THE HASHEMITE KINGDOM OF JORDAN

WATER SUPPLY CORPORATION

CITY OF IRBID WATER SUPPLY, SEWERAGE, STORM DRAINAGE, AND SOLID WASTE DISPOSAL PROJECT

CONTRACT NO. 1
(WASTEWATER TREATMENT FACILITY)

VOLUME 2

SPECIFICATIONS FOR ENGINEERING WORK
SCHEDULE OF DRAWINGS

ISSUED FOR TENDER

WESTON INTERNATIONAL, INC.
WEST CHESTER, PA. 19380

IN ASSOCIATION WITH

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MUSCATINE, IOWA 52761

SIGMA CONSULTING ENGINEERS
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AMMAN, JORDAN

CITY OF IRBID, JORDAN

CONTRACT NO. 1

WATER SUPPLY CORPORATION
OF
THE HASHEMITE KINGDOM OF JORDAN
WASTEWATER TREATMENT FACILITY

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Specifications for Civil, Mechanical
and Electrical Engineering Work

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SECTION 01000

GENERAL INFORMATION

PART 1 - GENERAL

1.01 DIVISION OF SPECIFICATIONS

A. The specifications for Contract No. 1 are divided into two categories. Those numbered 1 through 19 and bound separately into Volume 2A apply only to OPERATIONS BUILDING work. Those included in Volume 2 and designated DIVISIONS 2 through 16 apply to all the work of Contract No. 1 except the Operations Building.

1.02 CONTRACTOR FACILITIES

A. The Contractor shall provide facilities for use by all field personnel, including sanitary, eating, and first aid facilitie

B. Sanitary facilities shall be provided for use of Contractor's personnel for the execution of the Works, as follows:

1. Facilities shall consist of sufficient number of adequatel constructed enclosures or chemical units, complete and weathertight, adequately ventilated, and equipped with latching door.

2. Units shall be maintained sanitary at all times. Units shall be in accordance with the rules and customs of the users.

C. Eating facilities shall consist of a roofed structure with concrete floor, adequately equipped with tables, benches, and refuse receptacles. Eating facility and its surroundings shal be maintained clean and in sanitary condition at all times. Separate kitchens and sales stands if used shall be maintained in sanitary and orderly condition.

D. First aid facilities: Contractor shall set aside an area in his field office for the purpose of providing first aid assistance in case of injury. The area shall be equipped with a cot, running water, and industrial type first aid kit fully equipped at all times. A member of the Contractor's staff shall be knowledgeable in first aid procedures and shall be specifically designated to attend to cases of injury.

E. Refer to Section 01500 - Temporary Facilities for additional requirements.

F. Facilities remain property of the Contractor and, upon completion of the works, shall be removed from the easement.

.03 TEMPORARY UTILITIES

A. The Contractor shall be responsible for providing all temporary utilities needed for his construction activities, Engineer's field offices, testing, and employees.

.04 MATERIAL SUPPLIES AND DISPOSAL

A. The Contractor shall be responsible for locating, establishing, and maintaining uninterrupted during the course of the Works all the necessary supply of construction materials including, but not limited to, the following:

1. Bedding material.
2. Backfill material.
3. Concrete.

B. The Contractor shall be responsible for locating, as approved by the Engineer, establishing and maintaining all disposal areas necessary for the proper disposal of waste materials including, but not limited to, the following:

1. Construction debris.
2. Excess excavated material.

C. The Contractor shall provide all necessary transport of materials to and from material supply and disposal areas.

1.05 DUST SUPPRESSION AND MUD CONTROL

A. Throughout the construction period, the Contractor shall effectively suppress dust at the working area.

B. When mud conditions develop, make provisions as necessary for controlling the mud and proceeding with the work. Such control shall include temporary drainage provisions, installing granular material "working blanket", soil treatment, or other means to effectively deal with mud. Work delays due to muddy ground will not be recognized as valid reasons for time extensions.

1.06 PRE-CONSTRUCTION CONFERENCE

A. After award of Contract and prior to the start of on-site work, all key personnel to be engaged in execution of works by the Contractor shall attend a two-day Pre-Construction Conference in Amman or Irbid. The Contractor shall schedule, issue an agenda for, and administer the Pre-Construction Conference.

1.07 PROJECT PROCEDURE MANUAL

A. A project procedure manual will be prepared by the Engineer's Representative and made available to the Contractor at the Pre-Construction Conference.

B. The manual will define the administrative responsibilities of the Contractor and the Engineer's Representative and establish specific procedures for processing information and documentation.

END OF SECTION

SECTION 01012

COORDINATION OF WORK

PART 1 GENERAL

1.01 GENERAL

The Contractor shall be responsible for coordinating work under this contract with work performed by other contractors who may be working simultaneously on Contracts 2 through 8.

1.02 CONTRACT 1 - WASTEWATER TREATMENT PLANT

A. Coordinate with Contract 2 and Interceptor A.

B. Coordinate with Contract 3 and Interceptor B.

END OF SECTION

SECTION 01014

WORK SEQUENCE

PART 1 - GENERAL

1.01 GENERAL

A. Before starting any construction at the treatment plant, the Contractor shall lay out treatment plant survey base line and bench marks and verify invert elevation of influent sewer line. Any conflicts between the elevation of the influent sewer line and the treatment plant elevation shall be resolved by the Engineer.

B. Sequencing of excavation for structures shall be consistent with the excavation and backfill specification sections and shall be such as not to damage structural properties of the sub-soils.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

Not Used.

END OF SECTION

SECTION 01015

GENERAL CONDUCT OF WORK

PART 1 GENERAL

1.01 COORDINATION OF WORK

The Contractor shall be responsible for the coordination of all work so that the Contract can be completed within the time stipulated.

1.02 HANDLING AND STORAGE

A. The Contractor shall, at his own expense, handle, haul, and distribute all materials and all surplus materials for the different portions of the Work, as necessary. He shall provide suitable and adequate storage room for materials and equipment during the progress of the Work and be responsible for loss of, or damage to, materials and equipment furnished by him, until the final acceptance of the Work.

B. All excavated materials, construction equipment, materials and equipment to be incorporated in the Work shall be placed so as not to injure the Work and so that free access can be had at all times to all parts of the Work and to all public utility installations in the vicinity of the Work.

C. Storage charges and demurrage charges by transportation companies and vendors, which result from delays in handling, shall be borne by the Contractor.

1.03 CUTTING AND PATCHING

A. The Contractor shall leave all chases or openings for the installation of his own or any other contractor's or sub-contractor's work, and shall see that all sleeves or forms are in the work and properly set in ample time to prevent delays The Contractor shall verify that all such chases, openings, and sleeves are located accurately and are of proper size and shape and shall consult with the Engineer and the contractors or sub-contractors concerned in reference to this work.

B. In case the Contractor fails to leave all such openings or have all such sleeves and frames provided and set in proper time, he shall cut them or set them afterwards at his own expense, but in so doing he shall confine the cutting to the smallest extent possible consistent with the work to be done. In no case shall piers or structural members be cut without the consent and approval of the Engineer.

C. The Contractor shall carefully fit around, close up, repair, patch, and point around the work specified.

D. All cutting and patching work shall be done by workmen competent to do such work and with the proper small hand tools. Power tools shall not be used except where the type of tool proposed can be used without damage to the structure beyond the limits of the work.

E. Except with the consent of the contractor or sub-contractor involved, given in writing or in the presence of the Engineer, the Contractor shall not permit his sub-contractors to cut or alter the work of any other contractor or sub-contractor. All cutting and patching or repairing made necessary by the negligence, carelessness, or incompetence of the Contractor or any sub-contractor shall be done by the Contractor or sub-contractor who constructed the work, but such cutting and repairing or patching shall be done at no expense to the Owner.

1.04 PROTECTION AGAINST ELECTROLYSIS

Where dissimilar metals are used in conjunction with each other, suitable insulation shall be provided between adjoining surfaces so as to eliminate direct contact and any resultant electrolysis. The insulation shall be bituminous impreganted felt, heavy bituminous coatings, non-metallic separators or washers, or other approved materials.

1.05 WORK ON HIGHWAYS

A. All right-of-way for construction and access will be provided by Owner.

B. Before any work is commenced on highway right-of-way the Contractor shall obtain all necessary working permits from the appropriate departments. All work on highway rights-of-way shall be performed in

conformance with the requirements of the permit-issuing department.

1.06 EXCESS COST OF FIELD ENGINEERING AND INSPECTION

The Owner may charge to Contractor and may deduct from the periodic and final payment for the Work, all engineering and inspection expenses incurred by the Owner in the event that the Contract is not completed within the time stipulated in Contract Documents or the costs of evaluating any alternatives that the Contractor may propose. Cost for engineering and inspection expenses shall be determined on the basis of the hours worked, the salary costs of those involved and directly associated expenses. The Contractor shall be required to pay the Owner the amount actually incurred.

1.07 PROGRESS PHOTOGRAPHS

A. The Contractor shall take progress photographs throughout the duration of the Contract, consistent with the requirements of Section 01380.

1.08 ARCHAEOLOGICAL FINDS

A. All coins, documents, antiquities and artifacts found along the construction area belong to the Jordanian government.

B. Clause 27 of Conditions of Contract describes the procedure to be followed in the event of discovery of antiquities or artifacts.

END OF SECTION

SECTION 01090

ABBREVIATIONS

PART 1 - GENERAL

1.01 ABBREVIATIONS

Abbreviations used in these Contract Documents shall refer to and designate the following:

AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AGA	American Gas Association
AGMA	American Gear Manufacturers Association
AFBMA	Anti-Friction Bearing Manufacturer's Association
AIEE	American Institute of Electrical Engineers
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AMCA	Air Moving and Conditioning Association (U.S.A.)
ANSI	American National Standards Institute
API	American Petroleum Institute
ASHRAE	American Society of Heating Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing and Materials
AWWA	American Water Works Association
AWG	American Welding Society
CLFMI	Chain Link Fence Manufacturer's Institute
DIN	Deutsches Institute Fur Normung
EDR	Equivalent Direct Radiation
EPA	Environmental Protection Agency (U.S.A.)
FM	Factory Mutual System
FSS	Federal Specifications and Standards, General Service Administration
IEEE	Institute of Electrical and Electronic Engineers

IPCEA	Insulated Power and Cable Engineer's Association (U.S.A.)
ISA	Instrument Society of America
NBS	National Bureau of Standards (U.S.A.)
NCPI	National Clay Pipe Institute (U.S.A.)
NEC	National Electrical Code (U.S.A.)
NEMA	National Electrical Manufacturers Association (U.S.A.)
NIOSH	National Institute of Occupational Safety and Health (U.S.A.)
NFPA	National Fire Protection Association (U.S.A.)
NPT	National Pipe Thread
OSHA	Occupational Safety and Health Act
OS and Y	Outside Screw and Yoke
PCA	Portland Cement Association
MPWSS	Ministry of Public Works (Jordan) "Standard Specifications for Construction of Roads and Bridges"
SAE	Society of Automotive Engineers (U.S.A.)
SDI	Steel Deck Institute (U.S.A.)
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SSPC	Steel Structures Painting Council (U.S.A.)
SWD	Side Water Depth
UL	Underwriter's Laboratories, Inc.

END OF SECTION

SECTION 01095

MAINTENANCE PERIOD

PART 1 GENERAL

1.01 MAINTENANCE PERIOD

A. Upon issuance of the Certificate of Completion, the Contractor shall commence a one-year Maintenance Period. During this period the Contractor shall operate and maintain the entire treatment facility to produce the design effluent quality of the treated wastewater.

B. The intent of requiring the Contractor to operate the treatment facilities during the Maintenance Period is as follows:
   1. Start-up the treatment facilities and demonstrate to the Owner that the facilities will operate properly and meet the design criteria.
   2. Train Owner's personnel in the operation and maintenance of the facilities.

C. During the Maintenance Period the flow of sewage to the treatment facility will be well below the design flow. This condition is expected to cause operating difficulties. The Contractor and his operational personnel shall be prepared to deal with this condition to the extent that innovative and temporary procedures may be necessary to operate the facility.

D. The following items and services shall be provided and paid for by the Contractor.
   1. Treatment facility operator personnel.
   2. Treatment facility maintenance personnel.
   3. Treatment facility laboratory personnel.
   4. All maintenance and maintenance materials for equipment.

E. The following items and services shall be provided and paid for by Owner.
   1. All necessary utilities (water, electricity), after Contractor has received final Certificate of Completion.
   2. All necessary laboratory supplies.
   3. Those operator, maintenance, and laboratory personnel assigned to the Contractor for training purposes.

F. During the Maintenance Period the Contractor may be allowed to accomplish Phases III and IV of the Equipment Start-Up Procedure as called for in paragraph 3.02A of Section 11000, Mechanical Equipment General.

G. The term "Treatment Facility" includes all facilities installed as part of Contract No. 1.

1.02 TREATMENT FACILITY STAFF

A. The Contractor shall provide the services of treatment facility operators necessary to provide 24 hour continuous service for the life of the Maintenance Period.

B. It is intended that Owner operating, maintenance, and laboratory personnel be slowly phased-in, and Contractor operating, maintenance and laboratory personnel be slowly phased-out over the course of the one-year Maintenance Period, such that at the end of the one-year period, Owner personnel will be 100 percent functional. It is emphasized, however, that the Contractor is responsible for the facility and its operation and maintenance for the entire one-year period. Phase-in of personnel will be by mutual agreement between Owner and Contractor.

C. The Owner shall have the right of refusal for operation and maintenance personnel provided by the Contractor.

1.03 CHEMICALS

A. The Contractor shall provide and pay for all necessary chemicals to operate the treatment facility for the Maintenance Period, including but not limited to:
1. Chlorine
2. Polymer
3. Lime

B. In addition, upon completion of the Maintenance Period, the contractor shall provide the Chemicals called for in Section 11000.

1.04 MAINTENANCE

A. During the Maintenance Period the Contractor shall perform all major, minor and preventive maintenance, along with necessary repairs and parts.

B. The Contractor shall have the use of the Owner's tools provided under this contract. Upon completion of the Maintenance Period, the Contractor shall replace any lost or broken tools.

C. Contractor shall provide and pay for all necessary lubricants, oils and other maintenance items during the Maintenance Period. Upon completion of the Maintenance Period the Contractor shall provide the oils and lubricants specified in Section 11000.

D. Contractor shall perform all normal maintenance on all equipment in accordance with the equipment Operation and Maintenance Manuals. Accurate maintenance logs shall be kept by the Contractor on each piece of major equipment.

E. At the end of the Maintenance Period and before the Owner takes over operation of the facility, the Engineer will inspect all equipment and examine the Maintenance logs to

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determine that the equipment has be maintained properly during the Maintenance period. Equipment found not to be maintained properly shall be reconditioned or replaced at the Contractor's expense.

1.05 OPERATION BUILDING

A. During the Maintenance period the Operation Building will be operated by the Owner and his staff. The Contractor's operation and maintenance personnel shall have use of the facilities within the operation Building. The Contractor shall be responsible for any damage done by his personnel to the building or its facilities.

1.06 INSURANCE

A. During the one year Maintenance Period, the Contractor shall purchase and maintain all such comprehensive general liability and other insurances necessary to protect his employees, his equipment and the Owner's personnel and his representatives.

1.07 INSPECTION

A. At the completion of the Maintenance Period an inspection of the Treatment Facility, by the Owner, shall be performed to assure that the conditions of the facility are consistent with one year of operation.

B. Any repairs, clean-up or restoration found necessary from the inspection shall be performed by the Contractor before the Owner will accept the facility.

1.08 ACCEPTANCE

A. After successful completion of the one year Maintenance Period the Owner will issue a Certificate of Completion, after which Owner will assume responsibility for the Operation and Maintenance of the treatment facilities.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01100

ALTERNATES

PART 1 - GENERAL

1.01 ALTERNATES

A. Whenever a material, article, or piece of equipment is identified on the plans or in the specifications by reference to manufacturer's or vendor's names, trade names or catalogue numbers, it is intended to establish a standard. Any material, article, or equipment of other manufacturers and vendors, which will perform satisfactorily the duties imposed by the general design will be considered equally acceptable provided the material, article, or equipment so proposed is, in the opinion of the Engineer, of equal quality and function. The Engineer will determine equality based on such information, tests, or other supporting data submitted by the Contractor.

B. Upon acceptance and approval by the Engineer of an equal product, it shall remain the responsibility of the Contractor to coordinate installation of the item with all other items to be provided to assure proper fitting together of all items. Similar responsibility applies to items which are left to the Contractor's option. Any additional cost of equal items and any additional cost incidental to the coordination and/or fitting together of such items shall be borne by the Contractor at no extra cost to the Owner.

END OF SECTION

SECTION 01110

MATERIAL & EQUIPMENT

PART 1 GENERAL

1.01 For the purpose of indicating the standard of type, quality, design and performance of materials and equipment to be provided under this contract, various materials and equipment are specified as named commercial brands, or equal.

A. The design of the Project is based upon the materials and equipment so designated herein, but equal materials and equipment of other manufacturers will be acceptable, provided that the Contractor includes all revisions to associated mechanical, electrical, structural and site work which may be required by the use of equal materials and equipment other than that indicated as the basis of design of the Project.

B. Equipment and materials of other manufacturers not named, equal in all respects, may form the Basis of the Tender.

C. The following equipment was used as basis of design for this project.

Mechanically cleaned bar screen	Infilco
Sluice gates, slide gates, stop gates	Rodney Hunt
Vertical Turbine Pumps	Goulds
Seal water system	Aurora
Utility water system	Syncroflo
Chemical Dispensing System (Chlorine)	Wallace & Tiernan
Plunger Pumps	Ralph B. Carter
Digester Recirculation	Dorr-Oliver Envirex (alternate)
Mixers	Mixco Equip. Co.
Polymer System	Calgon
Primary Clarifiers	FMC
Circular Flocculator Clarifier	FMC
Sludge Thickeners	FMC
Trickling Filter Media	B. F. Goodrich

Trickling Filter Rotary Distributor	FMC
Positive Displacement Blower	Roots
Mechanical Surface Aerators	Mixco Equipment Co.
Motor Control Centers	Square D Cutler Hammer
Substation	Siemans-Allis
Emergency Generator	Caterpillar
Instrumentation System	BIF

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not USed

END OF SECTION

SECTION 01150

MEASUREMENT AND PAYMENT

WASTEWATER TREATMENT FACILITIES

PART 1 GENERAL

1.01 GENERAL

A. Items of work described herein are items specifically listed in Bill of Quantities for separate payment.

B. Unit prices or lump sum prices for materials provided from sources inside or outside Jordan shall include all costs for purchasing, delivery, handling, and unloading including any dock charges. Costs for transporting these materials to job site storage shall also be included under the appropriate unit price or lump sum item unless otherwise specified.

1.02 DESCRIPTION OF ITEMS IN BILL OF QUANTITIES

A. Following descriptions are intended to define areas of work associated with Bill of Quantity items:

1. SITE WORK

Item shall consist of site work for the entire treatment facility, drying beds, landfill facilities and the operation building. The price shall include all labor, equipment, and materials. The costs of all transportation, loading, unloading, storage insurance, duties and survey/layout work are also included.

This work is specified in Sections 01566, 02110, 02210, 02219, 02260, 02440, 02540, and called for on the Contract Drawings.

2. SITE PAVING

Item shall consist of site paving for the entire treatment facility, drying beds, landfill facilities, and the operation building. The price shall include all labor, equipment, and materials. The costs of all transportation, loading, unloading, storage, insurance and duties are also included. This work is specified in Sections 02222, 02224, 02513 and called for on the Contract Drawings.

3. YARD PIPING

Item shall consist of yard piping for the entire treatment facility, drying beds, landfill facilities and the operation building. Price shall include all labor, equipment, and materials. The costs of all transportation, loading, unloading, storage, insurance and duties are also included. Yard piping shall be defined as all above and below grade piping located outside of any structure or building and shall include site drainage, process piping, utility piping, and process drains.

This work is specified in Sections 02219, 02221, 02222, 02575, 15050, 15060, 15400 and as called for on the Contract Drawings.

4. ELECTRICAL DISTRIBUTION SYSTEM

The price shall consist of electrical distribution system for the entire treatment facility, drying beds, landfill facilities and the operation building. Price shall include all labor, equipment, and materials. The costs of all transportation, loading, unloading, storage insurance and duties are also included. Electrical distribution system shall be defined as all above and below grade power, lighting, grounding, and instrumentation wiring located outside of any structure or building, plus the intercommunication system, yard lighting and the main instrument control panel, CP-1, located in the operation building. This work is specified in Sections 13440, 13441, 13442, 13443, 13444, 16010, 16111, 16120, 16131, 16141, 16145, 16450, 16510, 16760, 16900, and as called for on the Contract Drawings.

5. ELECTRICAL SUBSTATIONS

The price shall consist of both electrical substations (main and auxiliary) and shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Electrical substations shall be defined as the primary switchgear (main substation only), as 1500 KVA transformers, breakers, meters, automatic transfer switch and 500 KW generator sets, concrete pads, connecting wiring, and grounding. This work is specified in Sections 02219, 02221, 02222, 02224, 02444, 03001, 03345, 10390, 15177, 16010, 16111, 16120, 16131, 16205, 16310, 16442, 16450, 16510, and as called for on the Contract Drawings.

6. MOBILE EQUIPMENT

The price for mobile equipment shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included.

This work is specified in Sections 14510, 14511, 14512, 14515, 11000 and as called for on the Contract Drawings.

7. TOOLS AND EQUIPMENT

The price for tools and equipment; the costs of all transportation, loading, unloading, storage, insurance, and duties are also included.

This work is specified in Sections 11000, 11550 and as called for on the Contract Drawings.

8. INFLUENT STRUCTURE

A. Structural

The price for structural work shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. The work is specified in Sections 02219, 02221, 02222, 02224, 03001, 03345, 05120, 05500, 07900, 09900, 10390, and 14300 and as called for on the Contract Drawings.

B. Mechanical Equipment and Installation

The price for mechanical equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Mechanical equipment shall be defined as all equipment needed to support the operation of the process, directly or indirectly including gates, HVAC equipment and duct work.

This work is specified in Sections 11000, 11201, 11312, 11331, 11373, 11375, 16151, 16152, 13445 and as called for on the Contract Drawings.

C. Piping Equipment and Installation

The price for piping work shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Piping shall be defined as all piping within the confines of a structure or building needed to support the operation of the process, directly or indirectly including plumbing, process piping, air piping, drain piping, HVAC piping and wall pipes and sleeves. This work is specified in Sections 15050, 15060, and as called for on the Contract Drawings.

D. Electrical/Instrumentation Equipment and Installation

The price for electrical/instrumentation work shall include all labor, materials, equipment. The costs of all transportation, loading, unloading, storage, insurance, duties are also included. Electrical/ instrumentation equipment shall be defined as all electrical/instrumentation within the confines of a structure or building needed to support the operation of the process, directly, or indirectly. This work is specified in Sections 16010, 16111, 16120, 16131, 16141, 16145, 16450, 16510, 16900, 13440, 13441, 13442, 13444, and as called for on the Contract Drawings.

9. SEPTAGE TANKS AND BUILDING

A. Structural/Architectural

The Price for structural/architectural work shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included.

This work is specified in Sections 02219, 02221, 02222, 02224, 03001, 03345, 04001, 05500, 07220, 07830, 07900, 08111, 08214, 08520, 09900, 10165, 10202, 10390, and 12610 and as called for on the Contract Drawings.

B. Mechanical Equipment and Installation

The price for mechanical equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Mechanical equipment shall be defined as all equipment needed to support the operation of the process, directly or indirectly including gates, HVAC equipment and duct work.

This work is specified in Sections 11000, 11312, 11353, 15400, 15450, 15740, 15820, 15840, 15860, 15890, 16151, 16152, and as called for on the Contract Drawings.

C. Piping Equipment and Installation

The price for piping equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Piping equipment shall be defined as all piping within the confines of a structure or building needed to support the operation of the process, directly or indirectly including plumbing, process piping, air piping, drain piping, HVAC piping and wall pipes and sleeves. This work is specified in Sections 15050, 15060, 15400, 15450 and as called for on the Contract Drawings.

D. Electrical/Instrumentation Equipment and Installation

The price for electrical/instrumentation equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included.

Electrical/instrumentation equipment shall be defined as all electrical/instrumentation within the confines of a structure or building needed to support the operation of the process, directly, or indirectly. This work is specified in Sections 16010, 16111, 16120, 16131, 16141, 16145, 16155, 16450, 16510, 16900, 16920, 13440, 13441, 13442, 13443, 13444, and as called for on the Contract Drawings.

10. PRIMARY CLARIFIER AND SLUDGE PUMPING BUILDING

A. Structural/Architectural

The price for structural/architectural work shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. This work is specified in Sections 02219, 02221, 02222, 02224, 03001, 03345, 04001, 05120, 05500, 07220, 07830, 07900, 08111, 08214, 09900, 10202, 10390, and as called for on the Contract Drawings.

B. Mechanical Equipment and Installation

The price for mechanical equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Mechanical equipment shall be defined as all equipment needed to support the operation of the process, directly or indirectly including gates, HVAC equipment and duct work.

This work is specified in Sections 11000, 11201, 11312, 11313, 11361, 15740, 15820, 15840, 15860, 15890, 16151, 16152, 13445 and as called for on the Contract Drawings.

C. Piping Equipment and Installation

The price for piping equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Piping equipment shall be defined as all piping within the confines of a structure or building needed to support the operation of the process, directly or indirectly including plumbing, process piping, air piping, drain piping, HVAC piping and wall pipes and sleeves. This work is specified in Sections 15050, 15060, 15400, 15450 and as called for on the Contract Drawings.

D. Electrical/Instrumentation Equipment and Installation

The price for electrical/instrumentation equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Electrical/instrumentation equipment shall be defined as all electrical/instrumentation within the confines of a structure or building needed to support the operation of the process, directly, or indirectly. This work is specified in Sections 16010, 16111, 16120, 16131, 16141, 16145, 16155, 16160, 16450, 16510, 16900, 13440, 13441, 13442, 13444, and as called for on the Contract Drawings.

