

3) Instructions for the Work

i) The Contractor shall make detailed work drawings for the wiring route, with reference to the Contract Drawings, as directed by the Engineer and submit them for approval.

ii) Drip holes shall be installed at the bottoms of manholes and hand holes.

d) Distribution Pump Power Equipment

1) Summary

This work shall install a control center in the distribution pump room to supervise and control the distribution pump and auxiliary equipment. The power source shall be 3 ϕ 4 W, 308V/220V obtained from the previously described extra-high voltage sub-station.

2) Installations and Equipment

Control center: 1 set

3) Scope of Construction

i) Installation of the equipment listed directly above

ii) Wiring for power line and the control cable

iii) Wiring for an electric cable for the previously listed distribution

iv) Groundings

v) Other work necessary for the above listed works

4) Work Included with Other Construction

Construction of a cable pit

5) Specifications of the Equipment

i) Control center: 1 set

(1) Type: Metal indoor closed type

(2) Size: Contractor shall submit approval drawings (made with reference to the Contract Drawings) to the Engineer for his decision.

(3) Rating:

(a)	Rated Voltage:	Main circuit, 420V
		Control circuit, AC 220V
(b)	Rated current:	Horizontal bus 800A
		Vertical bus 400A
(c)	Rated short internal current:	25KA (per second) or more
(d)	Rated breaking capacity:	25 KA or more
(e)	Protective relay:	terminal type, or 2E type

6) Auxiliary Items and Spare Parts

i) Test cable: 1 set

ii) Spare parts for operation: 2-year supply

o) Power Equipment for the Sedimentation Basin

1) Outline

This work is composed of the control center and the local switch panel, which shall operate to provide the power load for the sedimentation basin and supervisory controls for the drain pump This control center shall be installed in the chemical dosing room, and load control shall fundamentally be done at the site. The power source shall be the sub-station from which 3 ϕ 4 W 380V/220V shall be obtained.

2) Installations and Equipment

i) Control center: 1 set

ii) Field switch panel: 1 set

iii) Electrode-type level switch: 2 sets

3) Scope of the Construction

i) Installation of the equipment listed directly above in (2).

ii) Wiring work for the power and control cables

iii) Wiring work for the power cable to the control panel and for the separately listed distribution panel for the illumination system.

iv) Construction of the concrete troughs for the above listed works

v) Grounding work

vi) Other miscellaneous work accompanying the above-listed works

4) Works Included with Other Construction

Construction of the cable pit

5) Specifications of the Equipment

i) Control Center 1 set

(1) Type: Metal, indoor, closed type

(2) Size: Contractor shall submit approval drawings (made with reference to the contract Drawings) to the Engineer for his decision

(3) Rating

(a)	Rated voltage:	Main circuit, 420V
		Control circuit AC 220V
(b)	Rated current:	Horizontal bus, 800A
		Vertical bus, 400A
(c)	Rated short-time current:	25KA (per second) or more
(d)	Rated breaking capacity:	25KA or more
(e)	Protective relay:	Thermal type, or 2E type

ii) Local Switch Panel

(1)	Number and type:	(as shown in the Drawings)
(2)	Fittings	
(a)	Measuring instruments:	1.5 class flush type
(b)	Control switch:	illuminated button type
(c)	Change-over switch:	Arrow-shape knob type

iii) Electrode Level Switch: 2 sets, with relay unit

(1)	Contact capacity:	AC 100V, 1A or more
(2)	Power source:	AC 100V, 50 Hz
(3)	Number of electrodes:	Three for each set
(4)	Length of electrodes:	(pending Engineer's instructions)
(5)	Mounting location:	Drain pump well

6) Auxiliary Items and Spare Parts

i) Test cable: 1 set

ii) Spare parts for operation: 2-year supply

f) Instrumentation

1) Outline

This equipment shall measure flow rates, water levels, etc. in the treatment plant. The power source for the instrumentation shall be the special power source installed in the semi-graphic panel. In addition to mounting the meters in this semi-graphic panel, operational indicators and failure indicators for the previously described sub-station, the plant generator, and power equipment shall also be installed.

But, the piping for the sampling pump, used to inspect turbidity, shall be part of a different construction work and only the water examination table shall be done with the instrumentation equipment.