11. TRICKLING FILTER LIFT STATION

A. Structural/Architectural

The Price for structural/architectural work shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. This work is specified in Sections 02219, 02221, 02222, 02224, 03001, 03345, 04001, 05120, 05500, 07220, 07830, 07900, 08111, 08214, 09900, 10202, 10390, and as called for on the Contract Drawings.

B. Mechanical Equipment and Installation

The price for mechanical equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Mechanical equipment shall be defined as all equipment needed to support the operation of the process, directly or indirectly including gates, HVAC equipment and duct work.

This work is specified in Sections 11000, 11201, 11217, 11312, 15400, 15740, 15820, 15840, 15860, 15890, 16151, 16152, 13445 and as called for on the Contract Drawings.

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C. Piping Equipment and Installation

The price for piping equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Piping equipment shall be defined as all piping within the confines of a structure or building needed to support the operation of the process, directly or indirectly including plumbing, process piping, air piping, drain piping, HVAC piping and wall pipes and sleeves. This work is specified in Sections 15050, 15060, 15250, 15400, 15450 and as called for on the Contract Drawings.

D. Electrical/Instrumentation Equipment and Installation

The price for electrical/instrumentation equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Electrical/instrumentation equipment shall be defined as all electrical/instrumentation within the confines of a structure or building needed to support the operation of the process, directly, or indirectly. This work is specified in Sections 16010, 16111, 16120, 16131, 16141, 16145, 16155, 16450, 16510, 16900, 16920, 13440, 13441, 13442, 13443, 13444, and as called for on the Contract Drawings.

12. TRICKLING FILTER

A. Structural

The Price for structural work shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. This work is specified in Sections 02219, 02221, 02222, 02224, 03001, 03345, 05120, 05500, 07900, 09900, 10390, and as called for on the Contract Drawings.

B. Mechanical Equipment and Installation

The price for mechanical equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Mechanical equipment shall be defined as all equipment needed to support the operation of the process, directly or indirectly including gates, HVAC equipment and duct work.

This work is specified in Sections 11000, 11201, 11371, 11372, 15820, 15840, 15860, 15890, 16152, and as called for on the Contract Drawings.

C. Piping Equipment and Installation

The price for piping equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Piping equipment shall be defined as all piping within the confines of a structure or building needed to support the operation of the process, directly or indirectly including plumbing, process piping, air piping, drain piping, HVAC piping and wall pipes and sleeves. This work is specified in Sections 15050, 15060, and as called for on the Contract Drawings.

D. Electrical/Instrumentation Equipment and Installation

The price for electrical/instrumentation equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Electrical/instrumentation equipment shall be defined as all electrical/instrumentation within the confines of a structure or building needed to support the operation of the process, directly, or indirectly. This work is specified in Sections 16010, 16111, 16120, 16131, 16141, 16450, 16510, 16900, and as called for on the Contract Drawings.

13. AERATION BASIN

A. Structural

The price for structural work shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties, are also included. This work is specified in Sections 02219, 02221, 02222, 02224, 03001, 03345, 05120, 05500, 07900, 09900, 10390, and as called for on the Contract Drawings.

B. Mechanical Equipment and Installation

The price for mechanical equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Mechanical equipment shall be defined as all equipment needed to support the operation of the process, directly or indirectly including gates, HVAC equipment and duct work.

This work is specified in Sections 11000, 11201, 11374, 16151 and as called for on the Contract Drawings.

C. Piping Equipment and Installation

The price for piping equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Piping equipment shall be defined as all piping within the confines of a structure or building needed to support the operation of the process, directly or indirectly including plumbing, process piping, air piping, drain piping, HVAC piping and wall pipes and sleeves. This work is specified in Sections 15050, 15060, and as called for on the Contract Drawings.

D. Electrical/Instrumentation Equipment and Installation

The price for electrical/instrumentation equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Electrical/instrumentation equipment shall be defined as all electrical/instrumentation within the confines of a structure or building needed to support the operation of the process, directly, or indirectly. This work is specified in Sections 16010, 16111, 16120, 16131, 16141, 16145, 16450, 16510, 16900, 13440, 13441, 13442, 13444, and as called for on the Contract Drawings.

14. FLOCCULATOR CLARIFIER

A. Structural

The price for structural work shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties, are also included. This work is specified in Sections 02219, 02221, 02222, 02224, 03001, 03345, 05120, 05500, 07900, 09900, 10390, and as called for on the Contract Drawings.

B. Mechanical Equipment and Installation

The price for mechanical equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Mechanical equipment shall be defined as all equipment needed to support the operation of the process, directly or indirectly including gates, HVAC equipment and duct work.

This work is specified in Sections 11000, 11201, 11312, 11362, 16151, and as called for on the Contract Drawings.

C. Piping Equipment and Installation

The price for piping equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Piping equipment shall be defined as all piping within the confines of a structure or building needed to support the operation of the process, directly or indirectly including plumbing, process piping, air piping, drain piping, HVAC piping and wall pipes and sleeves. This work is specified in Sections 15050, 15060, and as called for on the Contract Drawings.

D. Electrical/Instrumentation Equipment and Installation

The price for electrical/instrumentation equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Electrical/instrumentation equipment shall be defined as all electrical/instrumentation within the confines of a structure or building needed to support the operation of the process, directly, or indirectly. This work is specified in Sections 16010, 16111, 16120, 16131, 16141, 16145, 16450, 16510, 16900, and as called for on the Contract Drawings.

15. CHLORINE CONTACT TANK BUILDING AND EFFLUENT STRUCTURE

A. Structural/Architectural

The price for structural/architectural work shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. This work is specified in Sections 02219, 02221, 02222, 02224, 03001, 03345, 04001, 05120, 05500, 07220, 07830, 07900, 08111, 08214, 08520, 09900, 10202, 10390, 14300 and as called for on the Contract Drawings.

B. Mechanical Equipment and Installation

The price for mechanical equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Mechanical equipment shall be defined as all equipment needed to support the operation of the process, directly or indirectly including gates, HVAC equipment and duct work.

This work is specified in Sections 11000, 11201, 11214, 11218, 11234, 11315, 15820, 15840, 15860, 15890, 16151, 16152, 13445 and as called for on the Contract Drawings.

C. Piping Equipment and Installation

The price for piping equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Piping equipment shall be defined as all piping within the confines of a structure or building needed to support the operation of the process, directly or indirectly including plumbing, process piping, air piping, drain piping, HVAC piping and wall pipes and sleeves. This work is specified in Sections 15050, 15060, 15250, 15400, 15450 and as called for on the Contract Drawings.

D. Electrical/Instrumentation Equipment and Installation

The price for electrical/instrumentation equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Electrical/instrumentation equipment shall be defined as all electrical/instrumentation within the confines of a structure or building needed to support the operation of the process, directly, or indirectly. This work is specified in Sections 16010, 16111, 16120, 16131, 16141, 16145, 16160, 16450, 16510, 16900, 13440, 13441, 13442, 13444, and as called for on the Contract Drawings.

16. CHLORINE-CYLINDER STORAGE BUILDING

A. Structural/Architectural

The price for structural/architectural work shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. This work is specified in Sections 02219, 02221, 02222, 02224, 03001, 03345, 05120, 05310, 07900, 09900, 10390, and 14300 and as called for on the Contract Drawings.

D. Electrical/Instrumentation Equipment and Installation

The price for electrical/instrumentation equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Electrical/instrumentation equipment shall be defined as all electrical/instrumentation within the confines of a structure or building needed to support the operation of the process, directly, or indirectly. This work is specified in Sections 16010, 16111, 16120, 16131, 16450, 16510, and as called for on the Contract Drawings.

17. DIGESTER BUILDING

A. Structural/Architectural

The price for structural/architectural work shall include all labor, materials, and equipment. The costs of all transportation loading, unloading, storage, insurance, and duties are also included. This work is specified in Sections 02219, 02221, 02222, 02224, 03001, 03345, 04001, 05120, 05500, 07220, 07830, 07900, 08111, 08214, 08520, 09900, 10202, 10390, and 14300 and as called for on the Contract Drawings.

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B. Mechanical Equipment and Installation

The price for mechanical equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are all included. Mechanical equipment shall be defined as all equipment needed to support the operation of the process, directly or indirectly including gates, HVAC equipment and duct work.

This work is specified in Sections 11000, 11201, 11217, 11312, 11313, 11315, 11354, 11373, 15177, 15616, 15740, 15820, 15840, 15860, 15890, 16151, 16152, 13445 and as called for on the Contract Drawings.

C. Piping Equipment and Installation

The price for piping equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Piping equipment shall be defined as all piping within the confines of a structure or building needed to support the operation of the process, directly or indirectly including plumbing, process piping, air piping, drain piping, HVAC piping and wall pipes and sleeves. This work is specified in Sections 15050, 15060, 15250, 15400, 15450 and as called for on the Contract Drawings.

D. Electrical/Instrumentation Equipment and Installation

The price for electrical/instrumentation equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Electrical/instrumentation equipment shall be defined as all electrical/instrumentation within the confines of a structure or building needed to support the operation of the process, directly, or indirectly. This work is specified in Sections 16010, 16111, 16120, 16131, 16141, 16145, 16155, 16450, 16510, 16900, 16920, 13440, 13441, 13442, 13443, 13444, and as called for on the Contract Drawings.

18. DIGESTER TANK

A. Structural

The price for structural work shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. This work is specified in Sections 02219, 02221, 02222, 02224, 03001, 03345, 05120, 05500, 07900, 09900, 10390, and as called for on the Contract Drawings.

B. Mechanical Equipment and Installation

The price for mechanical equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Mechanical equipment shall be defined as all equipment needed to support the operation of the process, directly or indirectly including gates, HVAC equipment and duct work.

This work is specified in Sections 11000, 11315, and as called for on the Contract Drawings.

C. Piping Equipment and Installation

The price for piping equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Piping equipment shall be defined as all piping within the confines of a structure or building needed to support the operation of the process, directly or indirectly including plumbing, process piping, air piping, drain piping, HVAC piping and wall pipes and sleeves. This work is specified in Sections 15050, 15060, and as called for on the Contract Drawings.

D. Electrical/Instrumentation Equipment and Installation

The price for electrical/instrumentation equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Electrical/instrumentation equipment shall be defined as all electrical/instrumentation within the confines of a structure or building needed to support the operation of the process, directly, or indirectly. This work is specified in Sections 16010, 16111, 16120, 16131, 16141, 16145, 16450, 16510, 16900, and as called for on the Contract Drawings.

19. SLUDGE THICKENER

A. Structural

The Price for structural work shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance and duties are also included. This work is specified in Sections 02219, 02221, 02222, 02224, 03001, 03345, 05120, 05500, 07900, 09900, 10390, and as called for on the Contract Drawings.

B. Mechanical Equipment and Installation

The price for mechanical equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance and duties are also included. Mechanical equipment shall be defined as all equipment needed to support the operation of the process, directly or indirectly including gates, HVAC equipment and duct work.

This work is specified in Sections 11000, 11201, 11363, 16151, and as called for on the Contract Drawings.

C. Piping Equipment and Installation

The price for piping equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Piping equipment shall be defined as all piping within the confines of a structure or building needed to support the operation of the process, directly or indirectly including plumbing, process piping, air piping, drain piping, HVAC piping and wall pipes and sleeves. This work is specified in Sections 15050, 15060, and as called for on the Contract Drawings.

D. Electrical/Instrumentation Equipment and Installation

The price for electrical/instrumentation equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Electrical/instrumentation equipment shall be defined as all electrical/instrumentation within the confines of a structure or building needed to support the operation of the process, directly, or indirectly. This work is specified in Sections 16010, 16111, 16120, 16131, 16141, 16145, 16450, 16510, 16900, and as called for on the Contract Drawings.

20. SLUDGE HOLDING TANK/THICKENER AND SLUDGE PUMP STATION

A. Structural/Architectural

The price for structural/architectural work shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. This work is specified in Sections 02219, 02221, 02222, 02224, 03001, 03345, 04001, 05120, 05500, 07220, 07830, 07900, 08111, 08214, 09900, 10202, 10390, and as called for on the Contract Drawings.

B. Mechanical Equipment and Installation

The price for mechanical equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Mechanical equipment shall be defined as all equipment needed to support the operation of the process, directly or indirectly including gates, HVAC equipment and duct work.

This work is specified in Sections 11000, 11201, 11217, 11312, 11313, 11363, 11373, 15740, 15820, 15840, 15860, 15890, 16151, 16152, 13445 and as called for on the Contract Drawings.

C. Piping Equipment and Installation

The price for piping equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Piping equipment shall be defined as all piping within the confines of a structure or building needed to support the operation of the process, directly or indirectly including plumbing, process piping, air piping, drain piping, HVAC piping and wall pipes and sleeves. This work is specified in Sections 15050, 15060, 15250, 15400, 15450 and as called for on the Contract Drawings.

D. Electrical/Instrumentation Equipment and Installation

The price for electrical/instrumentation equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Electrical/instrumentation equipment shall be defined as all electrical/instrumentation within the confines of a structure or building needed to support the operation of the process, directly, or indirectly. This work is specified in Sections 16010, 16111, 16120, 16131, 16141, 16145, 16155, 16450, 16510, 16900, 16920, 13440, 13441, 13442, 13443, 13444, and as called for on the Contract Drawings.

21. SLUDGE DRYING BEDS

A. Structural

The price for structural work shall include all cost for labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance and duties are also included. This work is specified in Sections 02219, 02221, 02222, 02224, 03001, 05120, 05500, 10390, and as called for on the Contract Drawings.

C. Piping Equipment and Installation

The price for piping equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Piping equipment shall be defined as all piping within the confines of a structure or building needed to support the operation of the process, directly or indirectly including plumbing, process piping, air piping, drain piping, HVAC piping and wall pipes and sleeves. This work is specified in Sections 15050, 15060, and as called for on the Contract Drawings.

D. Electrical/Instrumentation Equipment and Installation

The price for electrical/instrumentation equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Electrical/instrumentation equipment shall be defined as all electrical/instrumentation within the confines of a structure or building needed to support the operation of the process, direclty, or indirecIty. This work is specified in Sections 16010, 16111, 16120, 16131, 16160, 16450, 16510, and as called for on the Contract Drawings.

22. DRAINAGE AND STORMWATER HOLDING TANK

A. Structural

The price for structural work shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. This work specified in Sections 02219, 02221, 02222, 02224, 03001, 03345, 05120, 05500, 07900, 09900, 10390, and as called for on the Contract Drawings.

B. Mechanical Equipment and Installation

The price for mechanical equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Mechanical equipment shall be defined as all equipment needed to support the operation of the process, directly or indirectly including gates, HVAC equipment and duct work.

This work is specified in Sections 11000, 11201, and as called for on the Contract Drawings.

C. Piping Equipment and Installation

The price for piping equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Piping equipment shall be defined as all piping within the confines of a structure or building needed to support the operation of the process, directly or indirectly including plumbing, process piping, air piping, drain piping, HVAC piping and wall pipes and sleeves. This work is specified in Sections 15050, 15060, and as called for on the Contract Drawings.

23. OPERATION BUILDING

A. Structural/Architectural

The price for structural/architectural work shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. This work is specified in Sections 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 19 and as called for on the Contract Drawings.

B. Mechanical Equipment and Installation

The price for mechanical equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Mechanical equipment shall be defined as all equipment needed to support the operation of the process, directly or indirectly including HVAC equipment and duct work.

This work is specified in Sections 15, 16, 18 and as called for on the Contract Drawings.

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C. Piping Equipment and Installation

The price for piping equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Piping equipment shall be defined as all piping within the confines of a structure or building needed to support the operation of the process, directly or indirectly including plumbing, process piping, air piping, drain piping, HVAC piping and wall pipes and sleeves. This work is specified in Section 14 and as called for on the Contract Drawings.

D. Electrical/Instrumentation Equipment and Installation

The price for electrical/instrumentation equipment and installation shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance, and duties are also included. Electrical/instrumentation equipment shall be defined as all electrical/instrumentation within the confines of a structure or building needed to support the operation of the process, directly, or indirectly. This work is specified in Section 17 and as called for on the Contract Drawings.

24. LANDFILL

Price shall include all work required at the landfill and sludge mixing and storage areas. The price shall include all labor, materials, and equipment. The costs of all transportation, loading, unloading, storage, insurance and duties are also included. This work is specified in Section 02210, 02219, 02221, 02222, 02224, 02444, 02513, and as called for on the Contract Drawings.

25. PROVISIONAL SUMS

Payments shall be made based on billings submitted with supporting documentation for each item complete. Provisonal sums have been set aside as an allowance for:

A. Laboratory tests which may be required to be done by a testing laboratory other than the field laboratory (provided under Spec. Section 01410).

B. Reimbursement to Engineer or Owner for night or rest day (Friday) work (in accordance with Clause 45 of the Conditions of Contract), and

C. Maintenance Period (as described in Spec Section 01095). All maintenance period costs are included in this provisional sum to aid evaluation of Tenders. An actual cost for the Maintenance Period not to exceed this Provisional Sum will be negotiated with the Contractor prior to commencement of the Maintenance Period.

26. ALL OTHER WORK SPECIFIED, NOT INCLUDED IN SEPARATE LINE ITEMS

This item includes all costs for all labor, material, and equipment for all work not included in Items No. 1 through 25, inclusive. Such work includes, but is not limited to, mobilization, demobilization, field laboratory, field offices, shop drawings, construction photographs, project signs, Engineer's vehicles, construction scheduling/schedules, erosion control, clean-up, dust control, project record documents, operation and maintenance manuals, permits, licenses, warranties and bonds for equipment, insurance, bonds and guarantees. This work is included in, but not limited to Specification Sections 01300, 01330, 01340, 01380, 01410, 01500, 01560, 01566, 01580, 01592, 01710, 01720, 01730, 01735, and 01740.

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SECTION 01300

CONSTRUCTION PROGRESS AND SCHEDULES

PART 1 - GENERAL

1.01 SCHEDULES AND CHARTS

A. The time for completion of this Contract shall be 1368 calendar days after the Owner's Notice to Proceed. This includes a 90 day mobilization period, 30-month construction period, and 1-year maintenance period.

B. The total construction program for construction under this contract shall be laid out by the Contractor and submitted to the Engineer, thirty days after execution of the Contract, for approval. The schedule will be a basic critical path method (CPM). The CPM schedule shall specifically show the construction program for the entire contract and show the complete sequence of construction by activity for each of the subdivisions of this contract separately and shall indicate how the subdivisions shall be integrated into the entire program. Show start and completion dates for each subdivision.

C. Contractor shall update and revise schedule on a monthly basis. Revised schedule shall be submitted to Engineer seven (7) days after end of each calendar month.

D. The Contractor shall prepare and submit to the Engineer, seven (7) days after end of each calendar month, the contract Drawing's Index Map showing for each subdivision as broken down in item "B" above:

1. Work construction to date
2. Changes in pipeline routing from original contract drawings.
3. Schedule of work for the next calendar month.

END OF SECTION

SECTION 01330

SURVEY DATA

PART 1 GENERAL

1.01 LINES, GRADES, AND MEASUREMENTS

A. Reference marks establishing the controlling grades for the Work will be established by the Contractor and approved by the Engineer. These reference marks shall be replaced at the Contractor's expense if damaged or destroyed by construction operations.

B. The Treatment Plant Contractor will be provided with the influent sewer invert elevation and bench marks and before starting any work shall verify its elevation with respect to his construction bench marks and to the elevation shown on the Drawings.

C. The Contractor shall establish the Treatment Plant base line and necessary bench marks located throughout the plant site. The Contractor shall locate and layout each tank, structure, or building from this base line.

D. The Contractor shall make all measurements and check all dimensions necessary for the proper construction of the Work called for by the Drawings and Specifications. During the prosecution of the Work, he shall make all necessary measurements to prevent misfitting of said Work, and he shall be responsible thereof, and for the accurate construction of the Work.

1.02 QUALITY CONTROL

A. The Engineer will spot check lines, grades, elevations and reference points during construction. Any deviations from the Contract requirements or errors in setting out the Works shall be corrected by the Contractor at no expense to the Owner. Any works provided using incorrect line, grades, elevations or reference points shall be corrected as directed by the Engineer.

END OF SECTION

SECTION 01340

SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

A. Definitions, and Additional Responsibilities of Parties: Conditions of the Contract.

B. Section 01300: Construction Schedules

C. Section 01720: Record Documents

D. Designate in the construction schedule, or in a separate coordinated schedule, the dates for submission and the dates that reviewed Shop Drawings, Product Data and Samples will be needed.

1.02 SHOP DRAWINGS

A. Drawings shall be identified by reference to Contract Documents sheet and detail.

B. Minimum sheet size: 11" x 17"

C. Preparation
1. Show dimensions and clearances required.
2. Show weights of equipment or components.
3. Show structural and operating features.
4. Indicate type and brand of finish or shop coat.

1.03 CONTRACTOR RESPONSIBILITIES

A. Review Shop Drawings, Product Data and Samples prior to submission.

B. Determine and verify:
1. Field measurements.
2. Field construction criteria.
3. Catalog numbers and similar data.
4. Conformance with specifications.

C. Coordinate each submittal with requirements of the Work and of the Contract Documents.

D. Notify the Engineer in writing, at time of submission, of any deviations in the submittals from requirements of the Contract Documents.

E. Begin no fabrication or work which requires submittals until return of approved submittals.

F. Distribute submittals which carry Engineer's stamp of approval.

1.04 SUBMISSION REQUIREMENTS

A. Make submittals in accordance with approved schedule.

B. Number of submittals required:
   1. Shop Drawings: Submit one opaque reproduction plus two copies which will be retained by the Engineer.
   2. Product Data: Submit one opaque reproduction plus two copies which will be retained by the Engineer.
   3. Samples: Submit the number stated in each specification section.
   4. Certificates: Submit two copies which will be retained by the Engineer.

C. Submittals shall contain:
   1. The date of submission and the dates of any previous submissions.
   2. The Project title and number.
   3. Contract identification.
   4. The names of:
      a. Contractor.
      b. Supplier.
      c. Manufacturer.
   5. Identification of the product, with the specification section number.
   6. Field dimensions, clearly identified as such.
   7. Relation to adjacent or critical features of the Work or materials.
   8. Applicable standards, such as ASTM or Federal Specification numbers.
   9. Identification of deviations from Contract Documents.
   10. Identification of revisions on resubmittals.
   11. An 8 in. x 3 in. blank space for Contractor and Engineer stamps.
   12. Contractor's stamp, initialed or signed, certifying to review of submittal, verification of products, field measurements and field construction criteria, and coordination of the information within the submittal with requirements of the Work and of Contract Documents.

1.05 RESUBMISSION REQUIREMENTS

A. Make any corrections or changes in the submittals required by the Engineer and resubmit until none of the following Engineer review classifications are marked on the submittal:
   1. Rejected
   2. Resubmit

B. Shop Drawings and Product Data:
   1. Revise initial drawings or data, and resubmit as specified for the initial submittal.
   2. Indicate any changes which have been made other than those requested by the Engineer.

C. Samples: Submit new samples as required for initial submittal.

1.06 ENGINEER'S DUTIES

A. Review submittals in accord with schedule.

B. Affix stamp and initials or signature, and indicate requirements for resubmittal, or approval of submittal. Review classifications are as follows:
   1. No Exceptions Taken
   2. Note Markings
   3. Rejected
   4. Comments Attached
   5. Resubmit
   6. Contractor Confirm

C. Return submittals to Contractor for distribution, or for resubmission.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01370

SCHEDULE OF VALUES

PART 1 GENERAL

1.01 ESTIMATE

Within thirty days after execution of this contract, the Contractor shall furnish, on forms to be supplied by the Engineer, a detailed estimate giving a complete breakdown of the contract price by items of work.

END OF SECTION

SECTION 01380

CONSTRUCTION PHOTOGRAPHS

PART 1 GENERAL

1.01 REQUIREMENTS

A. The Contractor shall employ a competent photographer to take progress photographs throughout the duration of the contract. Photographs shall be taken at monthly intervals or as may be specifically directed by the Engineer. Each month the Contractor shall take not less than three photographs of each area where work is being conducted.

B. Photographs shall be 20 cms by 25 cms colored prints on glossy paper. The Engineer shall be provided with four copies of each print.

C. Each photograph shall contain a written description indicating the location of the camera, its direction, what is shown and the date taken.

D. Photographs shall be provided to the Engineer within two weeks from the date taken.

1.02 ORIGINALS

A. Remain property of the Contractor.

B. Negatives shall be retained for a period of two years from date of completion of the Works.

C. Contractor shall furnish additional prints to Engineer when requested, at commercial rates on date of purchase.

END OF SECTION

SECTION 01400

QUALITY CONTROL

RT 1 - GENERAL

01 CONTRACTOR STAFF

A. The Contractor shall provide at all times a construction force of sufficient size and of a sufficient number of required skills to accomplish the work in this Contract within the specified time and according to the quality and workmanship indicated herein.

B. The Contractor shall provide for qualified supervisory personnel for execution of the Works; an engineer assisted by foremen is preferable.

C. The Contractor shall provide for qualified staff as specified in other Sections.

.02 TESTING LABORATORY SERVICES

A. Tests will be required for soils, aggregates, asphalt, and concrete:

1. The majority of such testing shall be done in the field laboratory supplied under Contract No. 1. The field laboratory will be staffed by Engineer and by Owner.

2. Certain special test requirements may arise from time to time which are beyond the capability of the field laboratory. In these instances testing and analyses will be done by a qualified testing laboratory, approved by the Engineer. Payment for these special tests will be by the Contractor, from Provisional Sums in the Bill of Quantities.

B. Costs for all other required tests in the Specifications, unless otherwise noted, shall be the responsibility of the Contractor and shall be included as a part of the appropriate unit price in the Bill of Quantities.

C. When re-tests are required due to failure of a material to comply with quality standards, the cost of such additional testing done outside the field laboratory shall be at Contractor's expense.

1.03 INSPECTION SERVICES

A. Costs for inspection services required in the Specifications shall be the responsibility of the Contractor and shall be included as a part of the appropriate lump sum price in the Bill of Quantities.

END OF SECTION

SECTION 01410

FIELD TESTING LABORATORY SERVICES

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. The Contractor shall provide and maintain a fully-equipped materials testing laboratory to support the field construction Work.

B. The laboratory shall be located at a site near or adjacent to the Work. The site location will be mutually agreed upon by the Owner, Engineer, and Contractor.

C. The laboratory can be a mobile facility, or a fixed structure; however, the laboratory shall not be considered as a permanent structure. At the conclusion of the Work, the Contractor shall remove the laboratory and related appurtenances from the site, and restore the site to its original condition, or to the finished grades shown on the Drawings, whichever is appropriate.

D. The Contractor shall provide and maintain all required utilities to the laboratory, continuously 24 hours per day, seven days per week. Required utilities include electric power and potable water.

E. The laboratory shall be equipped with suitable benches, shelves, cupboards, desks, chairs, sinks, controlled drains, electric lights, and utility outlets. The laboratory shall be weatherproof and properly heated and ventilated. The laboratory shall include the equipment and means required to allow controlled curing of concrete specimens. Distilled water and bottled gas shall also be provided by the Contractor, as required. All equipment and apparatus, including consumables, required for carrying out the tests defined in PART 1.02 must be provided and maintained by the Contractor.

F. The laboratory must be in place, available for use, at the end of the 90-day mobilization period. The laboratory must be available for the entire construction period, and must be removed no later than 60 days after substantial completion of the Works.

G. The laboratory will be staffed by Owner and Engineer.

H. Details and layouts of the Contractor's proposed field-testing laboratory shall be submitted to the Engineer for approval before the laboratory is moved to the site.

1.02 LABORATORY TEST REQUIREMENTS

A. The laboratory shall be fully equipped to allow performance of the tests listed below:

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1. Aggregate
   a. Particle Size Analysis (by sieving)
   b. Density and Specific Gravity
   c. Moisture, Clay, and Silt Content
   d. Organic Impurities
2. Concrete Batches
   a. Slump
   b. Density
3. In-Place Concrete: test specimen
   a. Crushing STrength
   b. Weight
4. Fill
   a. Compaction (Proctor)
5. Mortar
6. Bituminous Paving

B. Testing will conform to the standards called-out in the specific specifications for Backfill, Concrete, Bituminous Paving, and Mortar in these Contract Documents.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.01 CONTRACTOR'S RESPONSIBILITIES

A. Provide and maintain the fully-equipped laboratory as described in this Section.

B. Provide and deliver to the laboratory adequate and representative samples of materials to be tested, as specified herein, and as directed by the Engineer. All labor and equipment required for obtaining and delivering these samples shall be provided by the Contractor. Reference Section 01340 for additional sample requirements.

C. Calibrate, at intervals agreed-to with Engineer, all testing equipment in the laboratory.

D. Replace items of laboratory equipment lost or damaged.

E. Equip the laboratory with, and maintain an adequate supply of, all consumables used in the laboratory.

F. Provide all labor and materials required for the maintenance of the laboratory and its associated equipment and appurtenances, and for all laboratory custodial services.

3.02 OWNER/ENGINEER RESPONSIBILITIES

A. Provide the laboratory staff required to perform the testing specified in this Section.

B. Provide the Contractor with one copy of all test results.

C. Promptly notify the Contractor of test results which indicate irregularities or deficiencies in the Work.

END OF SECTION

SECTION 01500

TEMPORARY FACILITIES

PART 1 GENERAL

1.01 GENERAL

Prior to the time that the Owner accepts and assumes his right to operate the facilities, the Contractor shall pay for all water, electricity, fuel, sanitary facilities, temporary structures and other necessary utilities, services and facilities.

1.02 PRECAUTIONS AGAINST WEATHER

During adverse weather conditions and against the possibility thereof, the Contractor shall take all necessary precautions so that the Work shall be properly done and be satisfactory in all respects. When required, protection shall be provided by use of tarpaulins, sheet plastic 20 mils thickness, wood and building paper shelter, or other approved means.

1.03 WATER SUPPLY

The Contractor, at his own expense, shall provide at the treatment plant site all water, both potable and non-potable, necessary for his operations and operation of the field laboratory. The Contractor shall make all arrangements necessary to obtain water.

1.04 ELECTRICAL ENERGY

A. The Contractor shall make all necessary applications and arrangements and pay all fees and charges for electrical energy for power and light necessary for the proper completion of the Work during its entire progress, except when the specifications particularly state that the Owner shall pay for the energy used in making tests. The Contractor shall provide and pay for all temporary wiring, switches, connections, and meters.

B. There shall be sufficient electric lighting so that all work may be done in a workmanlike manner when there is not sufficient daylight.

1.05 SANITARY FACILITIES

A. The Contractor shall provide adequate sanitary conveniences for the use of those employed on the Work. Such conveniences shall be made available when the first employees arrive on the Work, shall be properly secluded from public observation, and shall be constructed and maintained in suitable numbers and at such points and in such manner as may be required or approved.

B. The Contractor shall maintain the sanitary facilities in a satisfactory and sanitary condition at all times and shall enforce their use. He shall rigorously prohibit the committing of nuisances on the site of the Work, on the lands of the Owner, or on adjacent property.

1.06 FIELD OFFICE

A. The Contractor shall provide and maintain a field office for the exclusive use of the Engineer with minimum floor space of 50 square meters. The field office shall be available for his use during the contract duration. The field office shall be a separate, weathertight structure, with heating and air conditioning facilities, and potable water, completed and ready for occupancy within 60 days following the Owner's Notice to Proceed with the Project. A mobile field office equipped with the required facilities will be acceptable.

B. Construction:

1. Structurally sound, weathertight, with floors raised above ground and open to allow free circulation of air under trailer.
2. Temperature transmission resistance: Compatible with occupancy and storage requirements.
3. At Contractor's option, portable or mobile buildings may be used.
   a. Mobile homes, when used, shall be modified for office use.
   b. Do not use mobile homes for living quarters.

C. Office for Engineer:

1. A separate space for sole use of designated occupants, with secure entrance doors and one key per occupant.
2. Area: 50 sq. m. minimum, with minimum dimension 3 meters.
3. Windows:
   a. Minimum: 3, with a minimum total area of 10% of floor area.
   b. Operable sash and insect screens.
   c. Locate to provide view of Project Site.
4. Furnishings:
   a. Four standard size desks with six drawers, three at each end.
   b. One drafting table: 39 in. (1 m) x 72 in. (1.8 m) x 36 in. (0.92 m) high, with one equipment drawer.

      Locate table oriented in relation to the site at a window with a view of the site.

   c. One metal, double-door storage cabinet under table.
   d. Two plan racks to hold a minimum of six racks of project drawings.
   e. Two standard four-drawer letter-size metal filing cabinets with locks and keys.
   f. One standard four-drawer, one hour fire rated, insulated letter size steel filing cabinet with locks and keys.
   g. Twelve 1.f (2m) of bookshelves.
   h. Four swivel arm chairs.
   i. Four straight chairs.
   j. One drafting table stool.
   k. One waste basket per desk and table.
   l. One tackboard, 36 in. (0.92) x 30 in. (0.76 m)
   m. One wall mounted, dry chemical, class ABC fire extinguisher.
   n. One water cooler with drinking water supplied for duration of the Project.
   o. Xerox equipment - desk top, One electric typewriter.

5. Services:

   a. Lighting: 50 foot-candles at desk top height.

   b. Exterior lighting at entrance door.

   c. Automatic heating and mechanical cooling equipment to maintain comfort conditions.

   d. Minimum of four 220 volt duplex electric convenience outlet, at least one on each wall.

   e. Electric distribution panel: Two circuits minimum, 220 volt, 50 hertz service.

   f. Toilet facilities within trailer.

   g. Telephone: One direct line instrument.

   h. Telex

6. Identification:

   a. One 24 x 36 inch plywood sign, painted white with 3 inch high lettering showing name and address of the Department. Lettering shall be in English and in Arabic.

   b. Locate sign on exterior of office as directed by Engineer.

D. Contractor shall provide all office accessories (such as staplers, scissors, sharpeners) and all consumables, to include all paper, pencils, pens, drafting supplies, clips, and staples.

E. Sixty days after substantial completion of the Works, the field office shall be removed from the site, and the site shall be restored to its original condition, or to the final grades shown on the Drawings, as appropriate.

F. Engineer's Office provided shall be located adjacent to but separate from Contractor's field office, and shall be relocated during Construction of Works, should Contractor move his field office.

1.07 ENGINEER'S HOUSING

By Owner.

1.08 CUSTODIAL SERVICE

A. Contractor shall provide complete custodial services for field offices, and eating and sanitary facilities for the duration of the execution of the Works.

B. Frequency of service shall be sufficient to maintain aesthetically acceptable and hygienic conditions to the satisfaction of the Engineer.

END OF SECTION

SECTION 01560

MAINTENANCE OF WORK SITE

PART 1 GENERAL

1.01 SAFETY AND PROTECTION

A. Contractor shall be responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work. He shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury or loss to:

1. All employees on the Work and other persons who may be affected thereby.
2. All the Work and all materials or equipment to be incorporated therein, whether in storage on or off the site.
3. Other property at the site or adjacent thereto, including trees, shurbs, roadways.

B. All damage, injury or loss to any property referred to in paragraph 3 above, directly or indirectly, in whole or in part, by Contractor, any sub-contractor or anyone directly or indirectly, in whole or part, to the fault or negligence of Contractor, shall be replaced or restored to at least original condition at Contractor's expense. Contractor's duties and responsibilities for the safety and protection of the Work shall continue until such time as all the Work is completed and Engineer has issued a notice to Owner and Contractor as described herein that Work is acceptable and for a period of twelve months thereafter.

C. The Contractor shall not load or permit any part of any structure to be loaded with a weight that would endanger its safety.

D. The Contractor shall provide protection of the work from freezing and from other elements which would be harmful to it. The Contractor shall furnish heat or protective shelters or temporary buildings as required for the prosecution and protection of the work.

E. The Contractor shall take all necessary precautions for the safety of employees on the Work, and shall comply with all applicable provisions of National and local safety laws and building codes to prevent accidents or injury to persons on, about or adjacent to the premises where the work is being performed. He shall erect and properly maintain at all times, as required by the conditions and progress of the work, all necessary safeguards and barricades for the protection of employees on the work and the safety of others employed near the work and the public, and shall post danger signs and warning lights warning against the hazards created by such features of the construction as protruding nails, hoists, excavations, elevator hatchways, scaffoldings, window openings, stairways and falling materials.

F. The Contractor shall designate a responsible member of its organization on the Work, whose duty shall be the prevention of accidents. The name and position of the person so designated shall be reported in writing to the Engineer.

G. The Contractor shall immediately report in writing, giving full details, to the Engineer all serious accidents which arise out of or in connection with the performance of the Work, whether on or adjacent to the site, which cause death, serious personal injury or substantial property damage. In addition, if death or serious injury or substantial property damage is caused, the accident shall be reported immediately by telephone or messenger to the Engineer. If a claim is made or suit is filed by anyone against the Contractor or any subcontractor on account of any accident, the Contractor shall promptly report the facts in writing to the Engineer, with a copy to the Owner, giving full details of the claim.

H. The Contractor shall assume all risks of loss or damage of any kind to any vehicle, machinery, equipment, materials or supplies which he shall provide in doing the Work.

I. The Contractor shall take all precautions to prevent damage to the Work by the elements, storms or by water entering the site of the Work directly or through the ground. In case of damage by the elements, storm or water, the Contractor shall make such repairs or replacements or rebuild such parts of the Work as the Engineer may require in order that the Work may be completed as required by the Contract Documents. If Contractor believes that additional work done by him, which arose from causes beyond his control entitles him to an increase in the Contract Price or an extension of the Contract Time, he may make a claim thereof as provided herein.

J. The Contractor shall post illuminated warning and danger signs so as to apprise all persons against any hazards created by the Work being done under this contract.

K. The Contractor shall provide the necessary security protection of all materials and equipment delivered to the Site, installed, or to be installed as a part of the Temporary Works or Permanent Works.

L. The Contractor shall provide for the necessary security at all times and will be responsible for providing protection to the Construction Plant, the Temporary Works and Permanent Works, until issuance of the "Certificate of Completion" of the Works.

1.02 PROTECTION OF PUBLIC

The Contractor shall conduct his Work so as to interfere as little as possible with the private, personal activities of residents, private business and public business and travel. Wherever necessary or required, and at his own expense, he shall maintain fences, furnish full-time or part-time watchmen, guards, and/or like protective personnel, maintain lights, and take such additions, precautions as may be necessary to protect life and property.

1.03 PROTECTION OF NATURAL WATERCOURSES

A. The Contractor must use all care possible to prevent siltation and other pollution of waters during and after construction. Prohibited practices include, but are not limited to:

1. Dumping of spoil material into Wadi or on banks where it may wash or slide into the stream.
2. Operating of equipment in the Wadi.
3. Pumping of silt-laden water from excavations into the Wadi.
4. Disposing of trees, brush, and other debris in the Wadi.
5. Altering of the Wadi flow line.

B. The Contractor must take sufficient precautions to minimize run-off, due to construction, of polluting substances such as silt, clay, fuels, oils, bitumens calcium chloride, or other polluting materials harmful to humans, fish or other life, into the water supplies and surface waters. Unless otherwise permitted in writing control measures must be adequate to assure that turbidity in the receiving water shall not be increased to more than 10 Jackson Turbidity Units (JTU) in waters used for public water supply or fishing, unless limits have been established for the particular water. In surface water used for other purposes, the turbidity must not exceed 25 JTU unless otherwise permitted in writing. Special precautions shall be taken in the use of construction equipment to avoid operations which promote erosion. Refer to Section 01566.

C. In addition, the work area must be cleaned up, and graded, as the work proceeds.

END OF SECTION

SECTION 01566

EROSION CONTROL

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02110: Clearing.

B. Section 02210: Site Grading.

C. Section 02219: Excavation and Backfill.

D. Section 02221: Trenching, Backfilling and Compacting.

E. Section 02260: Finish Grading.

1.02 EROSION AND SEDIMENTATION CONTROL PLAN

A. Prepare erosion and sedimentation control plan. Person trained and experienced in erosion and sedimentation control methods and techniques shall prepare plan.

B. For plan, consider factors which contribute to erosion and sedimentation including, but not limited to, the following:
1. Topographic features of Project area.
2. Types, depth, slope and extent of soils.
3. Proposed alteration of Project area.
4. Amount of run-off from Project area and upstream watershed area.
5. Staging of earthmoving activities.
6. Temporary control measures and facilities for use during earthmoving.
7. Permanent control measures and facilities for long term protection.
8. Maintenance program for control facilities, including disposal of materials removed from control facilities or Project area.

PART 2 PRODUCTS

2.01 SEDIMENT BARRIERS

A. Sediment Barriers shall be constructed of locally available materials and shall be approximately 0.45 meters high by 0.45 to 1.0 meters wide.

B. Typical materials for sediment barriers shall include:
1. Coarse rock, field stone or broken concrete having minimum weight of 23 kg. to maximum 65 kg. with at least 60 percent weighing more than 45 kg.; 75 percent shall be larger than 0.30 meters.
2. Any other filter material such as bound brush.

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PART 3 EXECUTION

3.01 DIVERSION TERRACES

A. Construct terraces, as temporary measure, on the uphill side of disturbed areas to divert surface run-off away from unstabilized slopes, and Project area.

B. Construct terraces to following dimensions:
1. Height: 0.45 meters
2. Top Width: 0.61 meters
3. Side Slopes: two to one or flatter
4. Material: soil

3.02 INTERCEPTOR CHANNELS

A. Construct channels across disturbed areas where slope is perpendicular to excavated trenches.

B. Intercept and divert storm runoff to outlets on the lower side of disturbed area. Dispose of runoff with minimum erosion impact.

C. Construct channels to following dimensions:
1. Depth: 0.15 meters
2. Width: 0.61 to 1.22 meters
3. Side Slopes: two to one or flatter
4. Spacing: Where required
5. Material: Stable on-site material

3.03 TRENCH BARRIERS

A. Install trench barriers where disturbed area is sloped parallel to excavated trenches, when slope exceeds 15 percent or when Engineer deems necessary.

B. Stack trench barriers to the top of trench after installation of pipe, prior to backfill, if backfill is delayed.

C. Use trench barriers to prevent washout of trench.

D. Space trench barriers approximately every 46 meters.

E. Barriers shall be earth-filled sacks or piled stone.

3.04 SEDIMENT BARRIERS

A. Provide sediment barriers at storm drain inlets; across minor swales and ditches and other applications where barrier is temporary and structural strength is not required.

B. Pile stone to produce uniform top elevation 0.45-0.60 meters high with side slopes 3:1 maximum. Provide 1.9 square meters minimum cross sectional area per tributary acre.

C. Anchor brush so brush does not move and runoff cannot escape freely under barrier. Provide 1.40 square meters minimum cross sectional area per tributary acre.

END OF SECTION

SECTION 01570

LANDFILL OPERATION GUIDELINES

PART 1 GENERAL

1.01 INTRODUCTION

A. The Irbid landfill is designed for the disposal of sludges produced by the proposed municipal wastewater treatment plant. This plant is to be located approximately 2.5 kilometers northwest of the City along the Wadi Hamam. It is anticipated that sludge from this plant will be generated at the rate of 56 m3/day for the years 1985 to 2000 and at 68 m3/day for the years 2000 to 2035.

The overall area of 15.2 hectares allotted to the landfill is configured in a square, 390 meters on a side. The site is located on gently sloping terrain having a natural gradient of 2 to 3 percent which slopes from plant east to plant west. The upper layers (3 meters) of soil on the site are a sandy silty clay, known as "Mediterranean" soil, underlain by marl having a relatively low permeability. The design of the landfill requires no artificial liner, since it is anticipated that the marl layer will effectively serve this purpose.

The following guidelines are presented for the first 20 years of landfill operation. After that time, it may be desirable to convert to another means of sludge disposal, such as composting. However, the landfill has been designed for an overall 50-year service life and can provide sludge disposal for the remaining 30 years, if it is decided to continue its use.

The effort included in Contract No. 1 includes only the clearing and grading for the landfill area and the excavation of Cell No. 1. The additional effort described in Sections 1.02 and 1.03 is for information only, as guidance to describe the intended lifetime use of the landfill.

1.02 METHOD OF CONSTRUCTION

A. The landfill is to be constructed in a series of cells, each having a 2-year capacity. The overall cell layout (Cell Nos. 1 to 10 for the first 20 years of operation) is presented on Drawing Nos. 170 and 171. Each cell has dimensions of 195 meters by 78 meters and is to be excavated to approximately 3.5 meters below existing grade with sideslopes of 3 horizontal to 1 vertical. Excavated material is to be segregated into separate stockpiles for the sandy silty clay (Mediterranean soil) and the marl. These stockpiles are to be located in the northwest portion of the landfill site (based on plant north) in the area designated for Cell No. 10. Surplus excavated soils from the construction of the treatment plant, to be

stockpiled in the future sludge drying bed area, will also be available for landfilling. Suitable soil from the latter should first be utilized in the construction of Cell No. 1.

Excavation of Cell No. 1 is included in Contract Number 1. The entire cell should be excavated prior to the start of landfilling operations. The excavation of all future cells should be sublet under separate contracts. In each case, the excavation should be carried out in a manner which would minimize the time a cell is left open, but not interrupt landfilling operations.

The bottom of each cell is sloped at 2 to 3 percent; odd-numbered cell bottoms being sloped in a southwesterly direction and even-numbered cell bottoms sloped to the northwest. Due to the fact that the direction of landfilling in each cell proceeds upslope, dewatering measures will be necessary to keep the lower portion of the cell as dry as possible. These measures are further described in the next section.

Typical cell construction is shown on Drawing No. 170. Cells will be constructed by progressively filling each of 23 sub-cells. Sub-cells are approximately 8 meters wide and individually represent about two months of landfilling. Work shall proceed in the plant north direction for all odd-numbered cells and in the plant south direction for all even numbered cells. During the construction of a cell, a 5 meter access strip will be maintained along its west side to facilitate drainage and excavation on the subsequent cell. In addition, as each sub-cell is completed and covered with an intermediate soil layer (.300 meters thick), a temporary diversion berm shall be constructed across its west face. As the work progresses and sub-cells are filled and covered, a continuous diversion berm will be constructed that will direct stormwater runoff to the ditches bordering the landfill. These berms will remain in place as erosion control measures until the landfill has reached its 20 year capacity, at which time they should be removed.

1.03 LANDFILL OPERATION AND EQUIPMENT USAGE

A. As sludge is removed from the wastewater treatment plant drying beds, it shall be placed in the Sludge Holding Area. This area has been sized to accommodate the volume of sludge generated from one month of treatment plant operation. During sludge holding, local farmers should be encouraged to remove and use the sludge as a soil conditioner.

Periodically (about one time per month), sludge will be transferred from the Holding Area to the Mixing Area by a wheeled front-end loader. Soil from one of the designated stockpiles will also be brought to this area where it will be mixed with the sludge, using the loader, until a stable mixture, suitable for landfilling, is obtained. It is

anticipated that the soil requirement for mixing will range between 20 to 30 percent of the total sludge volume. Soil from the marl stockpile should be used as the mixing additive during the dry season and from the "Mediterranean" soil stockpile during the wet weather.

Every other work day, stabilized sludge from the Mixing Area will be hauled by dump truck to the cell under construction. Most of the day will be spent loading the truck and depositing the sludge in the appropriate sub-cell. The following day, while the truck is being used at the treatment plant, the front end loader will spread and compact the deposited sludge-soil mixture within the cell.

This spreading and compaction process will proceed from the east edge of the individual sub-cell being filled and shall proceed in a westerly direction. During wet weather, the sludge-soil mix should be deposited from the east edge of the sub-cell (Figure 1). In dry weather, the deposits should be made from the face of the last completed sub-cell (Figure 2).

In sub-cell construction, the front end loader operator should first construct an access ramp into the cell by compacting the sludge-soil mix in a manner that will develop a 10% slope from the east edge of the sub-cell.

Upon completing this ramp, the operator can proceed to construct the individual lifts (1.5 meters) within the sub-cell. This can be done by spreading the sludge-soil mix in layers not greater than 0.5 meters deep and compacting it by passing the loader over it a minimum of 3 times (Figure 3). The operator should try to develop the working face for the lift to a slope of 3 horizontal to 1 vertical. The sludge-soil mix is then spread against the slope as the loader moves up and down on it. The operator should make passes until he no longer can detect that the surface of the waste layer is being depressed more than it is rebounding.

As the fill advances west, the spreading operation results in repeated travel of the machine across the surface of the fill, providing further compaction of the sludge-soil mix. Upon completion of the third lift of the sub-cell, an intermediate layer of Mediterranean soil should be spread over the top of the sludge-soil mix and compacted to a depth of 0.30 meters.

During cell construction, a portable dewatering pump should be located at the top of the cell embankment near the low end of the access strip. The suction hose for the pump should be placed in the cell with ponded water being discharged and re-cycled through the active portion of the landfill.

After the first 10 cells have been filled and covered with the intermediate soil layer, the landfill will have provided approximately 20 years of service. The landfill

will be about 1.5 meters above what is now existing grade as shown on Drawings No. 174 and 175. If the decision is made at that time to continue the landfilling process for another 30 years, the cells will then be constructed above grade in a series of 4 lifts, each lift being 1.5 meters in height. Thus, the finished grade of the landfill providing 50 years of service life would be approximately 8 meters above what is now existing grade.

The equipment described in this section as part of the landfilling process is further defined in Spec Sec14511 and 14515.

END OF SECTION

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SECTION 01580

PROJECT IDENTIFICATION SIGNS

PART 1 - GENERAL

1.01 TEMPORARY PROJECT SIGNS

A. Signs identifying the construction work under this Contract shall be at the entrance to the Project site. Specific location and arrangement of the signs shall be approved by the Engineer.

B. Material:

1. Posts - ASTM A36 structural steel members as shown on Drawings.
2. Signs - 19mm (0.75 in.) exterior grade plywood as shown on Drawings.

C. Paint: all surfaces shall receive prime coat plus background coat of white gloss exterior enamel. Lettering to be black and blue gloss exterior enamel as shown on Drawings.