2) Installations and Equipment

i)	Raw water meter:	1 set
ii)	Chlorine cylinder pressure alarm:	1 set
iii)	Raw water turbidity meter:	1 set
iv)	Filter basin water level alarm:	6 sets
v)	Filter bed head loss alarm meter:	6 sets
vi)	Distribution pump water level meter:	1 set
vii)	Water level meter for distribution pump well:	1 set
viii)	Distribution pressure meter:	1 set
ix)	Elevated tank water level alarm:	1 set
x)	Back wash flow meter for filter bed:	1 set
xi)	Semi-graphic panel:	1 set

3) Scope of Construction

i) Installation and adjustment of the equipment listed directly above in (2).

ii) Wiring for power source and signal cable

iii) Construction of concrete troughs for the above equipment

iv) Other miscellaneous work accompanying the above-listed works

4) Work Included with Other Construction

i) Making floor perforations to install water level meters

ii) Installing piping to the sampling pump

5) General Specifications for the Equipment

i) Indicator

(1)	Type:	Movable coil type
(2)	Input:	4 ~ 20 mA, DC
(3)	Indication method:	Vertical, pointing by meter hand needle
(4)	Accuracy:	Within 1.5%

ii) Recording Indicator

(1)	Type:	Automatic balance type
(2)	Input:	4 ~ 20 mA, DC
(3)	According:	Within 0.5%
(4)	Recording method:	Pen recorder type
(5)	Power source:	AC 100V, 50 Hz

iii) Integrating Meter

(1)	Input:	4 ~ 20 mA, DC
(2)	Number of digits:	6 digits, with manual reset
(3)	Accuracy:	Within 0.5%
(4)	Power source:	AC 100V, 50 Hz

iv) Alarm Setting Device

(1) Input: 4 ~ 20 mA, DC

(2) Output: 2a, 2b contact capacity, AC 100V, 1A or more

(3) Setting: Upper and lower limits

(4) Power source: AC 100V, 50 Hz

v) Signal Converter

(1) Input: 3-core resistance signal

(2) Output: 4 ~ 20 mA DC

(3) According: Within ± 0.5%

(4) Power Source: AC 100V, 50 Hz

vi) Square Root Extraction Computer

(1) Input: 4 ~ 20 mA DC

(2) Accuracy: Within ± 0.5%

(3) Power source: AC 100V, 50 Hz

vii) Float-Type Water Level Indicator

(1) Measuring range: (pending Engineer's instructions)

(2) Output: 3-core potentio resistance signal

(3) Accuracy: Within ± 1.0%

(4) Material quality: Float, weight, and tape, SUS 304

(5) Mechanism: Drip-proof mechanism

viii) Differential Head Transmitter

(1) Measuring range: (pending Engineer's instructions)

(2) Output: 4 ~ 20 mA, DC

(3) Accuracy: Within ± 0.5%

(4) Material quality: Flange, union and diaphragm, SUS 316

(5) Mechanism: Drip-proof mechanism

(6) Power source: DC 24V (from special power source)

(7) Accessories: Manifold set, special power facilities, mounted in the semi-graphic panel

ix) Pressure Transmission Device

(as described in (viii) directly above)

x) Turbidity Meter

(1) Turbidity Meter Transmitter

(a) Mechanism: Flow-off type, drip-proof construction

(b) Measuring range: (pending Engineer's instructions)

(c) Measuring system: Transmission ray and scatter beam comparator system

(d) Output: 4 ~ 20 mA, DC

(e) Power source: AC 100V 50 Hz

(2) Ultra-Sonic Oscillator (for ultra-sonic washing)

(a) Mechanism: drip-proof mechanism

(b) Washing method: Continuous irradiation method

(c) Power source: AC 100V, 50 Hz

xi) Electrode-type Level Switch (with relay unit)

(1) Contract capacity AC 100V, 1A or more

(2) Power source: AC 100V, 50 Hz

(3) Number of electrodes: (as described below)

(4) Length of electrodes: (pending Engineer's instructions)