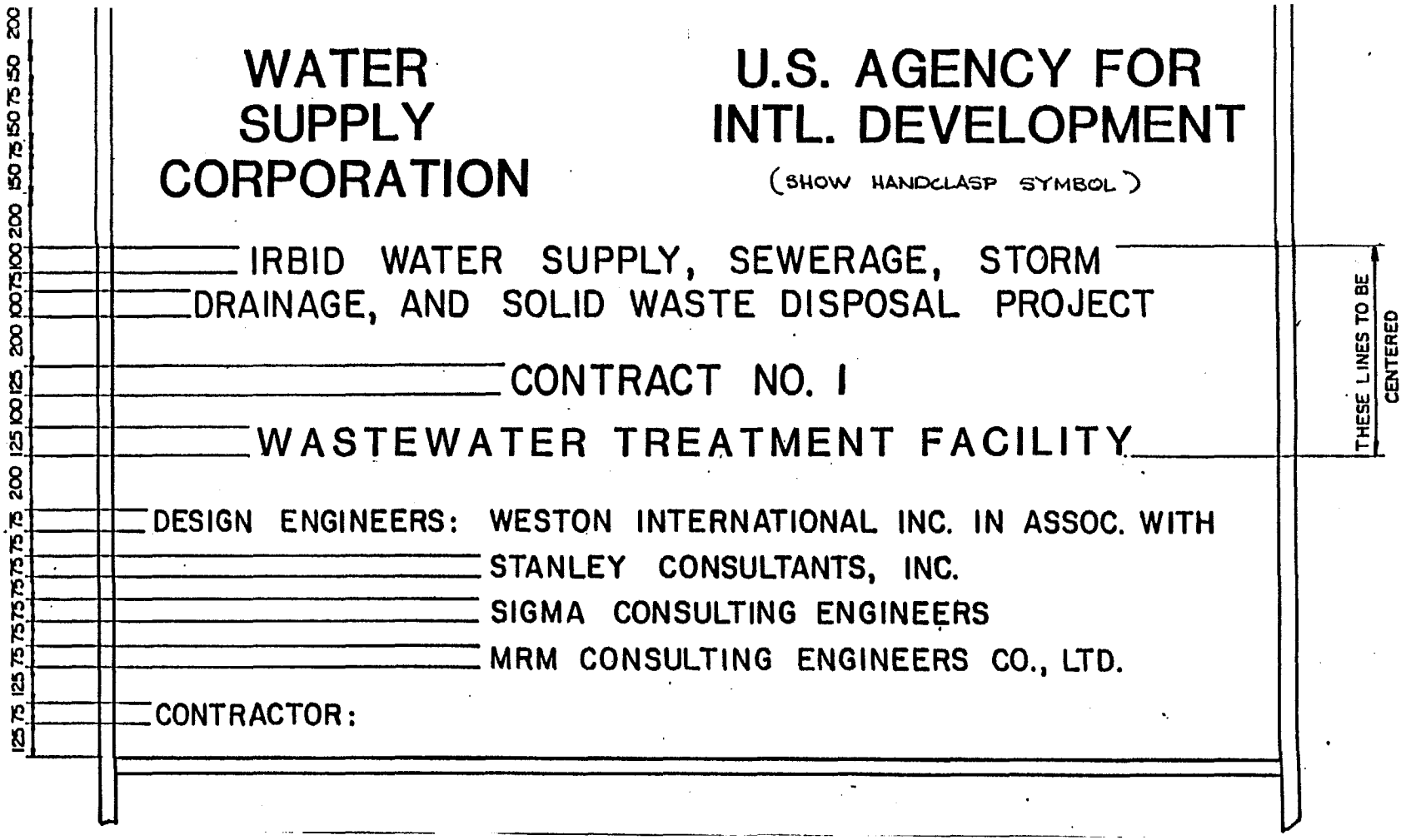
D. Lettering: both Arabic and English; exact final sign lettering to be provided to the Contractor by the Engineer at the Preconstruction Conference.

E. Installation: as shown on Drawings.

F. Maintenance: to be maintained and repainted as directed by Engineer during the course of the execution of the Works.

G. Dismantling: All signs required in this Section shall be dismantled, removed and disposed of by the Contractor prior to the Engineer's Representative's signing and delivery to the Owner of the Certificate of Completion.

END OF SECTION



DETAIL - PROJECT IDENTIFICATION SIGN

(ENGLISH)

NOTES:

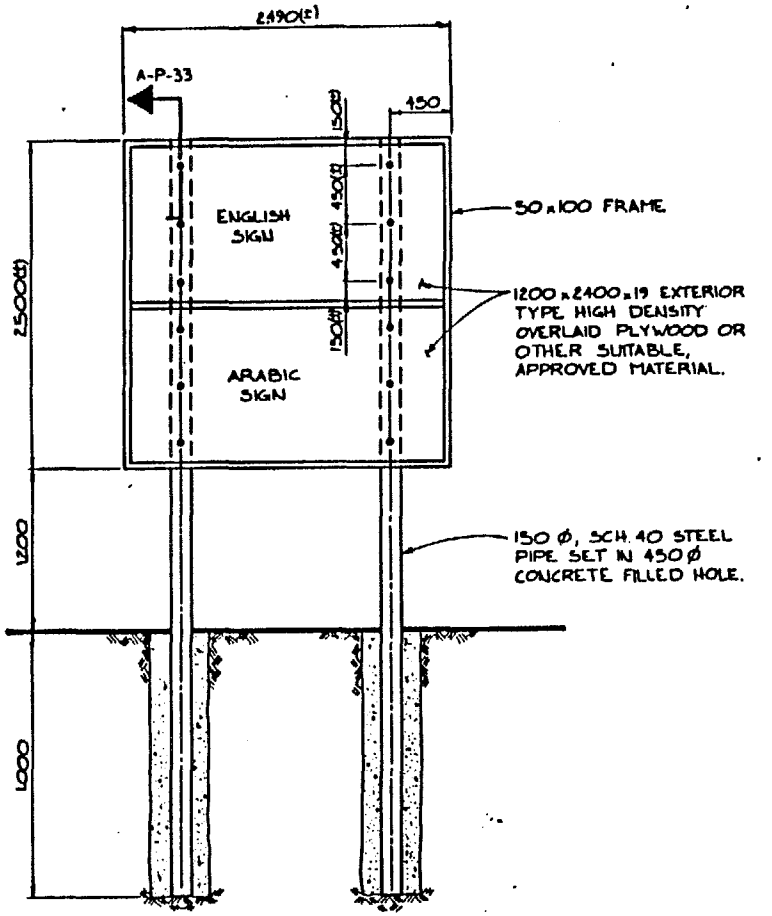
1. OTHER CONTRACT NOS. AND TITLES SHALL BE AS FOLLOWS:

   CONTRACT NO. 3 - SEWAGE COLLECTION & WATER DISTRIBUTION SYSTEMS
   CONTRACT NO. 5 - SEWAGE COLLECTION & WATER DISTRIBUTION SYSTEMS
   CONTRACT NO. 6 - SEWAGE COLLECTION SYSTEM
   CONTRACT NO. 7 - SEWAGE COLLECTION SYSTEM
   CONTRACT NO. 8 - STORM SEWERS

2. ARABIC SIGN SHALL USE CHARACTER SIZES AND SPACING SIMILAR TO ENGLISH.

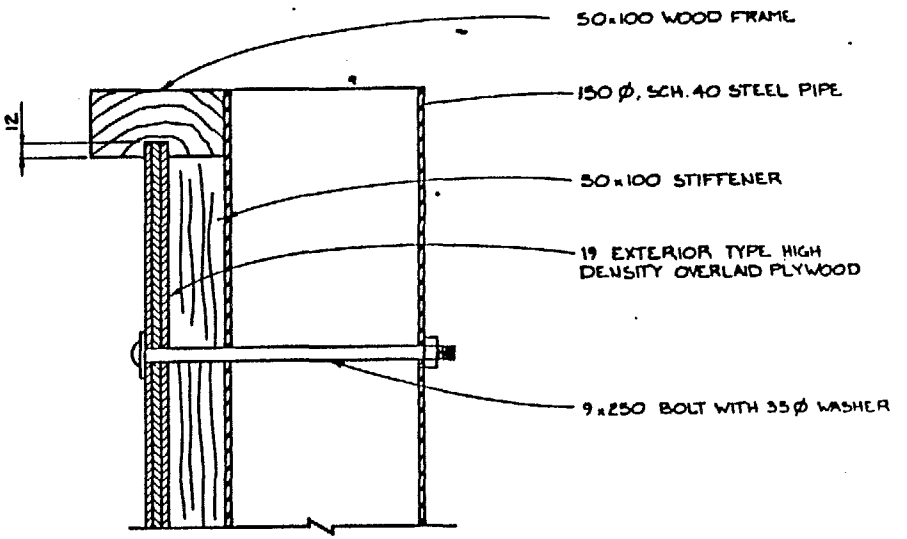
3. COLORS SHALL BE AS FOLLOWS:

   BACKGROUND - WHITE
   BORDER - BLACK
   LETTERING - BLUE



ELEVATION - PROJECT IDENTIFICATION SIGN

SCALE - 1:30



SECTION A-P-33 / P-33

SCALE - 1:3

NOTE:
ALL LUMBER SIZES ARE NOMINAL. FOR EXAMPLE, THE 50 x 100 LUMBER IS A U.S. 2x4 WHICH IS 1 1/2 x 3 1/2 ACTUAL SIZE.

SECTION 01592

ENGINEER'S TRANSPORT

1.01 VEHICLES

A. The Contractor shall provide five new enclosed five-passenger 4-wheel drive vehicles for use by the Engineer's Representative. Source and origin shall be the United States.

B. Vehicles provided will be equipped with:

1. Six cylinder gasoline engine.
2. Power Steering
3. Power brakes
4. Heavy duty shock and suspension package
5. Heater

C. Vehicles shall be of a manufacturer that has a Jordanian agent in Jordan with established spare parts and service facility to ensure prompt service.

D. Vehicles shall be delivered ready for use to the Engineer's Representative within 60 days after Notice to Proceed at a location to be determined at the pre-construction conference.

E. All fuel, insurance, fees, and maintenance required for the duration of the vehicle availability shall be paid for by the Contractor.

F. Vehicles shall be maintained in a serviceable condition to the satisfaction of the Engineer's Representative.

G. Contractor shall provide alternate transportation during vehicle maintenance.

H. Vehicles shall be available within 60 days after Notice to Proceed, for the duration of the construction period, and for 60 days after completion of the construction period.

1.02 TITLE

A. Title to the vehicles shall remain with the Owner during the execution of the Works.

B. Vehicles shall be turned-over to the Owner upon completion of the Works.

END OF SECTION

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SECTION 01635

ALTERNATE UNITS OF MEASURE

PART 1 - GENERAL

1.01 UNITS OF MEASURE

A. Where metric International System of Units (SI) units are specified, nominally equivalent English system units are generally acceptable for dimensions of materials and equipment, quantities of materials, and capacities, unless otherwise specified. Conversely, when English system units are specified, nominally equivalent metric (SI) units are generally acceptable, unless otherwise specified.

B. Where metric International System of Units (SI) or English system units are specified, equivalent acceptable English system or metric (SI) units are sometimes indicated in parentheses. Where these units are not indicated in parentheses furnishing of materials and equipment with such equivalent dimensions and capacities is not precluded, unless specified otherwise.

C. Contract specifications give dimensions and sizes in both English and Metric. Equipment to be purchased in United States have their dimensions in English since the equipment shall be manufactured in accordance with U. S. Standards.

D. Dimensions that are the basis of design of the piece of equipment are given in metric so the manufacturer has the responsibility for conversion.

E. Dimensions on the Contract Drawings are in metric.

END OF SECTION

SECTION 01710

CLEANING UP

PART 1 GENERAL

1.01 GENERAL

During its progress the Work and the adjacent areas affected thereby shall be kept clean and all rubbish, surplus material, and unneeded construction equipment shall be removed and all damage repaired.

1.02 REMOVAL OF DEBRIS

Where material or debris has washed or flowed into or been placed in watercourses, (Wadi), ditches, gutters, drains, catchbasins, or elsewhere as a result of the Contractor's operations, such material or debris shall be entirely removed and disposed of during progress of the Work, and the ditches, channels, drains, kept in a neat, clean and functioning condition.

1.03 PROJECT CLOSEOUT

On or before the completion of the Work, the Contractor shall, unless otherwise especially directed or permitted in writing, tear down and remove all temporary buildings and structures built by him; shall remove all temporary works, tools, and machinery or other construction equipment furnished by him; shall remove, acceptably disinfect, and cover all organic matter and material containing organic matter in, under, and around privies, houses, and other buildings used by him; shall remove all rubbish from any grounds which he has occupied; and shall leave the roads and all parts of the premises and adjacent property affected by his operations in a neat and satisfactory condition.

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1.04 RESTORATION/REPLACEMENT

A. The Contractor shall restore or replace, when and as directed, any public or private property damaged by his work, equipment, or employees, to a condition at least equal to that existing immediately prior to the beginning of operations. Suitable materials, equipment, and methods shall be used for such restoration as approved by the Engineer, or as required elsewhere in these specifications.

END OF SECTION

SECTION 01720

PROJECT RECORD DOCUMENTS

1.01 PROJECT RECORD DOCUMENTS

A. The Contractor shall supply the Owner a "Completion of Work" document prior to any Certificate of Completion being signed by Engineer and being delivered to Owner.

B. The Completion of Work document shall include two sets of "Record Drawings". The Contractor will maintain one set of drawings at the site, marked "Record Drawings" and record on this set each day all changes made from details and elevations shown on the Drawings.

C. Other documents which will serve as a permanent record of the Works shall be provided either by the Contractor or to the Contractor by the appropriate independent firm or agency for submittal to the Engineer. These documents will include:

1. Pipe, main and fitting tests reports and certifications.
2. Valve, meter, pump, generator and other appurtenant test reports and certifications.
3. Test reports and certifications for soils, aggregates, concrete, asphalt and reinforcing steel.
4. Construction photographs.

END OF SECTION

SECTION 01730

OPERATION AND MAINTENANCE MANUALS

PART 1 GENERAL

1.01 OPERATING AND MAINTENANCE MANUALS

A. Operation and Maintenance Manuals shall be provided for the equipment provided under this Contract. Manuals shall be prepared specifically for this installation and, as a minimum requirement, shall contain the following information:

1. Tracing, photocopy or other suitable reproduction of the equipment nameplates.
2. Complete installation, operation and maintenance instructions.
3. Troubleshooting guide.
4. Lubrication guide and chart.
5. Equipment performance curves.
6. Typical equipment drawings and layouts.
7. Name, address and telephone number of the manufacturer.
8. Name, address and telephone number of nearest source of replacement parts and service to the Project site.
9. Recommended spare parts list.
10. Copies of all shop drawings and other information required by the Specifications.

B. Three preliminary copies of each manual shall be submitted to the Engineer for approval within one month of receipt of approved shop drawings by the Contractor.

C. Drawings or diagrams bound in the manuals shall be Standard Size. Larger drawings shall be folded separately and placed in envelopes which are bound into the manuals. Suitable identification shall be placed on the outside of each envelope. All manuals shall be printed on Standard Size paper and bound in standard 3-ring, loose leaf, vinyl covered binders with the equipment name and item number embossed on the cover and the spine.

D. Upon receipt of approval of the manuals by the Engineer, the Contractor shall submit six copies of the operating and maintenance manuals prior to the delivery of the equipment to the Project site. These manuals shall be in additon to any instructions.

E. No final payments for equipment delivered under this Contract nor acceptance of equipment will be made until the required final operation and maintenance manuals have been received by the Engineer.

1.02 INFORMATION FORMS

A. The attached Equipment Reference Data form shall be completed for each item of equipment and submitted with the preliminary manuals.

B. The attached sample Equipment Preventive Maintenance form shall be used as a guide for the format of the operation and maintenance manuals.

EXAMPLE

Equipment Name: Bar Screen

Model: "MA"

Manufacturer: ABC Company

Remarks: * For use at -9°C to 10°C
** For use at 10°C to 45°C

	Preventive Maintenance Schedule	Frequen
Lubricate:	1. Shearing surfaces of shear pin device (A)	M
	2. Drive chain (B)	W
	3. Reducer (A)	M
	4. Electric motor (A)	A
	5. Shock absorber (C)	W
	6. Radius arm pivot (A)	W
	7. Headshaft bearing (A)	W
Inspect:	1. For overheating, excessive noise, vibration, loose bolts, craks, etc.	D
	2. Reducers oil level (D or E)	D
	3. Drive chain for wear and broken parts	W
Replace:	1. Oil in reducer (D or E)	After 1
		days th
		2500 hr
Lubricants:	(A) NLGI #2	
	(B) SAE #30 oil	
	(C) Machine oil	
	(D) AGMA #7	
	(E) AGMA # 8	

Frequency: D-Daily, W-Weekly, M-Monthly

EQUIPMENT PREVENTIVE MAINTENANCE

Equipment Name:

Model: | Manufacturer:

Remarks:

Preventive Maintenance Schedule	Frequency
Lubricate:	
Inspect:	
Replace:	
Lubricants:	

Frequency: D-Daily, W-Weekly, M-Monthly

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EQUIPMENT REFERENCE DATA

Equipment Name and Number	Type No.	ID No.	Plant Area	Level	Location in Area	Rel. Location

Manufacturer	Local Representative	Part or Model Number	Serial Number

Reference Drawing	Reference Catalog	Instruction Book	Date Put in Service

Electric Motor

HP	Frame	RPM	Volts	Amps	Phase

Type
- o Series
- o Shunt
- o Synchronous
- o Induction

Specification
- o Open
- o Exp. proof
- o Drip proof
- o Totally enclosed

Bearings
- o Sleeve
- o Ball
- o Roller

Lubricant

Pump

Capacity	TDH	RPM	Impeller	Packing

Type
- o Centrifugal
- o Plunger
- o Diaphragm
- o Gear
- o Screw

Installation
- o Horizontal
- o Vertical
- o Submerged

Lubrication
- o Water
- o Oil
- o Grease

Bearings
- o Sleeve
- o Ball
- o Roller

Lubricant

Drive or Reducer

HP	RPM in	RPM out	Ratio

Type
- o Gear
- o V-Belt
- o Chain
- o Varidrive

Bearings
- o Sleeve
- o Ball
- o Roller

Lubricant

Other Equipment

Type, Speed, Size, Capacity, Range

Bearings, Lubricant

SECTION 01735

TRAINING

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 01730: Operating and Maintenance Manuals.

1.02 PREPARATION

A. Complete starting and testing of equipment system.

B. Obtain Owner's acceptance of equipment.

C. Revise Operating and Maintenance Manuals to reflect changes in procedures or design criteria required during the starting and testing of the equipment system.

D. Schedule operator training with Owner a minimum of one week in advance.

1.03 OWNER RESPONSIBILITIES

A. Owner will provide all necessary process materials, support services and utilities for the duration of the demonstration.

1.04 TRAINING PERSONNEL QUALIFICATIONS

A. Provide manufacturer's technical personnel familiar with the design, operation and maintenance of the specific equipment.

1.05 OPERATOR TRAINING

A. Train Owner's personnel at the Project site using the actual installed equipment.

B. Conduct training sessions during the hours of Owner's normal daylight shift.

C. Provide length of training specified in individual equipment specification section.

D. Use classroom instruction and equipment demonstrations to train Owner's personnel in the following:

1. Start-Up
2. Normal operation

3. Routine maintenance
4. By-pass operation
5. Shut-down
6. Safety procedures
7. Emergency drills
8. Use of Operating and Maintenance Manuals

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

Not Used.

END OF SECTION

SECTION 01740

WARRANTIES AND BONDS FOR MATERIALS AND EQUIPMENT

PART 1 - GENERAL

1.01 GUARANTEES

A. Unless otherwise stipulated in this Contract, the Contractor shall guarantee all materials and equipment provided by the Contractor for a period of 12 months after the delivery of a signed Certificate of Completion to the Owner.

1. Materials and equipment shall be free from damage and imperfections in design, materials or construction which would create hazards, operating difficulties or unworkmanlike appearance.

2. Equipment quoted upon shall be capable of continuous and satisfactory performance under normal operating conditions at specified design conditions and capacity.

B. All manufacturer's guarantees of materials and equipment, in addition to Contractor's guarantees, shall be transferred and assigned to Owner prior to delivery of a signed Certificate of Completion to the Owner.

1.02 DEFECTIVE EQUIPMENT AND MATERIALS

A. Defective equipment:

1. If equipment fails to conform to requirements of Contract Documents or to operate satisfactorily, correct such defects promptly "at no cost to Owner."

2. Owner will have right to operate unsatisfactory equipment until it is replaced or corrected, without cost for depreciation, use, or wear.

3. Remove equipment from operation for examination, adjustment, alteration or change only at times approved by Owner.

B. Defective materials:

1. If materials fail to conform to requirements of Contract Documents, correct such defective materials promptly "at no cost to Owner."

2. Contractor shall repair or replace defective materials only at times approved by Owner.

END OF SECTION

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SECTION 02110

CLEARING

PART 1 GENERAL

1.01 RELATED WORK

A. Section 02210 - Site Grading.

B. Section 02219 - Excavation and Backfilling.

C. Section 02221 - Trenching, Backfilling and Compacting.

D. Section 02260 - Finish Grading.

1.02 REGULATORY REQUIREMENTS

A. Conform to applicable code for disposal of debris.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 CLEARING

A. Clear areas required for access to site and execution of Work.

B. Remove shrubs. Grub out roots and surface rock.

3.02 PROTECTION

A. Protect bench marks and existing work from damage or displacement.

B. Maintain site access for vehicle and pedestrian traffic.

3.03 REMOVAL

A. Remove debris from site. Burning of debris on site is not permitted, unless permission is obtained from applicable regulatory authority.

B. Obtain permission from applicable regulatory authority for disposal of debris to waste disposal site.

END OF SECTION

SECTION 02210

SITE GRADING

PART 1 GENERAL

1.01 RELATED WORK

A. Section 01570 - Landfill Operation Guidelines

B. Section 02219 - Excavation and Backfilling

C. Section 02221 - Trenching, Backfilling and Compacting

D. Section 02260 - Finish Grading

1.02 PROTECTION

A. Protect bench marks, fences, existing structures, roads and paving.

B. Protect above or below grade utilities which are to remain.

C. Repair damage.

PART 2 PRODUCTS

2.01 MATERIALS

A. Clean Fill: Excavated material, graded free of roots, rocks larger than 25 mm debris, and large weeds.

PART 3 EXECUTION

3.01 PREPARATION

A. Identify required lines, levels, contours, and datum.

B. Upon discovery of unknown utility or concealed conditions, discontinue affected work; notify Engineer.

3.02 SOIL EXCAVATION

A. Excavate soil from areas to be further excavated, relandscaped, or regraded and stockpile in area designated on site.

B. Do not excavate wet soil.

C. Stockpile soil to depth not exceeding 2.5 m in the wastewater treatment plant area and 4.0 m in the landfill area.

3.03 TOLERANCES

A. Top Surface of Subgrade: Plus or minus 25 mm in the wastewater treatment plant area and 75 mm in the landfill area.

END OF SECTION

SECTION 02219

EXCAVATION AND BACKFILL

PART 1 GENERAL

1.01 RELATED WORK

A. Section 01566: Erosion Control

B. Section 01570: Landfill Operation Guidelines

C. Section 02110: Clearing

D. Section 02210: Site Grading

E. Section 02221: Trenching, Backfilling and Compacting.

F. Section 02222: Select Backfill

G. Section 02224: Coarse Aggregate

1.02 SITE COMPACTION TESTING

A. Testing of compacted fill materials will be as directed by the Engineer and performed by the Engineer. Testing will be performed so as to least encumber the performance of work.

B. When work of this Section or other portions of work are completed notify Engineer to perform density tests. Do not proceed with additional portions of work until results have been verified.

C. If, during progress of work, tests indicate that compacted materials do not meet specified requirements, remove defective work, and replace as directed by Engineer. Upon completion notify the Engineer to perform density tests.

D. Ensure compacted fills are tested before proceeding with placement of surface materials.

1.03 SUBMITTALS

A. Submit minimum 4.5 kg samples of each type of excavated or imported fill material to be used. Forward samples to the Engineer packed tightly in containers to prevent contamination.

B. If recent test results are available for fill materials to be used, disregard samples submission and submit such test results to the Engineer. Such test results are to clearly indicate types of materials and composition, hardness, compactability and suitability for proposed usage.

1.04 SUB-SURFACE INVESTIGATIONS

A. Sub-Surface Explorations were conducted at the site by the Owner for guidance in the Engineering Design. Reports have been prepared covering these findings and are included herein, following this section for Contractor information. The Owner does not guarantee the accuracy of the information and such information is included for Contractor use so that he may form his own judgments thereon.

B. Geo-Mechanics
   1. Sub-Surface Explorations indicate the area is covered by a mantle of Mediterranean soils composed of sandy silty clay of thickness range between 1.50 M to 4.0 M depth.
   2. Underlying the Mediterranean soils is carbonaceous silty clay (Marl) which is fine grained, very soft when wet, and has a low dry density dependent on the percentage of clay fractions.
   3. No water table was observed in the drilled boreholes.

1.05 PROTECTION

A. Excavations for foundations of structures or Cell No. 1 of the landfill shall not be made during the winter rainy season, unless approved in writing by the Engineer.

B. Material surrounding all structures shall be placed and compacted and the area paved with bituminous paving material to prevent any percolation of rainwater or surface water into the foundation material.
   1. The paved surface, minimum 2 meters width, shall be applied at the surface of backfill even if backfill has not been placed to the finish grade indicated on the drawings.
   2. Prior to placement of backfill to finish grade, the temporary paved surface shall be completely removed.

C. Protect bench marks, existing structures and roads against damage from equipment and vehicular or foot traffic.

D. Protect excavations by shoring, bracing, sheet piling, underpinning, or other methods, as required to prevent cave-ins or loose dirt from falling into excavations.

E. Notify the Engineer of unexpected sub-surface conditions and discontinue work in area until the Engineer provides notification to resume work.

F. Protect bottom of excavations and soil around and beneath foundations from intrusion of water or rainwater.

G. Grade around excavation(s) to prevent surface water run-off into excavated area(s).

H. Repair damage, promptly, at no cost to Owner.

PART 2 PRODUCTS

2.01 FILL MATERIALS

A. Select backfill: conform to Section 02222.

B. Coarse Aggregate: conform to Section 02224.

C. In the wastewater treatment plant area, fill material shall be a well graded, sand and gravel mixture, blended with on-site excavated Mediterranean soil in a 50/50 mix. In the landfill area, fill material shall be on-site excavated Mediterranean soil or marl mixed with sludge as described in Section 01570.
   1. Off-site fill material shall be in accord with AASHTO Type 1 or 2.
   2. Mediterranean soils shall not be used as foundation material or fill material for the support of structures or pavements.
   3. Fill and compaction density and moisture control shall be provided through field and laboratory supervision.

D. Fill under landscaped areas: Free from alkali, salt, petroleum products. Use sub-soil excavated from site only if conforming to specified requirements.

PART 3 EXECUTION

3.01 PREPARATION AND LAYOUT

A. Establish extent of excavation by area and elevation; designate and identify datum elevation.

B. Set required lines and levels.

C. Maintain bench marks, monuments and other reference points.

3.02 UTILITIES

A. Known underground utilities are indicated on the Drawings.

B. Before starting excavation, establish location and extent of underground utilities occurring in work area.

C. Support and protect utility services uncovered by excavation.

3.03 EXCAVATION

A. Before starting excavation, clear work area in accord with Section 02110.

B. Excavate sub-soil in accordance with lines and levels required for construction of the work, including space for forms, bracing and shoring, applying dampproofing, foundation drainage system, and to permit inspection.

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C. When excavation is through paved areas, cut pavement to provide a square, uniform edge with minimum disturbance of remaining pavement.

D. Slopes of top soil (Mediterranean soil) excavation shall not exceed one horizontal to two vertical up to maximum depth of 4.0 meters.
   1. Cuts shall be executed during the dry season.
   2. In event of excavation in the wet season, if permitted by the Engineer, sheet piling shall be required to support the side slopes.

E. A drainage trench surrounding the construction area shall be excavated, filled with a filter material, and sloped to drain away from the area.

F. In excavations where weak subsoil material such as soft marl is encountered at bearing levels of structures this material shall be excavated.
   1. Scarify a minimum 1.5 meters below the indicated bearing elevation.
   2. Backfill to required bearing elevation by coarse aggregate compacted in maximum 0.30 meter lifts to maximum dry density utilizing minimum 20 ton capacity vibratory rollers.

G. Hand trim excavations and leave free from loose or organic matter.

H. Keep excavations dry until backfill is completed.

I. When complete, verify soil bearing capacities, depths and, dimensions.

J. Do additional excavation only by written authorization of Engineer.

K. Correct unauthorized excavation as directed, at no cost to Owner.

L. Fill over-excavated areas under structure bearing surfaces with concrete as specified for foundations or coarse aggregate and compact.

M. Excavations are not to interfere with normal 45 degree bearing splay of any foundation.

N. Stockpile excavated sub-soil for re-use where directed. Remove excess or unsuitable excavated sub-soil from site to storage location at the landfill site. In the landfill area, separate and stockpile excavated top soil (Mediterranean soil) and sub-soil (marl) at the locations designated on the Drawings.

O. Removal of boulders or buried rock in excess of 1/2 cu. meter may be authorized as an extra; other work is deemed to be within the scope of this Section.

3.04 BACKFILLING

A. Stockpile fill materials in area(s) designated by Owner.

B. Do not start backfilling operations until structures drainage system have been inspected and backfilling authorized by Engineer.

C. Ensure areas to be backfilled are free from debris and water.

D. Do not backfill over existing sub-grade surfaces which are porous, wet or spongy.

E. Compact existing sub-grade surfaces if densities are not equal to that required for backfill materials.

F. Cut out soft areas of existing sub-grade. Backfill with select backfill and compact to required density.

G. Backfill areas to grades, contours, levels and elevations.

H. Backfill systematically and as early as possible to allow maximum time for natural settlement and compaction.

I. Place and compact fill materials in continuous layers not exceeding 0.30 meters loose depth. Use a method so as not to disturb or damage completed work constructed in the excavations.

J. Maintain optimum moisture content of backfill materials to attain required compaction density.

K. Backfill simultaneously on each side of foundation walls and other structures to equalize soil pressures. Do not backfill against foundation walls until the slab at finish grade is in place.

L. Where temporary unbalanced pressures are liable to develop on walls before floor slabs are placed, erect necessary shoring to counteract imbalance. Leave in place until their removal is approved by Engineer.

3.05 FILL TYPES

A. Exterior side of foundation walls; Sub-soil fill to top of sub-grade elevation.

B. Within building area: sub-soil fill to underside of stabilizing base course for floor slabs.

C. Stabilizing base course under concrete slabs within building area:
   1. 0.3 meters of gravel fill topped with 5.0 centimeters of sand fill to underside of slabs.

D. Underground tanks: fill sides up to 0.61 meters from top of sub-grade elevation with select fill. Fill remainder

to top of sub-grade elevation with on site backfill material.

E. Fill under landscaped areas: sub-soil to top of sub-grade elevation.

3.06 COMPACTION

A. In the wastewater treatment plant area, compact fill materials to minimum uniform density of 95 percent of maximum dry density obtained by AASHTO Method T-180. In the landfill area, compact fill materials to minimum uniform density of 90 percent of maximum dry density obtained by same method.

3.07 SURPLUS MATERIALS

A. Remove surplus backfill materials to designated storage area at the landfill site.

B. Leave stockpile areas completely free of all excess fill materials.

END OF SECTION

SECTION 02221

TRENCHING, BACKFILLING AND COMPACTING

PART 1 GENERAL

1.01 RELATED WORK

A. Section 02110: Clearing

B. Section 02210: Site Grading

C. Section 02219: Excavation and Backfill

D. Section 02222: Select Backfill

E. Section 02224: Coarse Aggregate

F. Section 03001: Concrete Work

G. Section 15050: Pipe installation

1.02 SITE COMPACTION TESTING

A. Testing of compacted fill materials will be as directed by the Engineer and performed by the Field Testing Laboratory (reference Section 01410). Testing will be be performed so as to least encumber the performance of work.

B. When work of this Section or portions of work are completed notify the Engineer to perform density tests. Do not proceed with additional portions of work until results have been verified.

C. If, during progress of work, tests indicate that compacted materials do not meet specified requirements, remove defective work, replace and retest as directed by the Engineer at no cost to Owner.

D. Ensure compacted fills are tested before proceeding with placement of surface materials.

1.03 PROTECTION

A. Excavations shall not be made during the winter rainy season unless approved in writing by the Engineer.

B. Protect bench marks and existing structures, roads and paving against damage from vehicular or foot traffic.

C. Protect excavations by shoring, bracing, sheet piling underpinning, or by other methods, as required to prevent cave-ins or loose dirt from falling into excavations.

D. Underpin or otherwise support adjacent structure(s) which may be damaged by excavation work. This includes service lines and pipe chases.

E. Notify Engineer of any unexpected sub-surface conditions. Discontinue work in the area until Engineer provides notification to resume work.

F. Protect bottom of excavations and soil around and beneath foundations from intrusion of water or rainwater.

PART 2 PRODUCTS

2.01 BED AND FILL MATERIALS

A. Coarse Aggregate: Conform to Section 02224.

B. Backfill shall be excavated material having the required moisture content to permit compaction as specified. If, in the opinion of the Engineer, the excavated fill material will not provide the compaction specified, select backfill shall be provided. Select backfill shall conform to Section 02222.

C. Fill under landscaped areas: Free from alkali, salt, and petroleum products. Use select backfill excavated from site only if conforming to Section 02222.

PART 3 EXECUTION

3.01 PREPARATION AND LAYOUT

A. Establish extent of excavation by area and elevation. Designate and identify datum elevation.

B. Set required lines and levels.

C. Maintain bench marks, monuments and other reference points.

3.02 UTILITIES

A. Underground utilities are indicated on the Drawings.

B. Before starting excavation, locate underground utilities the work area and record on Project Record Documents. on Project Record Documents.

3.03 TRENCHING

A. Excavate for storm and sanitary sewers, mechanical and electrical services. Ensure trenching does not interfere with normal 45 degree bearing splay of any foundation.

B. Excavate in accordance with lines and grades.

C. Trench depths are calculated to provide adequate cover over pipes. Notify Engineer if adequate cover is lacking and correct as directed by Engineer.

D. Cut trenches sufficiently wide to enable proper installation of services and to allow for inspection. Trim and shape trench bottoms and leave free of irregularities, lumps and projections.

E. When complete, request the Engineer to inspect excavations. Correct unauthorized excavation as directed, at no cost to the Owner.

F. Make additional excavation to remove unsuitable foundation material as directed by Engineer. Backfill and compact over excavation with select backfill.

G. Stockpile excavated sub-soil for re-use where directed. Remove excess or unsuitable excavated sub-soil from site. Remove excavated material from site.

3.04 DEWATERING

A. Keep trenches dry. Provide necessary equipment including pumps, piping and temporary drains.

B. Direct surface drainage away from excavated areas.

C. Control the grading in and adjacent to excavations to prevent water running into excavated areas or onto adjacent properties or public thoroughfares.

D. Furnish and operate suitable pumps on a 24 hour basis to keep excavations free of water until services have been placed and backfilling is completed.

3.05 BEDDING

A. Manually place and compact bedding material in layers not exceeding 150 mm.

B. Manually shape bedding material to conform to pipe barrel and bell or flanges.

3.06 BACKFILLING

A. Do not start backfilling until services have been inspected.

B. Ensure trenches are free of building debris and water and that ground surfaces are not in a wet or spongy condition.

C. Backfill systematically and as early as possible to allow maximum time for natural settlement and compaction.

D. Place and compact fill materials in continuous layers not exceeding 150 mm. loose depth. Use a method so as not to disturb or damage services.

E. Maintain optimum moisture content of fill materials so as to attain required compaction density.

3.07 COMPACTION

A. From the bottom of the trench to a minimum height 200 mm above pipe crown compact backfill materials with hand-operated devices.

B. Compact fill materials to minimum uniform density of not less than 95% of maximum dry density obtained by AASHTO Method T-99, to within 230 cm of top of trench. Compact remainder of fill materials to minimum uniform density of not less than 100% of maximum dry density obtained by AASHTO Method T-99.

C. Remove and replace improperly compacted backfill material at no cost to Owner.

3.08 CLEAN UP

A. Remove surplus fill materials from site.

END OF SECTION

SECTION 02222

SELECT BACKFILL

PART 1 GENERAL

1.01 RELATED WORK

A. Section 02219: Excavation and Backfill.

B. Section 02221: Trenching, Backfilling and Compacting.

C. Section 02224: Coarse Aggregate.

1.02 BACKFILL QUALIFICATIONS

A. The Engineer will determine soil's conformance to specifications.

B. Do not use soils rejected by Engineer for select backfill.

PART 2 PRODUCTS

2.01 SELECT BACKFILL

A. Material: material excavated from Project site or additional material from other sites, both in accord with the following:
1. Consist of mineral soil with durable, natural, granular material, or granular aggregate combined with sand, stone, dust, or other filler material to provide well graded homogeneous mixture.
2. Contain no organic materials, loam, clay, wood, rubbish, rocks greater than 150 mm or 20 kg, building debris, or other materials which prevent specified compaction.
3. Contain no snow, ice, or frozen material.

2.02 GRADATION

A. Select backfill gradation shall conform to grading requirement B of Table 104.1, Section 104 of the Hashemite Kingdom of Jordan Standard Specifications for the Construction of Roads and Bridges.

PART 3 EXECUTION

3.01 LOCATIONS

A. Use select backfill for the following:
1. Backfill for pipe trenches and roadbeds.
2. Backfill around buildings, manholes, pump stations, and other structures.
3. As otherwise specified or ordered by the Engineer.

3.02 INSTALLATION

A. Place and compact select backfill in accord with Sections 02219, 02221, and 02260.

END OF SECTION

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SECTION 02224

COARSE AGGREGATE

PART 1 GENERAL

1.01 RELATED WORK

A. Section 02219: Excavation and Backfill.

B. Section 02221: Trenching, Backfilling, and Compacting.

C. Section 02513: Bituminous Concrete Paving.

1.02 REFERENCE STANDARDS

A. AASHTO Compaction Testing, T99 Method C.

PART 2 PRODUCTS

2.01 COARSE AGGREGATE

A. Material: well graded, machine crushed gravel or stone, free of roots, topsoil, loam, rubbish, ice, frozen soil, or other deleterious material.

B. Conform to Sections 200 and 300 of the Hashemite Kingdom of Jordan Standard Specifications for the Construction of Roads and Bridges. Gradations shall conform to designations A, B, and C of Table 200-1 (Section 200) and designation C of Table 300-1 (Section 300).

C. Conform to the following table for designations and gradations of aggregate for the sludge drying beds.

SIEVE GRADING	SLUDGE DRYING BED DESIGNATION COARSE	MEDIUM	FINE
1 -1/2 inch (38 mm)	100%	-	-
1 inch (25 mm)	90-100	-	-
3/4 inch (19 mm)	-	-	-
1/2 inch (13 mm)	25-60	100%	-
3/8 inch (9.5 mm)	-	75-100	100%
No. 4 (4.8 mm)	0-10	10-30	75-100
No. 10 (2.0 mm)	0-5	0-10	-
No. 100 (.035 mm)	-	-	10-30

PART 3 EXECUTION

3.01 LOCATION

A. Use coarse aggregate for the following:
1. Pipe bedding (designation C- Section 200).

2. Road and walkway base course (designations B and C, respectively - Section 200).
3. Sludge Drying Beds (coarse, medium and fine designations on previous page).
4. Structural base material (designation B - Section 200).
5. Landfill Access Road (designation B - Section 200; designation C - Section 300 as shown on the Drawings).
6. As directed by Engineer.

3.02 INSTALLATION

A. Spread coarse aggregate in 150 mm layers, maximum, before compaction unless noted otherwise on the Drawings.

B. Compact each layer of aggregate to a minimum uniform density of 95 percent of the maximum density obtained by AASHTO T99, Method C.

END OF SECTION

SECTION 02260

FINISH GRADING

PART 1 GENERAL

1.01 RELATED WORK

A. Section 02210: Site Grading

B. Section 02219: Excavation and Backfilling

C. Section 01570: Landfill Operation Guidelines

1.02 PROTECTION

A. Prevent damage to existing fencing, bench marks, pavement and utility lines. Correct damage at no cost to the Owner.

PART 2 PRODUCTS

2.01 MATERIALS

A. Clean Fill: soil from site which is free of roots, rocks larger than 75 mm, vegetative matter and building debris.

PART 3 EXECUTION

3.01 GRADING

A. Fine grade soil systematically to allow for a maximum amount of natural settlement and compaction. Eliminate uneven areas and low spots using soil from stockpile areas on site. Remove debris, roots, branches and stones in excess of 150 mm in size. Remove soil which has been contaminated with petroleum products.

B. Bring soil to required levels, profiles and contours. Make changes in grade gradual. Blend slopes into level areas.

C. Slope grade away from buildings and structures 50 mm in 3 m unless indicated otherwise on drawings.

D. Place clean fill in maximum of 200 mm layers and compact to not less than 95% of maximum density as determined by AASHTO T-99, Method C.

E. Remove surplus soil and debris from site.

F. Obtain permission from applicable regulatory authority for disposal of debris to waste disposal site.

END OF SECTION

SECTION 02444

CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.01 RELATED WORK

A. Section 02260: Finish Grading

B. Section 03001: Concrete Work

1.02 ERECTOR QUALIFICATIONS

A. Minimum of two years experience installing similar fencing.

1.03 REFERENCES

A. Chain Link Fence Manufacturers Institute (CLFMI) - Voluntary Standard for Chain Link Fence Installation.

B. ASTM A120 - Standard Specification for Pipe, Steel, Black and Hot-dipped Zinc-coated (galvanized) Welded and Seamless for Ordinary Uses.

C. ASTM A121 - Standard Specification for Zinc-coated (galavnized) Steel Barbed Wire.

D. ASTM A123 - Standard Specification for Zinc Hot-Galvanized Coatings on Products Fabricated from Rolled, Pressed and Forged Steel Shapes, Bars, and Strip).

E. ASTM C94 - Standard Specification for Ready-Mixed Concrete

F. FS RR-F-00191 - Fencing, Wire and Post, Metal (Chain-Link Fence Fabric)

1.04 SHOP DRAWINGS AND PRODUCT DATA

A. Submit shop drawings and product data in accordance with Section 01340.

B. Cleary indicate plan layout, grid, spacing of components, accessories, fitments, and anchorage.

C. Submit manufacturer's installation instructions and procedures, including standard details of fence and gate installation.

PART 2 PRODUCTS

2.01 MATERIALS

A. Framework: ASTM A120; Schedule 40, butt weld, standard weight, hot dip galvanized to (485 gm/square meter) coating.

2.02 CONCRETE MIX

A. Concrete: Conform to Section 03001.

2.03 COMPONENTS

A. Line Posts: (60 mm) diameter.

B. Corner and Terminal Posts: (73 mm) diameter.

C. Gate Posts: 168 mm diameter.

D. Top and Brace Rail: 42 mm diameter, plain end, sleeve coupled.

E. Gate Frame: 42 mm diameter galvanized steel tubing.

F. Caps: Aluminum Alloy sized to post dimension, set screw retained.

G. Extension arms: To accommodate 3 strands of barbed wire, sloped 45 degrees.

H. Fittings: Sleeves, bands, clips, rail ends, tension bars, fasteners and fittings, steel galvanized.

I. Fabric: (51 mm) diamond mesh, interwoven, 9 gage (4.0 mm) top selvage twisted tight, bottom selvage knuckle end closed.

J. Bottom tension wire: 6 gage (5.2 mm) steel single strand, galvanized.

K. Barbed wire: 12 gage (2.5 mm) wire, 3 strands, 4 points at 76 mm o.c. Galvanized.

L. Gate hardware: gate center rest, 2 piece drop latch, chain gate holdback, gate hinge 180 degree male and female, fork latch and latch catch, drop bolt, chain hold open, hardware for padlock.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install line posts, corner posts, top rails, post caps barbed wire arms fabric and gates, to provide a rigid structure for fence of height as indicated on Drawings.

Use manufacturer's standard fittings, fasteners and hardware. Slope barbed wire arms outward.

B. Maximum spacing of posts: 3.0 meters.

C. Install line, corner, and terminal posts plumb, set in concrete footings as specified in CLFMA Standard.

D. Set post to within 150 mm from bottom of concrete footing. Slope top of concrete for water runoff. Set top of footing 51 mm above finished grade.

E. Position bottom of fabric 76 mm above finished grade with tension wire stretched taut between posts.

F. Pass top rail through line post tops to form continuous bracing. Install 175 mm long couplings midspan at pipe ends.

G. Brace each gate and corner post back to adjacent line post with horizontal center brace rail. Install brace rail, one bay from end and gate posts.

H. Install center and bottom brace rail on corner and gate leaves.

I. Fasten fabric to top rail, line posts, braces, and bottom tension wire with wire ties maximum 381 mm centers.

J. Attach fabric to end, corner, and gate posts with tension bars and tension bar clips.

K. Stretch fabric between terminal posts or at intervals of 30 m maximum whichever is the least dimension.

L. Install 3 strands of barbed wire on arms, tensioned and secured.

M. Install gates using fabric and barbed wire overhang to match fence. Install 3 hinges per leaf, latch, catches, drop bolt, foot bolts and sockets retainer and locking clamp.

N. Provide concrete center rest and drop bolt retainers at center of double gate openings.

END OF SECTION

SECTION 02513

BITUMINOUS CONCRETE PAVING

PART 1 GENERAL

1.01 RELATED WORK

A. Section 01410: Field Testing Laboratory Services

B. Section 02210: Site Grading.

C. Section 02575: Manholes.

1.02 REFERENCE STANDARDS

A. All bituminous paving work shall conform to Sections 104, 200, 310, 311 and 322 of the Hashemite Kingdom of Jordan Standard Specifications for the Construction of Roads and Bridges.

1.03 TESTING AND INSPECTION

A. Testing and inspection of bituminous pavement mix(es) and testing of placed stabilizing base and special sub-base courses and bituminous pavement will be performed by Field-Testing Laboratory (reference Section 01410). Testing and inspection will be performed in accordance with the applicable tests listed in Sections 104, 200, 310, 311 and 322 of Kingdom of Jordan Standard Specifications for Roads and Bridges.

B. Allow testing laboratory access to the mixing plant for verification of weights or proportions, character of materials used and determination of temperatures used in the preparation of bituminous concrete mix.

C. When and if required, the testing laboratory will perform laboratory tests on proposed bituminous pavement mix(es) to determine conformity with requirements.

D. The testing laboratory will perform one series of compaction tests for stabilizing base course and for each bituminous pavement course.

E. When stabilizing base and special subbase courses or portion thereof has been placed and compacted in accordance with requirements, notify the testing laboratory to perform density tests. Do not place bituminous pavement until results have been verified and base course installation approved.

F. If compaction tests indicate that stabilizing base courses or bituminous paving do not meet specified requirements, remove defective work, replace and retest at own expense.

PART 2 PRODUCTS

2.01 STABILIZING BASE COURSE MATERIALS

A. Special Sub-base: Conform to Grading B, Section 104.

B. Granular Base: Conform to Grading B, Section 200.

C. Prime Coat: Conform to Section 310.

2.02 BITUMINOUS PAVEMENT MATERIALS

A. Binder Course: Conform to Grading A, Section 322.

B. Wearing Course: Conform to Grading B, Section 322.

C. Tack Coat: Conform to Section 311.

PART 3 EXECUTION

3.01 PREPARATION

A. Ensure grading of sub-grade to required elevation.

B. Thoroughly scarify exposed surface to a depth of 152 mm and compact to 95% density at optimum moisture content as determined by AASHTO, T-99.

C. Maintain subgrade in a dry state while it is exposed during construction.

D. Before final rolling, shape entire section, add additional sub-soil as required and compact sub-grade to provide grades, elevation and cross-section indicated. Points of finished sub-grade surface shall be within 25 mm of elevations indicated.

3.02 PLACEMENT OF STABILIZING BASE COURSES

A. Bring special sub-base course to required depth(s) and profiles indicated. Extend sub-base course minimum 152 mm beyond bituminous pavement width. Place in layers not exceeding 100 mm in depth. Compact each layer to minimum uniform density of 95% of maximum density at optimum moisture content as determined by AASHTO, T-99. Ensure granular sub-base course materials are not contaminated with deleterious materials.

B. Add water during compaction to bring granular material to optimum moisture content, if directed by Engineer.

C. Spread base course materials over prepared special sub-base in layers not exceeding 100 mm in depth. Compact to minimum uniform density of 95% of maximum density at optimum moisture content as determined by AASHTO, T-99. Ensure top surface of base course is true to lines and

grades indicated, with all points within 13 mm. of elevations indicated.

D. If directed by the Engineer, add water during compaction to bring stabilizing base course materials to optimum moisture content. When an excess moisture exists, rework stabilizing base course materials until optimum moisture content is obtained.

3.03 PRIMING PREPARED SUBGRADE AND STABILIZED BASE COURSE

A. Ensure prepared subgrade and stabilized base course are dry and free of loose or foreign material before priming.

B. Apply primer over prepared subgrade at a uniform rate of 1.5 liters per square meter and stabilizing base course at a rate of 2.25 liters per square meter. Ensure primer is at temperature recommended by manufacturer. Use clean natural sand to blot excess primer.

C. Coat surfaces of manholes which are to remain free of asphalt with oil to prevent asphalt adhesion.

3.04 PLACEMENT OF BITUMINOUS PAVEMENT

A. Place bituminous pavement binder course within 24 hours of priming stabilizing base course. Place surface course within 12 hours of placing and compacting binder course.

B. Place binder course to a compacted depth of 6.5 mm. Place wearing course to a compacted depth of 5 mm.

C. Do not place bituminous pavement when surface temperature is 4 degrees C or lower. Ensure bituminous pavement is minimum 118 degrees C immediately after placing and prior to initial rolling.

D. Compact each bituminous paving course to required density, with approved rolling equipment. Start compaction as soon as pavement will bear equipment without checking or undue displacement.

E. Carry out compaction in three operations in pass sequence. Ensure each pass of roller overlaps previous passes to ensure smooth surface free of roller marks. Keep roller wheels sufficiently moist so as not to pick up material.

F. Perform hand tamping in areas not accessible to rolling equipment.

G. Ensure joints made during paving operations are straight, clean, vertical and free of broken or loose material. Prime vertical surfaces of joints to ensure tight bond.

H. Ensure surface of completed bituminous pavement is true to lines, profiles and elevations indicated, and is free from depressions exceeding 3 mm when measured with a 3 m straight-edge.

I. Do not allow vehicular traffic on newly paved areas until surface has cooled to atmospheric temperature.

END OF SECTION

SECTION 02540

RIPRAP

PART 1 GENERAL

1.01 SCOPE

A. Furnish all labor, materials, tools, and equipment and perform all operations necessary for the placement of a protective covering of stone of the size and type described herein, and location shown on the Drawings or as directed by the Engineer.

PART 2 PRODUCTS

2.01 STONE

A. Field stone, quarry stone, or rock fragments used for riprap shall be sound, free from structural defects, and approximately rectangular in shape.

B. The quality of the riprap shall be approved by the Engineer.

C. Riprap will be of the following type:
1. 0.3 meters thick
2. 75 percent with a minimum volume of 0.06 cubic meters.

2.02 GRAVEL BLANKET

A. Gravel blanket material shall consist of a mixture of stones or rock fragments and particles with 95 to 100 percent passing a 75 mm sieve and 25 to 70 percent passing the Number 4 sieve.

PART 3 EXECUTION

3.01 RIPRAP STONES

A. Riprap stones shall be individually laid, upward from the toe of the slope with the larger stones at the toe of the slope.

B. The stone shall be placed with close joints approximately perpendicular to the slope.

C. Open joints shall be filled with spalls.

3.02 GRAVEL BLANKET

A. Where a gravel blanket is shown on the plan or ordered by the Engineer, the gravel shall be placed in layers not exceeding 30 cm compacted depth.

B. The finished surface shall be reasonably uniform in appearance, approximately parallel to and within 15 cm of the lines and grades shown on the Drawings.

END OF SECTION

SECTION 02575

MANHOLES

PART 1 GENERAL

1.01 RELATED WORK

A. Section 03001: Cast-in-Place Concrete.

1.02 STORAGE AND HANDLING

A. Store manhole components at the site to prevent damage before installation.

B. Handle precast manhole components with lifting slings and plugs that will not damage the precast manhole lip.

C. Repair all damage to precast sections that is not cause for rejection. Chip and scarify the area around minor breaks and apply grout. Allow grout to cure before precast sections are installed.

PART 2 PRODUCTS

2.01 MANHOLE BARRELS

A. Barrel sections: ASTM C76, reinforced, Class II, Wall B.

B. Size: as designated on the Drawings.

C. The top section shall be an eccentric conical section with thickened upper walls or reinforced concrete pipe section with the smallest inside diameter equal to 750 mm, to receive the manhole frame and cover.