6) Specifications and Mechanisms of Instruments

i) Raw water 1 set

(1) Venturi tube, 500 mm dia: 1 item

(2) Differential head transmitter: 1 item

(3) Square root extraction computer: 1 item

(4) Recording indicator: 1 item

(5) Integrating meter: 1 item

(Items (3) to (5) above shall be installed in the semi-graphic: panel)

ii) Chlorine Cylinder Pressure Alarm Device 1 set

The boundary limit for the construction herein listed shall be the contact point with the separate work of the chlorine injection control panel. Also included is the light indicator to be installed on the semi-graphic panel

iii) Raw Water Turbidity Meter 1 set

(1) Turbidity meter: 1 set

(2) Table: 1 set

This table shall be made of pipe and angles, and an overflow tank shall be installed on top. Also, water pipping and drain pipe to the turbidity transmitter shall be provided. Flexible joint pipe and union joints shall be used for the drain pipe, and inspection and maintenance of the oscillator shall be made easy.

(3) Sampling pump 1 item

With 0.4 KW motor flow volume and other data shall conform with values of the turbidity meter

(4) Recording indicator

(Items (1),(2) and (3) listed directly above shall be installed in the chemical dosing room. Item (4) shall be installed on the semigraphic panel. Piping to the sampling pump shall be part of another, different work.)

iv) Filter basin Water Level Alarm Device — 6 items

(1) Electrode level switch — 2 electrodes (lower limit alarm)

v) Filter Basin Head Loss Alarm Meter — 6 sets

(1) Differential head transmitter: 6 items

(2) Alarm setting device: 6 items

(item (2) listed above shall be installed on the semi-graphic panel)

vi) Distribution Pump Water Level Meter — 1 set

(1) Float-type water level occillator: 1 item

(2) Signal convertor: 1 item

(3) Alarm setting device: 1 item

(4) Indicator: 1 item

(items (2) (3) and (4) listed above shall be installed on the semi-graphic panel)

vii) Distribution Pressure Meter — 1 set

(1) Pressure convertor: 1 item

(2) Alarm setting device: 1 item

(3) Indicator: 1 item

(item (2) and (3) listed directly above shall be installed on the semi-graphic panel)

viii) Distributing Pressure Meter — 1 set

(1) Venturi-tube, 500 mm dia.: 1 item

(2) Differential head transmitter: 1 item

(3) Square root extraction computer: 1 item

(4) Recording indicator: 1 item

(5) Integrating meter: 1 item

(items (3) (4) and (5) listed directly above shall be installed on the semi-graphic panel)

ix) Elevated Tank Water Level Alarm — 1 set

(1) Electrode level switch: — 1 item

(2) Number of electrodes: — 3 (lower and upper limit alarm)

x) Back Wash Flowmeter for Filter Bed — 1 set

(1) Venturi tube, 500 mm dia.: — 1 item

(2) Differential head transmitter — 1 item

(3) Square root extraction computer — 1 item

(4) Recording indicator: — 1 item

(5) Integrating meter: — 1 item

(items (3) (4) and (5) listed directly above shall be installed on the semi-graphic panel).

xi) Semi-Graphic Panel — 1 set

(1) Type: Metal, indoor stand, closed type

(2) Size: The Contractor shall submit approval drawings (made with reference to the Contract Drawings) to the Engineer for his decision.

(3) Fittings:

(In addition to the exclusive, special power source for the meters, fittings for mounting items (i) to (x) listed above shall be provided as necessary.)

7) Accessories and Spare Parts

i) Tool set for the instrumentation: — 1 set

ii) Set of maintenance parts for the instrumentation: — 1 set

iii) Recording paper, ink, and expendables — 2-year supply

g) Installation of Outdoor Illumination

1) Outline

This work shall provide illumination for the passage way in the yard, to be automatically turned on and off by means of a photo-switch

2) Installations and Equipment

Outdoor lights 3 fixtures

3) Scope of the Work

i) Installation of equipment listed directly above in (2)

ii) Wirings and connections for the outdoor lights

iii) Groundings

4) Specifications of the Equipment

i)	Outside lights	3 fixtures
	(1) Type:	fixtures mounted on a steel pipe pole
	(2) Power source:	220V, 50 Hz
	(3) Lamps used:	Floorescent, 2 lamps each 20W
	(4) Accessaries:	Photo-switch

5) Spare Parts

i)	Floorescent lamps:	number required for installation
ii)	Stabilizer:	number required for installation only