D. Cast two lift holes in each barrel section.

E. Details are shown on the Drawings.

2.02 MANHOLE BASES

A. Precast concrete bases: integrally cast, consisting of manhole bottom and walls extending a minimum of 150 mm above the top of the highest inflowing sewer.
   1. Form the top of the base section to receive the tongue of the barrel section.
   2. Provide a minimum of 100 mm between the invert of the lowest outflowing sewer and floor of the base to provide for the construction of a formed invert and bench wall within the manhole.
   3. Cast two lift holes in the bases.
   4. Minimum concrete thickness: 200 mm.
   5. Integrally cast gaskets in openings in manhole bases for pipe connections.

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B. Cast-in-Place bases: construct of cast-in-place concrete, conforming to Section 03001, consisting of manhole bottom shaped invert and walls which shall extend a minimum of 150 mm above the top of the highest inflowing sewer.

2.03 JOINTS

A. Joints: Tongue and groove joints.

B. Joint Sealant: cold applied bituminous compound.

2.04 MANHOLE STEPS

A. Manhole steps: aluminum, drop type manufactured by Oliver Tire and Rubber Company or equal.

B. Cast steps into the walls of barrel sections, align vertically and space on equal centers in the assembled manhole, maximum twelve inches. Locate steps a minimum of 150 mm from the ends of barrel sections.

2.05 MANHOLE COVERS AND FRAMES

A. Manhole covers and frames: cast close grained, gray iron free from cracks, holes, swells and cold shuts with quality so a blow from a hammer will produce an indentation on a rectangular edge of the casting without flaking the metal.

B. Cast covers and frames to the pattern and dimensions specified.

C. Machine bearing surfaces.

D. Coat castings, both inside and out, with coal-tar-pitch varnish.

E. The total weight of each manhole cover and frame: minimum 181 kg.

F. Dimensions
1. The opening inside diameter: 750 mm.
2. Total height: minimum eight inches.

2.06 BRICK

A. Brick: clay or shale, type FBS, Grade SW in accord with ASTM C62.

2.07 MORTAR

A. Cement: ASTM C150, type II, gray portland cement.

B. Sand: ASTM C33, natural, brown, clean, well graded sand with 100 percent passing a No. 4 sieve.

C. Water: clean, potable, free of materials deleterious to mortar.

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D. Mortar mix: one part cement and three parts damp sand by volume with water enough to produce a consistancy compatible with application.

PART 3 EXECUTION

3.01 PREPARATION

A. Place and compact a 150 mm mat of coarse aggregate over a base of sound, level, undisturbed earth. Bring gravel to proper elevation and level.

B. Before pouring a cast-in-place base, set the downstream and upstream pipes to proper grade so the pipe ends will be flush with the inside of the manhole. Place concrete bedding under the pipes a minimum of one meter from the manhole base wall or within 150 mm of the pipe joint as indicated on the Drawings.

3.02 PRECAST BASES

A. Set base on prepared mat, level and align with connected pipes. Do not use wedges or shims to level base.

B. Construct flow channels and bench walls of mortar and brick or concrete.

3.03 CAST-IN-PLACE BASES

A. Use metal forms supplied by barrel section manufacturer. Forms shall include a ring at the top to form the joint to receive the first barrel section.

B. Cast flow channels and bench walls monolithically with the base.

3.04 MANHOLE CONSTRUCTION

A. Install barrel sections using joint sealant. Level each section. Do not use wedges or shims for leveling.

B. Set and secure pipes entering precast manhole sections at the correct line and grade.

C. Grout pipe joint to manhole and manhole joints with mortar to provide watertight joint.

D. Keep ground water from newly grouted pipe and manhole sections and freshly laid brick until mortar has set and joint is watertight.

3.05 DROP MANHOLES

A. Encase and support the riser and incoming pipe with concrete down to undisturbed earth as shown on the Drawings.

B. Encasing the riser with brick is not permitted.

C. Lay all pipes to correct lines and grade before concreting is begun.

3.06 FLOW CHANNELS AND BENCH WALLS

A. Flow channels: minimum depth equal to 3/4 the diameter of the pipe to which it connects. Grade channel to give a smooth, uninterrupted flow through the manhole.

B. Pitch bench walls a minimum of one mm per centimeter from the inside periphery of the manhole to the edge of the flow channel.

3.07 MASONRY WORK

A. Bring the top of precast manholes to proper grade for receiving manhole frames with not more than three courses of brick.

B. Lay brick plumb, straight, level, square and true in full beds of mortar with shoved joints maximum 15 mm thick.

C. Install steps and miscellaneous items specified elsewhere bonded in the masonry.

D. Parge masonry walls on the inside and outside with a one-half inch coat of mortar.

E. Do not construct masonry when air temperature is 4 deg. C and falling without means to heat mortar materials and approval of Engineer.

3.08 COVERS AND FRAMES

A. Install covers and frames embedded in mortar.

B. Covers which rock after installation will be rejected. Plugging, burning-in or filling is not permitted. Covers shall fit frames in any position.

C. Remove and replace rejected covers.

END OF SECTION

SECTION 03001

CONCRETE WORK

PART 1 GENERAL

1.01 RELATED WORK

A. Section 01410; Field Testing Laboratory Services

B. Section 03345: Finishing Horizontal Surfaces

C. Section 05120: Structural Steel

D. Section 09900: Painting

E. Section 11201: Sluice Gates, Slide Gates, and Stop Gates

1.02 QUALITY ASSURANCE

A. Perform cast-in-place concrete work in accordance with ACI 301, unless specified otherwise in this Project Manual.

B. Keep copy of ACI 301 in field office for duration of project.

1.03 TESTS

A. Testing of concrete mix will be performed by Field Testing Laboratory provided by the Contractor for Contract No. 1. Copies of test results will be furnished to Owner and Contractor.

B. Testing of the concrete mix shall be performed on test cylinders made and cured in accord with ASTM C31 and C192. Tests procedure shall be in accord with ASTM C116 using an apparatus designed to provide sufficient pressure and to calibrate pressure vs. compressive load of each test specimen. The intent of the compressive test shall be to confirm the quality of the mix design as specified in Subsection 2.03.

C. Prior to start of concrete work:
1. Submit concrete mix design for each classification of strength slump.
2. Mix sample batches of each concrete mix design specified.
3. Take three test cylinders for each sample batch for compression test at seven and twenty-eight days.
4. Test cylinders will be cured and tested to determine criteria for judging quality of concrete placed during construction.

D. Sample concrete in accord with ASTM C172.

E. Make slump test in accord with ASTM C143 for each 7.65 cubic meters or per truck load of delivered concrete. Furnish material and assistance required to make tests.

F. Test air content in accord with ASTM C231.

G. Cure test cylinders in accord with ASTM C31 and C192.

H. Make one set of three cylinders for each classification of concrete placed in one day, and for every 76.5 cubic meters of concrete placed or from each concreting location. Make and test additional cylinders when deemed necessary by the Engineer. Lab cure two of the three specimens and field cure the remaining one. Make tests in accord with ASTM C116.

I. Compression tests of test cylinders shall be made at 7 and 28 days. Test cylinders shall be made as specified in ASTM C31. Seven-day tests may be used to predict concrete strength provided that the relation between 7 and 28-day strengths have been pre-established by earlier testing.
   1. Tests shall be made in accord with Chapter 16 - Testing, ACI 301 except as herein modified.
   2. Acceptance of concrete shall be based upon the average of all sets of three consecutive strength tests results equal or exceed the specified strength, and that no individual strength test result falls below the specified strength by more than 500 psi.

J. Provide molds, materials, and assistance required for preparation of test cylinders. Single use paper molds may be used if they comply with ASTM C470.

K. Do not remove forms from or apply loads to concrete structures for which strength tests have not been made and results of which have not equaled or exceeded minimum requirements.

L. In cases where average strengths are below minimum required values, the Engineer shall have the right to require conditions of temperature and/or moisture necessary to secure the required strength and may require load or core tests to be made on affected portions of the Work.

1.04 REFERENCE STANDARDS

A. ACI 301 - Specifications for Structural Concrete for Buildings.

B. Portland Cement: Jordanian Specification Standard No. 219.

1.05 SHOP DRAWINGS

A. Submit shop Drawings of reinforcing steel in accordance with Section 01340.

B. Indicate bar sizes, spacings, locations and quantities of reinforcing steel, and wire fabric, bending and cutting schedules, and supporting and spacing devices.

C. Indicate pertinent formwork dimensioning, methods of construction, materials, arrangement of joints, ties and shores, location of bracing and temporary supports, schedule of erection and stripping.

PART 2 PRODUCTS

2.01 CONCRETE MATERIALS

A. Cement shall be portland cement per ASTM C150, or equal.
1. Cement shall be normal Type 1 for general construction, Contracts 1, 2 and 3.

B. Use one brand of cement throughout the project unless otherwise specified. The Contractor is directly responsible for arrangements with Jordan Cement Factory Co. to obtain cement which will meet ASTM C150, or equal, and also which will comply with Clause 86 of the Conditions of Contract.

C. Fine and coarse aggregates: ASTM C33, except that aggregate shall be limited to 40% in accord with ASTM C131 and C535.

D. Water shall be clean, free of injurious amounts of oil, alkali, organic matter, or other deleterious material.

2.02 ADMIXTURES (ACI 301 2.2)

A. Type and dosage of admixture: conform to manufacturer's instructions for temperature conditions.

B. Water reducing admixtures: hydroxylated carboxylic acid type conforming to ASTM C494, Type D with the exception that:
1. Maximum shrinkage: maximum 100 percent of control mix.
2. Relative durability factor: minimum 100 percent of control mix.
3. Use only as approved by Engineer.

C. Do not use calcium chloride in concrete containing aluminum items.

2.03 MIX DESIGN (ACI 301 3.2 and ACI 350)

A. Provide minimum 28-day compressive strength as follows:

Concrete Class	Cement Type	Min. 28 Day Compressive Strength kg/sq cm	Maximum Water-Cement Ratio By Weight
A	1	211	.58
B	1	211	.45
C	1	176	.65
D	2	211	.58

1. Minimum Cement Content: 308 kg/cu.m.
2. Maximum Cement Content: 361 kg/cu.m.

B. Use Class A concrete for General Structural Construction in Contracts 1, 2 and 3.

C. Use Class B concrete for structural construction of liquid containment structures; Contract 1.

D. Use Class C concrete for secondary concrete and unreinforced concrete construction including fill concrete, headwalls, and similar structures in Contracts 1, 2 and 3.

E. Provide over design factor of 1.15 for the concrete mix.

2.04 SLUMP (ACI 301 3.5)

A. Slump for consolidation by vibration: 102 mm. Slump for consolidation other than by vibration: 127 mm.

2.05 PROPORTIONS (ACI 301 3.8)

A. Selection of proportions for normal weight concrete: Method 1.

2.06 REINFORCING STEEL (ACI 301 5.2)

A. Reinforcing Steel: 60 yield grade; deformed billet steel bars, ASTM A615; plain finish.

B. Welded Steel Wire Fabric: plain type, ASTM A185; in flat sheets; plain finish size as shown on Drawings.

2.07 EXPANSION JOINTS (ACI 301 6.2)

A. Premolded expansion joint filler: type required shown on Drawings, conforming to ASTM D1751.

B. Compression Seals: The seals shall be preformed elastic joint seals of the open-cell compression type and manufactured from vulcanized elastomeric compound using polymerized chloroprene. The seals shall be Acmaseal, Style No. A-162 as manufactured by Acme Highway Products

Corporation. The compression seals shall be installed where indicated on the Drawings.

C. Joint Sealant: The joint sealant shall be a non-sag two (2) component, polysulfide system. The sealant is Colma Joint Sealant (NS) as manufactured by Sika Chemical Corporation. The sealant shall be installed where indicated on the Drawings.

2.08 WATERSTOPS (ACI 301 6.3)

A. Waterstops: extruded polyvinyl chloride conforming to Corps of Engineers CRD C-572. 152 mm by 10 mm flat dumbbell construction or as indicated on the Drawings.

2.09 ACCESSORIES

A. Bonding Agent: two component modified epoxy resin; Sikadur Hi-Mod manufactured by Sika Chemical Co. or Epoxtite Binder Code 2385 manufactured by W.R. Grace & Co.

B. Non-Shrink Grout: Premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 2400 psi (17 MPa) in 28 days.

PART 3 EXECUTION

3.01 GENERAL

A. Install concrete work in accordance with ACI 301 except as amended by this Section.

B. Notify Engineer minimum 24 hours prior to placement of any concrete.

C. Transport concrete from mixer to place of final deposit in a continuous manner to prevent separation or loss of material and as rapidly as practicable until the unit of operations is complete. Do not use concrete which has reached an initial set or has contained water for more than one hour.

D. Deposit concrete as nearly as practicable to final position to prevent segregation from rehandling. In walls, place concrete in horizontal layers with first batches placed at ends and progress toward the center.

E. Compact concrete immediately after placing by thoroughly agitating the mass to force out air pockets and work the mixture into corners, around reinforcement and inserts, and prevent formation of voids. Do not use vibrators to move concrete horizontally.

F. Concrete trucks will not be permitted on existing foundations.

G. Do not deposit concrete in or under water without Engineer's permission.

H. Fresh concrete shall not be placed on concrete which has hardened sufficiently to cause formation of cold joints or planes of weakness within the section. If a section cannot be placed continuously, construction joints shall be located at points as provided for in the Drawings or as approved by the Engineer. When work is resumed, concrete previously placed shall be thoroughly cleansed of foreign materials and laitance, using a stiff wire brush or other tools, and a stream of water if necessary, and then slushed with grout consisting of one part Portland cement and two parts sand.

I. Free drop of concrete for more than 1.5 meters will not be allowed. Where greater drops are required, a tremie shall be employed. Discharge of the tremie shall be controlled such that the concrete may be effectively compacted into horizontal layers not exceeding 30 cm. in thickness with a minimum of lateral movement.

J. Hot weather placement of concrete shall be in strict accordance with Recommended Practice for Hot Weather Concreting, ACI 305-72. Subgrades shall be kept moist in hot weather to prevent extraction of water from the concrete.

K. Cold weather placement of concrete shall be in strict accordance with recommended practice for cold weather concreting, AIC 306-66.

3.02 FORMWORK (ACI 301 4.2)

A. Obtain Engineer's authorization for use of earth forms. When using earth forms, hand-trim sides and bottoms, and remove loose dirt prior to placing concrete.

B. Chamfer exposed edges: 3/4 in x 3/4 in unless otherwise noted on the Drawings.

C. Tape or seal joints and seams to provide a smooth surface.

D. Make and erect forms so finished concrete will conform to shapes, lines, grades and dimensions shown on Drawings and to produce plumb, even, true concrete surfaces. Form all exposed concrete surfaces.

E. Through-bolts or ties will not be permitted in liquid retaining structures. The Contractor shall use only such bolts or ties as are capable of being removed in whole or in part so that no part remaining embedded in the concrete shall be nearer the surface of the concrete than the specified minimum thickness of cover to the reinforcement. Brace and shore forms as required. Design forms to remain in correct position during and after placement of concrete and not to deflect under weight of wet concrete.
1. Make forms tight to prevent mortar leakage.

3.03 FORM SURFACES PREPARATION (ACI 301 4.4)

A. Apply form release agent on formwork in accordance with manufacturer's recommendations. Apply prior to placing reinforcing steel, anchoring devices and embedded parts. Do not apply form release agent where concrete surfaces will receive applied coverings which are affected by agent.

3.04 FINISHING FORMED SURFACES (ACI 301.10.4)

A. Formed Surface Finishes: Provide rough form finish at surfaces not exposed to view. Provide smooth form finish at surfaces exposed to view and as shown on Drawings. Provide smooth rubbed finish at outside exposed building walls.

3.05 REMOVAL OF FORMS (ACI 301 4.5)

A. Do not remove forms and bracing until concrete has gained sufficient strength to carry its own weight, construction loads, and design loads which are liable to be imposed upon it. Verify strength of concrete by compressive test results.

3.06 RESHORING (ACI 301 4.6)

A. Remove load supporting forms only when concrete has attained 75 percent of required 28 day compressive strength, provided construction is reshored.

3.07 SLABS (ACI 301 11.1)

A. Pour floor slabs in checkerboard pattern indicated on Drawings. Use 5 mm thick blade, cutting 1/4 into depth of slab thickness, where indicated.

B. Separate slabs-on-grade from vertical surfaces with 13 mm thick joint filler, or as shown on Drawings. Extend joint filler from bottom of slab to within 3 mm of finished slab surface.

C. Provide Class A tolerances according to ACI 301 11.9. Pitch to drains 20 mm/m nominal.

3.08 WELDING (ACI 301 5.3)

A. Welding Reinforcing Steel: Not permitted without the express approval of Engineer.

3.09 CONSTRUCTION JOINTS (ACI 301 6.1)

A. Install waterstops in construction joints where shown on Drawings and where required for waterproof integrity.

3.10 INSERTS, EMBEDDED PARTS AND OPENINGS

A. Provide formed openings where required for pipes, conduits, sleeves and other work to be embedded in and passing through concrete members.

B. Coordinate work of other sections and cooperate with trade involved in forming and setting openings, slots, recesses, chases, sleeves, bolts, anchors and other inserts.

3.11 CONNECTIONS TO EXISTING WORK

A. In locations where new concrete is dowelled to existing work, drill holes in existing concrete, where indicated, insert steel dowels and pack solidly with non-shrink grout.

B. Prepare previously placed concrete by cleaning with steel brush and applying bonding agent. Apply bonding agent in accordance with manufacturer's recommendations.

3.12 REPAIR OF SURFACE DEFECTS (ACI 301 9.1)

A. Allow Engineer to inspect concrete surfaces immediately upon removal of forms.

B. Modify or replace concrete not conforming to required lines, detail and elevations.

C. Repair or replace concrete not properly placed resulting in excessive honeycombing and other defects. Do not patch, repair or replace exposed concrete except upon express direction of Engineer.

3.13 CURING

A. Curing shall be in accordance with recommended practice for curing concrete ACI 308-71.

3.14 TESTING WATERTIGHT STRUCTURES

A. At the option of the Owner liquid containment structures of Contract 1 shall be tested by filling with clean water after they have been completed prior to backfilling about the structure.
   1. The Owner shall furnish the clean water for testing.
   2. The Contractor shall provide for adequate storage of the water including such chemical as required to maintain the quality of the water. Adequate storage may be a completed, pre-tested tank that the Owner has approved for Storage.
   3. In addition the Contractor shall provide all pumps and accessories necessary to handle the water to and from the structure being tested.

B. After a 24 hour test period, should leakage become evident at any point, or should the water lower by a measurable amount, except by evaporation or spillage, as determined

by the Owner, the structure shall be repaired by an approved method. The test procedure shall be repeated until satisfactory results are obtained.

C. The Contractor shall provide all labor and material required to perform these tests. He shall notify the Owner/Engineer well in advance of testing, provide access to the test structure and submit a written report of each test. Backfilling shall not commence prior to approval of the Owner.

END OF SECTION

SECTION 03345

FINISHING HORIZONTAL SURFACES

PART 1 GENERAL

1.01 RELATED WORK

A. Section 03001: Concrete Work.

1.02 REFERENCE STANDARDS

A. ACI 302 - Recommended Practice for Concrete Floor and Slab Construction.

B. ACI 308 - Recommended Practice for Curing Concrete.

C. ASTM C309 - Liquid Membrane - Forming Compounds for Curing Concrete.

1.03 DELIVERY OF MATERIALS

A. Furnish concrete hardener and curing compound in manufacturer's packaging complete with application instructions.

PART 2 PRODUCTS

2.01 HARDENERS

A. Chemical Hardener: Sikaguard 655 type; manufactured by Sika, Chemical Corporation, or equal.

PART 3 EXECUTION

3.01 FLOOR FINISHING

A. Finish concrete floor surfaces in accordance with ACI 302.

B. Uniformly spread, screed, and float concrete. Do not use grate tampers or mesh rollers. Do not spread concrete by vibration.

C. Maintain surface flatness, with maximum variation of 3 mm in 3 m.

D. In areas with floor drains, maintain floor level at walls and pitch surfaces uniformly to drains 20 mm/m nominal, or as indicated on drawings.

E. Mechanically or manually float surfaces using cork floats for surfaces of water containment, structures and surfaces which will be covered with a finish floor treatment.

F. Steel trowel surfaces which will be left exposed.

G. Apply concrete hardener on floor surfaces in pump rooms, motor control rooms, and chlorine building lavatory. Apply in accordance with manufacturer's recommendations.

3.02 CURING

A. Cure finish floor surfaces in accordance with ACI 308. Review method with Engineer. Do not use curing compounds without the express approval of the Engineer, and then in accord with ASTM C309.

END OF SECTION

SECTION 04001

MASONRY

PART 1 GENERAL

1.01 RELATED WORK

A. Section 07900: Sealants for expansion/contraction joints

1.02 QUALITY ASSURANCE

A. Perform masonry work in accordance with requirements of ANSI A41.1 unless indicated otherwise herein.

B. Perform mortar work in accordance with requirements of ASTM C476 unless indicated otherwise herein.

1.03 TESTING

A. Testing of mortar mix will be performed by the Field Testing Laboratory (reference Section 01410). Make tests in accord with ASTM C270.

B. Provide free access to portions of work and co-operate with Laboratory personnel.

C. Submit proposed mortar mix design to testing laboratory for approval prior to commencement of work.

D. Tests of mortar mix will be performed to ensure conformance with requirements stated herein and to ensure mortar will not produce efflorescence.

E. If mortar mix does not conform with requirements stated herein, re-establish and re-submit for further testing.

1.04 REFERENCE STANDARDS

A. ASTM C150 - Portland Cement.

B. ASTM C91 - Masonry Cement.

C. ASTM C5 - Quicklime for Structural Purposes.

D. ASTM C207 - Hydrated Lime for Masonry Purposes.

E. ASTM C270 - Standard Specification for Mortar for Unit Masonry.

F. ASTM C144 - Aggregate for Masonry Mortar.

G. ASTM C90 - Hollow Load Bearing Concrete Masonry Units.

H. ASTM C145 - Solid Load Bearing Concrete Masonry Units.

I. ASTM C129 - Hollow Non-Load Bearing Concrete Masonry Units.

J. ASTM C476 - Mortar and Grout for Unit Masonry.

K. ANSI A41.1 - Building Code Requirements for Masonry.

1.05 SUBMITTALS

A. Submit manufacturer's recommendations and product data in accordance with Section 01340.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Maintain materials and surrounding air temperature at minimum 50 deg. F. (10 deg. C) prior to, during and 48 hours after completion of masonry work.

B. When ambient temperature is less than 50 deg. F. (10 deg. C), provide adequate equipment or cover to maintain a minimum temperature of 50 deg. F. (10 deg. C) and to protect masonry work completed or in progress. Conform to all other requirements stated in Division 1.

1.07 PROTECTION

A. Maintain protective boards at exposed external corners which may be damaged by construction activities. Provide such protection without damaging completed work.

B. Keep expansion joint voids clear of mortar.

C. Provide temporary bracing during masonry erection. Maintain in place until building structure provides permanent bracing.

PART 2 PRODUCTS

2.01 MASONRY

A. Concrete Blocks: ASTM C90 Hollow Core C145 Solid Core C129 Hollow Core Non-Load Bearing grade N, type I; modular size complete with corners, bases, bond beams, lintels and fillers to match and compliment block units; standard weight.

2.02 MORTAR MATERIALS

A. Portland Cement: ASTM C150 normal - Type I, gray color.

B. Masonry Cement: ASTM C91 for general use.

C. Aggregates: standard masonry type, ASTM C144 free from frozen and foreign matter.

D. Hydrated Lime: ASTM C207 type S.

E. Quicklime: non-hydraulic type ASTM C5.

F. Premix Mortar: commercially prepared type, ASTM C387 mortar type N using gray cement.

G. Water: clean and free from injurious amounts of oil, alkali, organic matter or other deleterious material.

2.03 REINFORCEMENT AND ANCHORAGES

A. Multiple Wythe Wall Horizontal Reinforcing: truss type; galvanized steel construction; 3/16 inch (4.8 mm) side rods with No. 9 gage (3.75 mm) cross ties;

2.04 THROUGH-WALL FLASHINGS

A. Plastic Flashings: sheet polyvinylchloride; 10 mils (0.25 mm) thick.

2.05 ACCESSORIES

A. Control Joints: preformed PVC material; of size and profile as shown on the Drawings.

B. Joint Filler: SBR rubber oversized 50% self expanding.

2.06 MORTAR MIX

A. Provide minimum type N mortar in accord with ASTM C270 for load bearing walls and non-load bearing walls with maximum 2% ammonia stearate or calcium stearate per cement volume.

B. Thoroughly mix mortar ingredients, in quantities needed for immediate use.

C. Do not use anti-freeze compounds to lower the freezing point of mortar.

D. Use mortar within two (2) hours of mixing at temperatures over 26 degrees C., and two and one half hours at temperatures under 10 degrees C.

E. If necessary, retemper mortar within two hours of mixing to replace water lost by evaporation. Do not retemper mortar after two hours of mixing.

PART 3 EXECUTION

3.01 PREPARATION

A. Ensure items built-in by other trades for this work are properly located and sized.

B. Establish lines, levels and coursing. Protect from disturbances.

3.02 WORKMANSHIP AND INSTALLATION

A. Place masonry in accordance with lines and levels indicated on Drawings.

B. Fully bond external and internal corners and intersections.

C. Isolate masonry partitions from vertical structural framing members with a control joint, with mortar raked back 6 mm regardless of joint treatment.

D. Buttering corners of joints, deep or excessive furrowing of mortar joints is not permitted.

E. Do not shift or tap masonry after mortar has taken initial set. Where adjustment must be made, remove mortar and replace.

F. Perform jobsite cutting of masonry with proper power tools to provide straight and true, unchipped edges.

G. Ensure masonry courses are of uniform height. Make vertical and horizontal joints equal and of uniform thickness. Lay in full bed of mortar, properly jointed with other work.

H. Remove excess mortar and projections. Take care to prevent breaking masonry corners.

I. Lay concrete block in running bond. Course 1 block unit and 1 mortar joint to equal 203 mm. Form concave mortar joints.

3.03 TOLERANCES

A. Maximum variation from masonry unit to adjacent masonry unit is 1.6 mm.

B. Maximum variation from vertical and horizontal building lines is 6.4 mm in 3 m.

C. Maintain flush face on exposed masonry surfaces.

3.04 REINFORCEMENT AND ANCHORAGES

A. Place masonry reinforcing and anchorages for concrete unit masonry as follows:
   1. Provide composite wythe walls with horizontal masonry reinforcing in every second mortar joint.
   2. Place horizontal masonry reinforcing in first joint above and below openings. Place continuous in first joint below top of walls.
   3. Fully reinforce corners and intersections.
   4. Lap masonry reinforcing splices minimum 152 mm.
   5. Ensure that anchorages embedded in concrete members for concrete block are properly placed. Embed free end of anchorages in every third concrete block joint.

3.05 THROUGH WALL FLASHINGS

A. Place flashing in accord with manufacturer's instructions.

3.06 CONTROL JOINTS

A. Do not continue masonry reinforcing across control joints.

3.07 BUILT-IN WORK

A. As work progresses, build-in hollow metal frames, window frames, steel angle lintels, and other items supplied by other trades.

B. Build-in items plumb and true.

C. Bed anchors of hollow metal frames in mortar joints. Fill frame voids solid with mortar. Fill masonry cores with grout minimum 305 mm from framed openings.

D. Do not build-in organic materials which will be subjected to rot or deterioration.

3.08 CUTTING AND FITTING

A. Cooperate fully with other sections of work to ensure correct size, shape and location.

3.09 PARGE

A. Parge concrete block walls in 1 uniform coat. Maintain 25 mm total thickness.

B. Dampen masonry walls prior to application.

C. Trowel finished surface smooth and flat with a maximum surface variation of 1:960.

3.10 CLEANING

A. Remove excess mortar and smears upon completion of masonry work.

B. Point or replace defective mortar. Match adjacent work.

C. Clean soiled surfaces using a non-acidic solution which will not harm masonry or adjacent materials. Consult masonry manufacturer for acceptable cleaners. Use non-metallic tools in cleaning operations.

END OF SECTION

SECTION 05120

STRUCTURAL STEEL

PART 1 GENERAL

1.01 WORK FURNISHED BUT INSTALLED BY OTHERS

A. Section 03001: Concrete Work (specifically: anchorages)

1.02 RELATED WORK

A. Section 03001: Concrete Work (specifically: grouting)

B. Section 05310: Metal Roof Deck.

1.03 REFERENCES

A. ASTM A36 - Structural Steel.

B. ASTM - A325 - High Strength Bolts for Structural Steel Joints.

C. AWS D1.1 - Structural Welding Code.

D. AISC - Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.

E. FS TT-P-31 - Paint, Oil: Iron Oxide, Ready Mix, Red and Brown.

1.04 SHOP DRAWINGS

A. Submit shop drawings in accordance with Section 01340 prior to fabrication of steel. Prepare shop drawings in accord with AISC "Manual of Steel Detailing."

B. Indicate sizes, spacing, and locations of structural members, connections, attachments and fasteners.

C. Indicate welded connections using standard AWS welding symbols. Indicate net weld lengths.

PART 2 PRODUCTS

2.01 MATERIALS

A. Structural Steel Members: ASTM A36.

B. Bolts, Nuts, and Washers: ASTM A325.

C. Welding Electrodes: E-70 Series of AWS A5.1.

D. Primer: FS TT-P-31, red.

2.02 FABRICATION

A. Fabricate structural steel members in accordance with AISC Specification.

B. Except as noted on Drawings, provide bearing type connections capable of transferring full strength of member to be supported using 3/4 inch diameter bolts. Provide minimum double angle connection as scheduled in the AISC Manual of Steel Construction, Table II.

C. Shop side of connection angles may be fillet welded in accord with AISC Manual of Steel Construction Table III, or bolted. The welded connection shall be of equal strength to the bolted connection.

D. Perform shop welding by qualified welder, preferably in the flat position, and in accord with applicable requirements of the AWS "Code for Arc and Gas Welding in Building Construction", and AISC "Minimum Requirements and Tentative Standard Welded Connections for Buildings".

E. Punch or drill bolt holes. If metal thickness is greater than hole diameter, subpunch and ream bolt holes to required size for bolt diamter.

2.03 FINISH

A. Clean, prepare, and shop prime structural steel members. Do not prime surfaces to be field welded or in contact with concrete.

PART 3 EXECUTION

3.01 ERECTION

A. Erect structural steel in accordance with AISC Specification.

B. Make provision for erection loads, and for sufficient temporary bracing to maintain structure safe, plumb, and in true alignment until completion of erection and installation of permanent bracing.

C. Do not field cut or alter structural members without approval of Engineer.

D. After erection, prime welds, abrasions, and surfaces not shop primed, except surfaces to be in contact with concrete. Use a primer consistent with shop coat.

END OF SECTION

SECTION 05310

METAL ROOF DECK

PART 1 GENERAL

1.01 RELATED WORK

A. Section 05120 - Structural Steel:

1.02 REFERENCES

A. ASTM A36 - Structural Steel.

B. ASTM A446 - Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality.

C. AWS D1.1 - Structural Welding Code.

D. SDI - Design Manual for Composite Decks, Form Decks, Roof Decks.

1.03 SHOP DRAWINGS

A. Submit Shop Drawings in accordance with Section 01340.

B. Indicate decking plan, deck profile dimensions, supports, projections, openings, finishes, pertinent details, and accessories.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Store decking on wood sleepers with slope for positive drainage.

PART 2 PRODUCTS

2.01 MATERIALS

A. Sheet Steel: ASTM A446, Grade B structural quality; with G90 coating.

B. Bearing Plates: ASTM A36 steel.

C. Welding Materials: AWS D1.1.

D. Touch-up Primer: Zinc chromate type.

2.02 FABRICATION

A. Metal Decking: Minimum 20 gage (0.9 mm thick) sheet steel, 1-1/2 inch (38 mm) high, fluted profile to SDI NR; 24 inch (600 mm wide) sheets; double span; lock seam joints.

B. Fabricate metal decking in accordance with SDI Design Manual for Composite Decks, Form Decks, Roof Decks to

accommodate maximum working stress of 22,400 psi (1575 kg per square cm) and maximum span deflection of 1/240

PART 3 EXECUTION

3.01 INSTALLATION

A. Erect metal decking in accordance with SDI Design Manual for Composite Decks, Form Decks, Roof Decks. Provide welding in accordance with AWS D1.1.

B. On steel support members provide 3 inch (75 mm) minimum bearing. Align and level on supports.

C. Mechanically fasten male/female side laps at (600 mm) on-center (oc) maximum. Weld male/female side lap at (450 mm) oc maximum.

D. Fasten deck to steel support members at ends and intermediate supports with (19 mm) fusing welds at (300 mm) oc maximum.

E. Immediately after welding deck in place, touch-up welds, burned areas, and surface coating damage with prime paint.

END OF SECTION

SECTION 05500

METAL FABRICATIONS

PART 1 GENERAL

1.01 RELATED WORK

A. Section 05120: Structural Steel (specifically: column anchor bolts)

1.02 WORK FURNISHED BUT NOT INSTALLED

A. Section 03001 Concrete Work (specifically: cast-in-metal)

1.03 REFERENCE STANDARDS

A. Aluminum Association

B. ASTM A36 - Structural Steel.

C. ASTM A307 - Low-Carbon Steel Externally and Internally Threaded Fasteners.

D. ASTM A325 - High Strength Bolts for Structural Steel Joints Including Suitable Nuts and Plain Hardened Washers.

E. AWS D1.1 - Structural Welding Code.

1.04 SHOP DRAWINGS

A. Submit shop drawings of metal fabrications in accordance with Section 01340.

B. Indicate sizes, connection attachments, reinforcing, anchorage, size and type of fasteners and accessories.

C. Include erection drawings, elevations and details where applicable.

D. Indicate welded connections using standard AWS welding symbols. Indicate net weld lengths.

PART 2 PRODUCTS

2.01 MATERIALS

A. Steel: ASTM A36.

B. Low carbon steel standard threaded fasteners: ASTM A307. High strength steel bolts, nuts and washers: ASTM A325.

C. Electrodes for welding structural steel: E-70 series AWS A5.1.

D. Stainless steel: Type 304 (18-8) for sheets and plates. Type 316 for bolts.

E. Aluminum alloy in accord with Aluminum Association Specifications and Designations:
   1. 6061-T6: For rolled sections, plate, pipe and all bolts and screws.
   2. 6063-T6: For tube and pipe in non-corrosive areas, handrails and gratings.
   3. 6066-T6: For weldings and extrusions.
   4. 6151-T6: For forgings and forging stock.

F. Electrodes for welding aluminum: AWS A5.10.

G. Galvanizing: ASTM A525.

H. Shop Paint Materials:
   1. Zinc chromate primer: Federal Specification TT-P-45.
   2. Aluminum finish paint: aluminum paste pigment, ASTM D962, Type 2, Class B mixed with varnish, Federal Specification TT-V-81d, Type II. Mix two pounds pigment with one gallon varnish.
   3. Bituminous paint: U.S. Military Specification MIL-P-6883.

2.02 HANDRAILS

A. Handrail posts, rails and formed elbows: minimum 1-1/2 inch (40 mm) nominal diameter or square Schedule 40, extruded aluminum tube, factory welded construction, fabricated as shown on the Drawings. Design to comply with OSHA safety requirements. Minimum one hour clear anodize (NAAMM A41) finish. Use one type of cross-section for the Project.

B. Make splices, where necessary, and maintain strength and stiffness of the handrail.

C. Platform or walkway railing height: top rail 42 inches (1.0 m) nominal, vertical height from the upper surface of the top rail to floor, and intermediate rail halfway between top rail and floor.

D. Do not allow rails to overhang terminal posts to extent of constituting a projection hazard.

E. Posts: single unspliced tube length spaced maximum 6 feet (2.0 m) on center. Close post tops to provide a smooth-surfaced top rail of same material as railing.

F. Toe plates: same material and finish as railings, fabricate as shown on Drawings.

G. Field connections: design for assembly without welding, as shown on Drawings, with non-protruding stainless steel, Type 316 fasteners.

H. Individually pack and ship handrail tube and elbows in plastic film left intact until final acceptance by Engineer to protect finish.

2.03 GRATING AND FRAMES

A. Floor grating: aluminum I-bar type as shown on Drawings. Design bearing bars for maximum deflection 1/4 inch with 100 psf uniform load.

B. Grating construction: straight, parallel bearing bars joined by cross bars. Space bearing bars at 1-3/16 inch centers and cross bars at 4 inch centers. Weld bars of same depth as bearing bars to ends of bearing bars to provide banded end condition. Trim cross bar ends flush with outside face of outside bearing bars. Groove bearing bars top and bottom, longitudinally to provide anti-skid characteristics. Limit grating panel weight to 100 lbs. Minimum one hour clear anodized finish (NAAMM A41).

C. Frames: steel as shown on Drawings.

D. Fasteners: stainless steel saddle clip type with bolt, nut, and washer provided by the grating manufacturer. Minimum of two fasteners over each support.

2.04 ANCHOR BOLTS

A. Anchor bolts for equipment not furnished by equipment manufacturer and other miscellaneous anchor bolts: size and location as shown on Drawings. See various certified equipment shop drawings for anchor bolt size and location needed to anchor machinery and equipment.

B. Anchor bolts exposed to humid or wet conditions and where noted on the Contract Drawings shall be Type 316 stainless steel.

2.05 EXPANSION ANCHORS

A. For attachment to cured concrete: multi-unit expansion anchors installed in twist-drilled holes of diameter and length as recommended by Manufacturer.

B. For attachment to hollow core or solid masonry: sleeve anchors.

C. Size and material: capable of developing the full strength of anchor's cross section, material as specified by manufacturer of equipment or material being installed. Anchors exposed to humid or wet conditions and where noted on the Drawings: Type 316 Stainless Steel.

2.06 WALKWAYS AND LADDERS

A. Walkways and access platform design unless otherwise specified minimum design load of 100 psf with a maximum deflection of 1/360 of the span under full live load. In

addition, design exterior walkways and access platforms for a minimum lateral and uplift wind load of 30 psf in addition to other applied loads. Do not add seismic loads to wind loads. Shop prime finish.

B. Steel ladder: fabricated of 2 inch by 3/8 inch flat bar strings 16 inches apart, and 3/4 inch round bar rungs spaced 12 inches on centers in drilled holes in strings with welded connections as shown on Drawings. Shop prime finish.

2.07 LINTELS

A. Loose masonry lintels: galvanized steel with minimum 8 inch bearing at both jambs, size and location as shown on the Drawings.

2.08 FABRICATION

A. Verify dimensions on site prior to shop fabrication.

B. Fabricate items with joints neatly fitted and properly secured.

C. Fit and shop assemble in largest practical sections, for delivery to site.

D. Grind exposed welds smooth and flush with adjacent finished surfaces.

E. Exposed mechanical fastenings: flush countersunk screws or bolts unobtrusively located consistent with design of structure, except where specifically noted otherwise.

F. Make exposed joints flush butt-type hair-line joints where mechanically fastened.

G. Supply components required for proper anchorage of metal fabrications. Fabricate anchorage and related components of same material and finish as metal fabrication, unless otherwise specified.

H. Thoroughly clean surfaces of rust, scale, grease and foreign matter prior to prime painting, galvanizing or chrome plating.

I. Galvanize or prime paint items as scheduled. Do not shop prime surfaces in contact with concrete or requiring field welding. Shop prime in 1 coat. Provide minimum G115 weight of zinc galvanized coating.

2.09 SHOP PAINTING

A. Paint aluminum surfaces in contact with steel with one coat of zinc chromate primer. Allow zinc chromate paint to dry hard prior to assembling parts.

B. Paint steel surfaces to be placed in contact with aluminum with one coat zinc chromate primer and one coat of aluminum finish paint. Do not paint stainless steel or aluminized, hot-dip galvanized, or electro-galvanized steel.

C. Paint aluminum surfaces placed in contact with concrete or masonry construction with one heavy coat of bituminous paint. Apply paint as received from manufacturer without adding thinner.

PART 3 EXECUTION

3.01 ERECTION

A. Obtain Engineer's approval prior to site cutting or making adjustments which are not part of scheduled work.

B. Install metal fabrications square and level, accurately fitted and free from distortion or defects.

C. Make provision for erection stresses by temporary bracing. Keep work in alignment.

D. Replace items damaged in course of installation.

E. Perform field welding in accordance with AWS D1.1.

F. After installation, touch-up field welds and scratched and damaged prime painted or galvanized surfaces. Use a primer consistant with shop coat.

G. Supply to appropriate sections, items requiring to be cast into concrete, complete with necessary setting templates.

END OF SECTION

SECTION 07220

ROOF INSULATION SYSTEM

PART 1 GENERAL

1.01 RELATED WORK

A. Section 03001: Concrete Work.

1.02 SUBMITTALS

A. Submit product data in accord with Section 01340.

B. Prior to the installation of the insulation system, layout drawings shall be submitted by the Contractor and approved by the Engineer.

PART 2 PRODUCTS

2.01 MATERIALS

A. Insulation: Insulation shall be tapered "Foamglas" insulation, 1-1/2 (38 mm minimum thickness) as manufactured by Pittsburgh Corning Corporation. Taper shall provide a minimum slope of 1/8 inch per foot (3.2 mm per 305 mm).

B. Adhesive: Asphalt, ASTM D449, Type A, and Asphalt Primer, ASTM D-41.

C. Membrane: Asphalt Saturated Asbestos or Organic Felt, 15 lbs. (6.8 kg).

D. 1/8" (3 mm) hardboard protection board bond breaker.

PART 3 EXECUTION

3.01 PREPARATION

A. The structural concrete deck to which the waterproofing membrane is to be applied shall be smooth, dry and free of foreign material.

B. The surface of the deck shall be flat, free of fins and irregularities that will impede adhesive bond.

C. Insulation boards shall be unbroken, free of damage with face membrane undamaged.

3.02 INSTALLATION

A. The concrete structural deck shall first be primed with asphalt primer at the rate of one gallon per 9.29 sq. m.

SECTION 07830

ROOF AND FLOOR HATCHES

PART 1 GENERAL

1.01 GUARANTEE

A. Provide manufacturer's guarantee against defects in materials and workmanship for a period of five years.

1.02 SHOP DRAWINGS

A. Submit shop drawings in accordance with Section 01340.

B. Clearly indicate general construction, configurations, jointing methods and locations when applicable, fastening methods and installation details.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manufacturer and Types: SS, D and KD type manufactured by The Bilco Company.

2.02 ROOF HATCHES

A. Provide type SS or D with 11 gage aluminum covers and 3 inch beaded flange, neatly welded. Insulation: glass fiber 1 inch thickness, covered and protected by 18 gage aluminum liner.

B. Curb: 12 inches (.305 m) in height, 11 gage aluminum, formed with a 3-1/2 inch flange with holes provided for securing to the concrete curbing. Equip curb with an integral metal cap flashing of the same gage and material as the curb, fully welded at the corners for weather-tightness. Insulation on the exterior of the curb shall be rigid fiber board 1 inch in thickness.

C. Assemble hatch with heavy pintle hinges, compression spring operators enclosed in telescopic tubes, positive snap latch with turn handles and padlock hasps inside and outside, and neoprene draft seal. Equip cover with an automatic hold-open arm complete with red vinyl grip handle to permit one hand release. Hardware shall be stainless steel, mill finish.

D. As noted on the Drawings, roof hatches Type SS shall be modified for installation of roof ventilators as specified in Section 15820. The hatch leaf shall be modified to provide adequate support and opening for the ventilator to be installed.

B. The hot asphalt for securing the waterproofing membrane (15 lb. felt) and insulation board, shall be applied at a minimum temperature of 150 deg. C and not heated above 200 deg. C.

C. The structural slab shall be covered with a single ply 15 lb. felt membrane. Adhere the felt using a minimum of 25 lbs. per 9.3 sq. m of hot bituman on the deck.

D. Adhere the "Foamglas" insulation to the single ply felt membrane with a solid mopping of hot bituman applied at a rate of 25 lbs. per 9.3 sq. m. Place insulation immediately into the hot asphalt and walk into place to insure imbedment.

E. The insulation shall be laid in parallel courses with all joints staggered between courses. Joints shall be tightly butted. When more than one layer of insulation is used, joints shall be staggered where possible with relation to the layer beneath, and each layer shall be firmly adhered to the previous layer with hot asphalt.

F. Do not apply insulation when ambient temperatures are below 4 deg. C..

G. Insulation shall be kept dry before and during application. No more insulation shall be laid in a day than can be protected with hardboard the same day.

H. When the adhesive coats for the insulation have cooled, lay a 1/8" (3 mm) hardboard protection board with taped joints over the insulation prior to placing the 2-1/2" (64 mm) concrete topping.

END OF SECTION

2.03 FLOOR HATCHES

A. Provide type KD with 1/4 inch extruded aluminum frame and built-in neoprene cushion and with strap anchors bolted to exterior. Door leaf: 1/4 inch aluminum diamond plate reinforced with aluminum stiffeners as required. Cast steel hinges shall be bolted to underside and pivot on torsion bars that counterbalance the door for easy operation. The door shall open to 90 degrees and lock automatically in that position. Provide a vinyl grip handle to release the cover for closing.

B. Build door to withstand a live load of 150 pounds per square foot, and equip with a snap lock and removable handle. Mill finish, with bituminous coating to be applied to exterior of frame by manufacturer. Hardware shall be stainless steel.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install roof hatch(es) in accordance with manufacturer's recommendations. Co-ordinate with installation of roofing system and related flashings. Provide weathertight installation.

END OF SECTION

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SECTION 07900

SEALANTS

PART 1 GENERAL

1.01 RELATED WORK

A. Section 03001: Sealants used in conjunction with concrete.

B. Section 04001: Sealants used in conjunction with masonry.

1.02 REFERENCES

A. FS TT-S-227 - Sealing Compound, Rubber Base, Two Component.

1.03 SUBMITTALS

A. Submit product data and samples in accordance with Section 01340.

B. Submit manufacturer's surface preparation and installation instructions.

C. Submit samples of sealant colors.

PART 2 PRODUCTS

2.01 SEALANT MATERIALS

A. Sealant: Polysulphide base, two component, chemical curing; Type 1 - self leveling; 2 - non-sagging; conforming to requirements of FS TT-S-227, Class A; Shore A hardness of minimum 20 and maximum 25 non-staining and color as selected.

2.02 ACCESSORIES

A. Primer: Non-staining type, recommended by sealant manufacturer to suit application.

B. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.

PART 3 EXECUTION

3.01 INSPECTION

A. Verify joint dimensions, physical, and environmental conditions are acceptable to receive work of this Section.

B. Beginning of installation means acceptance.

3.02 PREPARATION

A. Clean, prepare, and size joints in accordance with manufacturer's instructions. Remove any loose materials and other foreign matter which might impair adhesion of sealant.

B. Verify that joint shaping materials and release tapes are compatible with sealant.

C. Examine joint dimensions and size materials to achieve required width/depth ratios.

D. Use joint filler to achieve required joint depths, to allow sealants to perform properly.

E. Use bond breaker where required.

3.03 INSTALLATION

A. Install sealant in accordance with manufacturer's instructions.

B. Apply sealant within recommended temperature ranges. Consult manufacturer when sealant cannot be applied within recommended temperature ranges.

C. Tool joints concave.

D. Joints: Free of air pockets, foreign embedded matter, ridges, and sags.

END OF SECTION

SECTION 08111

STANDARD STEEL FRAMES

PART 1 GENERAL

1.01 RELATED WORK

A. Section 08214: Steel Faced Wood Doors.

B. Section 08700: Hardware

1.02 REFERENCE STANDARDS

A. SDI-100 - Recommended Specifications-Standard Steel Doors and Frames of Steel Door Institute.

B. ASTM A569 - Steel, Carbon, Hot-Rolled Sheet and Strip, Commercial Quality.

C. ASTM A366 - Steel, Carbon, Cold-Rolled Sheet, Commercial Quality.

1.03 SHOP DRAWINGS AND PRODUCT DATA

A. Submit shop drawings and product data in accordance with Section 01340.

B. Indicate general construction, configurations, jointing methods, reinforcements, anchorage methods, hardware locations and installation details.

PART 2 PRODUCTS

2.01 HOLLOW METAL FRAMES

A. Materials and Fabrication: SDI-100 except as amended in this Section.

B. Types: knockdown frames.

C. Mortar Guard Boxes: minimum 22 gage (0.76 mm thick); welded in place.

D. Door Bumpers: manufacturer's standard resilient type; removable for replacement.

2.02 FABRICATION

A. Accurately form interlocking joints of knocked down frames to maintain alignment of parts when field assembled.

B. Provide removable transom for doors as indicated on Drawings.

C. Reinforce frames wider than 4 feet (1200 mm) with formed steel channels weld in place, flush with top of frames.

D. Reinforce and prepare frames to receive hardware. Refer to Section 08700 for hardware requirements.

E. Place minimum of 3 single bumpers on single door frames. Space equally along strike jambs.

F. Place minimum of 2 single bumpers on double door frames. Place on frame heads.

G. Provide jamb anchors: SDI-100. Weld floor jamb anchors in place.

H. Fill surface depressions of hollow metal frames with metallic paste filler and grind to smooth finish.

I. Chemically treat surfaces and apply one coat of primer.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install door frames in accordance with SDI-100 except as amended in this Section.

B. Install hollow metal frames plumb and square, in correct locations indicated on Drawings and with a maximum diagonal distortion of 1/16 inch (2 mm). Ensure frames are securely and rigidly anchored to adjacent construction.

C. After installation, touch-up scratched or damaged surfaces. Use type of primer identical to that used for shop coat.

END OF SECTION

SECTION 08214

STEEL FACED WOOD DOORS

PART 1 GENERAL

1.01 RELATED WORK

A. Section 08111: Standard Steel Frames

B. Section 08700: Hardware

1.02 SHOP DRAWINGS AND PRODUCT DATA

A. Submit shop drawings and product data of metal faced wood doors in accordance with Section 01340.

B. Indicate general construction, jointing methods, hardware locations, and locations of cut-outs for glass and louvers.

PART 2 PRODUCTS

2.01 STEEL FACED WOOD DOORS

A. Size(s): 1-3/4 inches (44 mm) thick.

B. Construction: Solid wood core of kiln dried white pine with 1/4 inch (6.4 mm) thick plywood bonded to each face; 3/8 inch (9.5 mm) x 1-1/2 inch (38 mm) steel jamb reinforcement at each vertical edge of door; 24 gage (0.61 mm) steel sheet pressure laminated to each door face.

2.02 SAFETY GLASS

A. Safety Glass: clear, fully tempered, 1/4 inch (6 mm) thick minimum.

2.03 LOUVERS

A. Louvers: stormproof, fixed or adjustable blades as shown on Drawings.

B. Provide 14/18 aluminum mesh insect screens on exterior doors.

2.04 FABRICATION

A. Metal facings: One piece, full door height and size and free of defects or distortions. Lap metal edges of facings over door edges. Solder and dress joints to smooth flush finish.

B. Reinforce and prepare doors to receive hardware. Refer to Section 08700 for hardware requirements.

C. Make cut-outs for glass and louvers. Reinforce cut-out areas at perimeter. Provide accurately cut and fitted matching stops. Rigidly secure stops on security side of doors.

D. Provide astragals for double doors.

E. Prime paint door surfaces.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install doors plumb, square, and with maximum diagonal distortion of 1/16 inch (1.6 mm). Install hardware in accordance with requirements of Section 08700.

B. Install louvers and glass in accordance with door manufacturer's instructions.

END OF SECTION

SECTION 08520

ALUMINUM WINDOWS

PART 1 GENERAL

1.01 RELATED WORK

A. Section 04001: Masonry. Preparation of adjacent work to receive work of this Section.

B. Section 07900: Sealants Perimeter sealant and back-up materials.

1.02 SYSTEM DESCRIPTION

A. Windows with fixed and sliding sash.

B. Glazing: Interior.

1.03 PERFORMANCE

A. Window components to provide for expansion and contraction caused by a cycling temperature range of 170 F degrees (96 C degrees) without causing detrimental effects to components.

B. Design and size members to withstand dead loads and live loads caused by pressure and suction of wind as measured in accordance with ANSI/ASTM E330.

C. Limit mullion deflection to 1/200 or flexure limit of glass with full recovery of glazing materials, whichever is less.

D. Drain water entering joints, condensation occurring in glazing channels, or migrating moisture occurring within system, to exterior.

E. Limit air infiltration through assembly to 0.06 cu ft/min/sq ft (150 cu cm/min/sq m) of assembly surface area, measured at a reference differential pressure across assembly of 0.3 inches (8.5 mm) water gage as measured in accordance with ANSI/ASTM E283.

1.04 REFERENCES

A. ANSI/ASTM A167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

B. ANSI/ASTM A386 - Zinc-Coating (Hot-Dip) on Assembled Steel Products.

C. ANSI/ASTM B221 - Aluminum-Alloy Extruded Bar, Rod, Wire, Shape, and Tube.

D. ANSI/ASTM E283 - Rate of Air Leakage through Exterior Windows, Curtain Walls, and Doors.

E. ANSI/ASTM E330 - Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.

F. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.

G. FS RR-W-365 - Wire Fabric (Insect Screening).

H. FS TT-P-641 - Primer Coating; Zinc Dust-Zinc Oxide (For Galvanized Surfaces).

1.05 SHOP DRAWINGS AND PRODUCT DATA

A. Submit shop drawings and product data and installation instructions in accordance with Section 01340.

B. Include wall opening and component dimensions; wall opening tolerances required; anchorage and fasteners; affected related work; installation requirements; and

C. Provide wrapping to protect prefinished aluminum surfaces.

PART 2 PRODUCTS

2.01 MATERIALS

A. Extruded Aluminum: ANSI/ASTM B221; 6063; alloy, T5 temper.

B. Touch-Up Primer for Galvanized Surfaces: FS TT-P-641.

2.02 FABRICATED COMPONENTS

A. Frames: Nominal 3 inches (70 mm) wide x 2 inches (50 mm) deep profile, of 1/8 inch (3.2 mm) thick section; non-thermally broken, applied glass stops of snap-on type.

B. Insect Screens: FS RR-W-365, woven aluminum mesh. 14/18 mesh size; fitted taut in tubular aluminum frame. Miter and reinforce frame corners; provide with spring loaded steel retainer pins.

C. Operable Sash Weatherstripping: Wool pile permanently resilient, profiled to effect weatherseal.

D. Operable Sash Hardware: adjustable steel rollers; corrosion resistant self-locking latch; opening handle.

E. Fasteners: Stainless steel.

2.03 GLASS AND GLAZING MATERIALS

A. Glass: Clear, DSB, single pane of float or plate glass.

2.04 FABRICATION

A. Fabricate windows allowing for minimum clearances and shim spacing around perimeter of assembly, yet enabling installation.

B. Rigidly fit joints and corners. Accurately fit and secure corners tight. Make corner joints flush, hairline, and weatherproof. Seal corner joints with sealant.

C. Develop drainage holes with moisture pattern to exterior.

D. Prepare components to receive anchor devices. Fabricate anchorage items.

E. Prepare components with internal reinforcement for operating hardware.

2.05 FINISHES

A. Exposed Aluminum Surfaces: clear annodized.

B. Concealed Steel Items: Galvanized in accordance with ANSI/ASTM A386 to 2.0 oz/sq ft (610 g/sq m). Primed with iron oxide paint.

C. Apply one coat of bituminous paint to concealed aluminum and steel surfaces in contact with cementitious or dissimilar materials.

PART 3 EXECUTION

3.01 INSPECTION

A. Verify wall openings and adjoining air and vapor seal materials are ready to receive work of this Section.

B. Beginning of installation means acceptance of existing conditions.

3.02 INSTALLATION

A. Install window frames, glass and glazing and hardware in accordance with manufacturer's instructions.

B. Use anchorage devices to securely attach frame to structure.

C. Align window frame plumb and level, free of warp or twist. Maintain dimensional tolerances, aligning with adjacent work.

D. Coordinate attachment and seal of air and vapor barrier materials.

E. Pack fibrous insulation in shim spaces at perimeter to maintain continuity of thermal barrier.

F. Install glass in accordance with manufacturer's instructions using exterior wet combination dry method of glazing.

G. Install perimeter type sealant, backing materials, and installation requirements in accordance with Section 07900.

H. Adjust operable hardware for smooth operation and tight fit of sash.

3.03 CLEANING

A. Remove protective material from prefinished aluminum surfaces.

B. Wash down exposed surfaces using a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.

C. Remove excess sealant by moderate use of mineral spirits or other solvent acceptable to sealant manufacturer.

END OF SECTION

SECTION 08700

HARDWARE

PART 1 GENERAL

1.01 RELATED WORK

A. Section 08214: Steel Faced Wood Doors

1.02 REFERENCE STANDARDS

A. ANSI A115.2 - Door and Frame Preparation for Bored or Cylindrical Locks for 1-3/4 (44 mm) inch Doors.

B. ANSI A115.4 - Door and Frame Preparation for Lever Extension Flush Bolts.

C. ANSI A115.9 - Door and Frame Preparation for Closer, Offset Hung, Single Acting.

D. ANSI A156.1 - Butts and Hinges.

E. ANSI A156.2 - Locks and Lock Trim.

F. ANSI A156.4 - Door Controls (Closers).

G. ANSI A156.6 - Architectural Door Trim.

1.03 SHOP DRAWINGS AND PRODUCT DATA

A. Submit shop drawings and product data in accordance with Section 01340.

B. Indicate locations and mounting heights of each type of hardware.

C. Supply templates to door and frame manufacturer(s) to enable proper and accurate sizing and locations of cut outs for hardware.

1.04 KEYING

A. Door locks: Master keyed.

B. Supply 2 keys for each lock. Supply 2 master keys.

PART 2 PRODUCTS

2.01 HARDWARE

A. Provide items as listed in schedule at end of this section, complete to function as intended.

B. Items of same function and performance are acceptable in conformance with Section 01630.

2.02 FINISHES

A. Flush bolts and door closers: US26D.

B. All other hardware: US32D.

2.03 BUTT HINGES

A. Butts: Button-tip, ball bearings, heavy duty template type, steel. Provide non-rising pins on all exterior doors. Manufactured by Stanley; Hager; McKinney; or equal.

2.04 LOCKS AND LATCHES

A. Sets: Heavy duty cylindrical type stainless steel chassis, Cleveland Magnalock, Series 9 Line, provided with maximum security keying system manufactured by Sargent and Company, Russwin, Corbin, or equal.

2.05 OVERHEAD TYPE CLOSERS

A. Standard Closers: Surface mounted, liquid, equipped with key controlled checking adjustment screws, Type 50-F90 degrees manufactured by Sargent, Type 500 SH 90 degrees by Russwin, or equal.

B. Exterior closers: sized for 4 foot (1.22 m) door, with separate overhead holders.

C. Interior Closers: sized as recommended by the manufacturer, parallel arm with manual holder feature.

2.06 DOOR STOPS AND BUMPERS

A. Use floor stops only where conditions prevent the use of wall stops.

B. Wall stops: Type 3404 or 3405 manufactured by Sargent; 355-1/2 or 356-1/2 by Russwin; or equal.

C. Floor stops: 3380 or 3381 manufactured by Sargent; 209-1/2 or 210-1/2 by Russwin; or equal.

2.07 WEATHER STRIPPING

A. Door frames, jamb and head: surface applied, interlocking strips having a resilient sealing material, Series 335A and 336A manufactured by Pemko; No. 42 by Zero; or equal.

B. Bottom rail of doors: recessed waterstop 211A manufactured by Pemko; No. 153 by Zero; or equal.

2.08 METAL SADDLES

A. Metal saddles: extruded aluminum, not less than 1/4 inch (64 mm) thick, extending full width of openings, neatly

coped to frame, secured in place with countersunk stainless steel screws and expansion shields.

2.09 FLUSH BOLTS

A. Flush bolts: forged brass, with cast bronze dust proof strikes, top and bottom, Type 3450 manufactured by Sargent.

2.10 KICKPLATES

A. Kickplates: 1/8 inch (3.2 mm) plastic laminate color as selected by Engineer, 8 inch (.203 m) high by full width of door less 1-1/2 inch (38 mm) on push side and 1 inch (25.4 mm) on pull size.

2.11 FASTENERS

A. Provide screws and bolts to apply finish hardware in materials compatible with hardware.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install hardware in accordance with manufacturer's instructions, using proper templates.

B. Maintain following mounting heights for doors, from finished floor to center line of hardware item:
1. Locksets, Latchsets: 40 in. (1.016 m)
2. Pulls, push plates: 42 in. (1.067 m)

3.02 HARDWARE SCHEDULE

A. HARDWARE SET NO. 1 (Single Exterior Door)

1.	1-1/2 pair	Butts
2.	1 -	Lockset 84-9-G05LL
3.	1	Door Closure

B. HARDWARE SET NO. 2 (Pair Exterior Doors)

1.	3 pair	Butts
2.	1 -	Lockset 84-9-G05LL
3.	1 -	Door Closure (Active Leaf)
4.	2 -	Flush Bolts (Top/Bottom)

C. HARDWARE SET NO. 4 (Interior Toilet/Locker Room Doors)

1.	1-1/2 pair	Butts
2.	1 -	Push Plate
3.	1 -	Pull Plate
4.	1 -	Door Closure
5.	1 -	Door Stop
6.	2 -	Kickplate

D. HARDWARE SET NO. 5 (Pair Exterior Doors)

1.	4 Pair	Butts
2.	1 -	Lockset 84-9-G05LL
3.	2 -	Flush Bolts (Top/Bottom)

E. HARDWARE SET No. 6 (Single Interior Passage Door)

1.	1-1/2 Pair	Butts
2.	1 -	Latchset 84-9-U15LL
3.	1 -	Door Closure
4.	1 -	Door Stop

END OF SECTION

SECTION 09900

PAINTING

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. Steel Structures Painting Council

1.02 SAMPLES

A. Colors to be selected by Owner prior to commencement of work from a color schedule submitted, including color names and/or numbers.

1.03 MAINTENANCE MATERIALS

A. Leave on premises, where directed by Owner, not less than one gallon of each color used.

B. Containers to be tightly sealed and clearly labelled for identification.

1.04 DELIVERY, STORAGE AND HANDLING

A. Deliver paint materials in sealed original labelled containers, bearing manufacturer's name, type of paint, brand name, color designation and instructions for mixing and/or reducing.

B. Provide adequate storage facilities. Store paint materials at minimum ambient temperature of 45 degrees F (7 degrees C) in well ventilated area.

C. Take precautionary measures to prevent fire hazards and spontaneous combustions.

1.05 ENVIRONMENTAL CONDITIONS

A. Ensure surface temperatures or the surrounding air temperature is above 40 degrees F (5 degrees C) before applying finishes. Minimum application temperatures for interior work is 65 degrees F (7 degrees C) and 50 degrees F (10 degrees C) for exterior work.

B. Provide adequate continuous ventilation and sufficient heating facilities to maintain temperatures above 45 degrees F (7 degrees C) for 24 hours before, during and 48 hours after application of finishes.

C. Provide lighting on surfaces to be finished.

1.06 PROTECTION

A. Adequately protect other surfaces from paint and damage. Repair damage as a result of inadequate or unsuitable protection.

B. Furnish sufficient drop cloths, shields and protective equipment to prevent spray or droppings from fouling surfaces not being painted and in particular, surfaces within storage and preparation area.

C. Place cotton waste, cloths and material which may constitute a fire hazard in closed metal containers and remove daily from site.

D. Remove electrical plates, surface hardware, fittings and fastenings, prior to painting operations. These items are to be carefully stored, cleaned and replaced on completion of work in each area. Do not use solvent to clean hardware that may remove permanent lacquer finish.

PART 2 PRODUCTS

2.01 MATERIALS

A. Paint, type and brand shall be manufactured by a reputable paint manufacturer and be first line quality and approved by Engineer.

B. Safety colors: conform to ANSI Z535.1.

C. Paint Accessory Materials: (linseed oil, turpentine and other materials not specifically indicated herein but required to achieve the finishes specified) of high quality and approved manufacturer.

D. Paints: Ready-mixed except field catalysed coatings. Pigments fully ground maintaining a soft paste consistency, capable of readily and uniformly dispersing to a complete homogeneous mixture.

E. Paints to have good flowing and brushing properties and be capable of drying or curing free of streaks or sags.

PART 3 EXECUTION

3.01 INSPECTION

A. Thoroughly examine surfaces scheduled to be painted prior to commencement of work. Report in writing to Engineer, any condition that may potentially affect proper application. Do not commence until such defects have been corrected.

B. Correct defects and deficiencies in surfaces which may adversely affect work of this section.

3.02 PREPARATION OF SURFACES

A. Remove mildew by scrubbing with solution of tri-sodium phosphate and bleach. Rinse with clean water and allow surface to dry completely.

B. Remove dirt, loose mortar, scale, powder and other foreign matter from concrete and concrete block surfaces which are to be painted or to receive a clear seal. Remove oil and grease with a solution of tri-sodium phosphate, rinse well and allow to thoroughly dry.

C. Remove stains from concrete and concrete block surfaces caused by weathering of corroding metals with a solution of sodium metasilicate with a neutralizing rinse after being thoroughly wetted with water. Allow to thoroughly dry.

D. Remove grease, rust, scale, dirt and dust from steel and iron surfaces. Where heavy coatings of scale are evident, remove by wire brushing, sandblasting or any other necessary method. Ensure steel surfaces are satisfactory before paint finishing.

E. Clean unprimed steel surfaces by washing with solvent.

F. Apply a treatment of phosphoric acid solution, ensuring weld joints, bolts and nuts are similarly cleaned. Prime surfaces to indicate defects, if any. Paint after defects have been remedied.

G. Sand and scrape shop primed steel surfaces to remove loose primer and rust. Feather out edges to make tough-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Re-prime steel including shop primed steels as required where primed surfaces are sufficiently damaged to expose base metal and/or rust.

3.03 APPLICATIONS

A. Apply each coat at proper consistency.

B. Each coat of paint is to be slightly darker than preceeding coat unless otherwise approved by Engineer.

C. Sand lightly between coats to achieve required finish, if required by manufacturer.

D. Do not apply finishes on surfaces that are not sufficiently dry.

E. Allow each coat of finish to dry before following coat is applied, unless directed otherwise by manufacturer.

F. Prime top and bottom edges of metal doors with enamel undercoat when they are to be painted.

G. Apply safety color markings to materials and equipment as scheduled.

04 MECHANICAL AND ELECTRICAL EQUIPMENT

A. Refer to mechanical and electrical sections and safety color schedule with respect to painting and finishing requirements, color coding identification, banding of equipment, ducting, piping and conduit.

B. Finish paint primed equipment to color selected.

C. Prime and paint insulated and bare pipes, conduits, boxes, insulated and bare ducts, hangers, brackets, collars and supports, except where items are plated or covered with a pre-finished coating.

D. Replace identification markings on mechanical or electrical equipment when painted over or spattered.

E. Paint exposed conduit and electrical equipment occurring in finished areas. Color and texture to match adjacent surfaces.

F. Color code equipment, piping conduit and exposed ductwork in accordance with requirements indicated for color banding and identification (flow arrows, naming, numbering).

3.05 WORK NOT INCLUDED

A. Aluminum products.

B. Concrete and Concrete Masonry, except as noted in these specifications or on the contract drawings.

C. Plastics including FRP and polypropylene.

D. All galvanized surfaces, except as noted.

E. Stainless steel.

3.06 CLEANING

A. As work proceeds and upon completion, promptly remove paint where spilled, splashed or spattered.

B. During progress of work keep premises free fom any unnecessary accumulation of tools, equipment, surplus materials and debris.

C. Upon completion of work leave premises neat and clean, to the satisfaction of Engineer.

3.07 SAFETY COLOR SCHEDULE

A. RED, fire protection, danger and stop.

1. Fire boxes, extinguishers, exit signs, sprinkler piping.
2. Portable containers of flammable liquids identified by striping or lettering in yellow against red background.
3. Emergency stop bars or switches.

B. ORANGE
1. Gear box housings.
2. Exposed edges of pulleys, gear.
3. Safety starting buttons.

C. YELLOW, Physical Hazard Caution, generally used with Black in checks or stripes
1. Unguarded edges of platforms.
2. Physical protrusions into traffic pattern areas.
3. Elevator door edges.
4. Pulley blocks.
5. Material handling equipment.

D. GREEN, Safety Equipment and locations
1. First aid kits, stretchers, safety showers.
2. First aid signs, dispensaries, drinking water stations.

E. BLUE, Equipment Under Repair Caution
1. Blue flags, barriers, or signs located at control valves or power switches of equipment being repaired.

F. BLACK AND WHITE, Traffic and Housekeeping Areas, each color used alone or in check or stripe combinations.
1. Aisle ways.
2. Directional signs.
3. Floor areas around safety equipment.
4. Location of refuse areas.
5. Drinking water and food dispensing equipment.

G. PURPLE, Radiation Hazards
1. Storage areas.
2. Containers or equipment.

3.08 PAINTING AND FINISHING SCHEDULE

A. Concrete: Smooth Finish
1. Surface Preparation: Remove all curing oils, form oils, laitance and soluble salts and blow clean with dry air.
2. Prime Coat: one coat thinned of coal tar epoxy coating (one part thinner to two parts coal tar epoxy) applied at the rate of 200-300 sq. ft. per gallon. Dry Finial Thickness (D.F.T. 16 mils.
3. Finish Coat; one coat epoxy - coal tar minimum 8 mil D.F.T.
4. Areas of Application:
   a. The interior walls, base slab and sump in Septage holding Tanks.
   b. The wet wall side of the PUmp Room of the Primary Clarifier

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c. The interior walls and base slab of the Sludge Holding/Thickener Tank.
d. The interior walls and base slab of the Digester Tank.

B. Concrete Floors: As noted on drawings
1. Surface Preparation: Acid etch, rinse and dry.
2. Prime Coat; One coat catalized phenolic 68 percent solids by volume minimum 4 mil D.F.T.

C. Steel, Structural Steel - continuous Immersion
1. Surface Preparation: SSPC SP-5 or SP-8
2. Prime Coat: One coat weldable inorganic zinc 50 percent solids by weight minimum 3 mil D.F.T.
3. Intermediate Coat: One coat epoxy - coal tar 75 percent solids by volume minimum 8 mil D.F.T.
4. Finish Coat: One coat epoxy - coal tar 75 percent solids by volume minimum 8 mil D.F.T.

D. Steel, Structural STeel Exterior/Interior General Exposure
1. Surface Preparation: SSPC SP6 or SP8.
2. Prime Coat: One coat and field touch-up inorganic zinc primer 75 percent solids by weight minimum 3 mil D.F.T.
3. Intermediate Coat : One coat water based epoxy 52 percent solids by volume minimum 4 mil D.F.T.
4. Finish coat: One coat non-gloss water based epoxy 52 percent solids by volume minimum 4 mil D.F.T. or one coat gloss modified acrylic 32 percent solids by volume minimum 2 mil D.F.T.

E. STEEL DOORS AND FRAMES
1. Surface Preparation: All primed metal surfaces must be dry and free of dirt, oil or other foreign matter.
2. Prime Coat: one coat and field tough-up lead chromate primer minimum 1.5 mils D.F.T.
3. Intermediate Coat: One coat polyamide-cured epoxy resin Coating minimum 1.75 mils D.F.T.
4. Finish Coat: One coat polyamide-cured epoxy resin coating minimum 1.75 mils D.F.T.

3.09 COLOR AND IDENTIFICATION OF PIPING

A. Paint piping according to the following schedule. Color numbers given are Koppers Company. Stencil pipe service name and flow direction in black every 15 meters minimum and where pipe enters and leaves a room or building.

Service	Color
Potable cold water	Dark Blue 303
Domestic hot water	Light Blue 301
Sealing water, wash water plant effluent	Dark Green 323
Equipment drains	Orange 324
Vents	Ivory 379
Sanitary drains	Orange 329
Thickened sludge	Light Brown 334
Ferric Chloride piping	Aqua Green 300
Blower inlet & outlet lines, process air, comp. air	Sunset Gray 371
Oil lines	Brick Red 357
Structural steel	Sally Green (Andrew Brown)
Chlorine	Light Yellow 319
Raw Sewage	Sally Green (Andrew Brown)
Sludge lines	Light Brown 334
Scum and grease	Sea Green 304
Hoists and trolleys	Safety Yellow 389

END OF SECTION

SECTION 10165

TOILET COMPARTMENT

RT 1 GENERAL

01 SUBMITTALS

A. Submit Shop Drawings in accordance with Section 01340.

B. Submit samples of colors available for Owner's selection.

RT 2 PRODUCTS

01 TOILET COMPARTMENT

A. Units shall be one inch thick made up of two sheets of galvanized bonderized steel of not less than No. 22 gauge for door and No. 20 gauge for partitions, assembled over and cemented under pressure to an approved sound-deadening core. Edges shall be formed and sealed with continuous oval-crown locking strip electrically welded with welds spaced not over 18 inches apart, around entire perimeter. Corners shall be mitered, welded and finished.

B. Partitions and door shall be reinforced internally and prepierced for the application of fittings and hardware. Door shall be of equal width in any one range of compartments.

2.02 PILASTERS

A. Pilasters shall be 1-1/4 inch thick made up of two sheets of No. 2 gauge galvanized bonderized steel welded and finished as specified above for door and partisions. Height of pilaster shall extend from floor to top of headrail. Pilaster when set in place, shall be anchored to floor by means of fittings providing for vertical adjustment. Base of pilaster and floor anchorage shall be concealed by three inch high polished stainless steel cover base.

B. Headrail shall be continuous 1 inch x 1-1/2 inches lock seam tubular steel overhead brace extending through top of pilasters and securely bracing partitions. Headrail shall extend continuously across front of compartment and back to wall over end partition. Secure braces to each pilaster and to wall. Exposed ends of headrail shall be capped.

2.03 URINAL SCREEN

A. Urinal screen shall be 1-1/4 inches thick, fabricated of two enameling iron sheet steel faces and sound-deadening core, assembled, welded together and sealed as specified for partition panels. Seal edges of screen panels with

No. 20 gauge stainless steel interlocking edge trim. Provide no. 14 gauge stainless steel T-shaped support brackets 12 inches long by 6 inches wide, formed to fit over and to fasten to top and bottom edges of screen.

2.04 HARDWARE

A. Furnish compartment complete with all necessary operating and latching hardware.

B. All hardware, except working parts of gravity hinges, shall be heavy brass, polished chromium plated. Hinges shall be gravity type with concealed stainless steel ball bearing rollers of self- lubricating bronze bearings. Where door opens into compartment, hinges shall hold door in open position when not latched. Door shall have one cast pull, one coat hook with rubber tipped bumper, one slide bar or throw latch, and one combination door stop and latch keeper.

2.05 FINISH

A. All units shall be mechanically cleaned. Finish shall consist of a prime coat and a finish color coat of thermo-setting acrylic enamel, baked on to produce a uniform, smooth protective finish.

B. At completion of work furnish the Owner with complete "touch-up" kit for each color used for future repairs.

END OF SECTION

SECTION 10202

METAL WALL LOUVERS

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. ASTM B209 - Aluminum-Alloy Sheet and Plate.

B. ASTM B221 - Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.

C. ASTM A36 - Structural Steel.

1.02 SAMPLES

A. Submit color samples in accordance with Section 01340.

1.03 SHOP DRAWINGS

A. Submit shop drawings in accordance with Section 01340.

B. Clearly indicate, in large scale, profile of frame and installation details, relation to adjacent construction, flashing, blade configuration connections to duct work and insect screens, and percentage of free air opening.

1.04 PROTECTION

A. Protect louvers and finishes from damage during delivery and installation.

B. Protect adjacent surfaces, finishes and materials from damage during installation of louvers.

1.05 SIZES

A. See attached louver schedule for louver size, type and location.

PART 2 PRODUCTS

2.01 TYPE

A. Louvers are to be Storm Proof, operable type except where connected to duct work, which should be fixed type.

2.02 MATERIALS

A. Aluminum: Extruded; ASTM B221.

2.03 FABRICATION

A. Aluminum Louvers: extruded, 4 inch (100 mm) deep, minimum 0.081 inch (2 mm) thick with reinforcing bosses integral

waterstop fastened with stainless steel screws to extruded aluminum channel shape frame minimum 0.081 inch (2 mm) thick to provide a rigid and square self supporting unit.

B. Operable louvers shall be manual adjustable.

C. Insect Screen: 18 x 16 size aluminum mesh; set in aluminum frame.

2.04 FINISHES

A. Aluminum: hard color anodized.

B. Color(s): as selected by Engineer.

PART 3 EXECUTION

3.01 PREPARATION

A. Take site dimensions affecting this work.

B. Ensure openings affecting this work are properly prepared and that flashings are correctly located to divert moisture to exterior.

3.02 INSTALLATION

A. Install louvers in openings properly aligned and level.

B. Secure louver rigid with concealed fasteners of non-corrosive metals to suit materials as being encountered.

C. Coordinate installation method with application of masonry and mechanical work.

D. Set and tie in to flashings to ensure diversion of moisture to exterior.

E. Install insect screens fixed to exterior. Hinge screens for access.

LOUVER SCHEDULE

ITEM NO.	LOCATION	DWG. NO.	TYPE
L-1	Prime.Clar. Sludge Bldg.	217	Operable
L-2	Trickling Filter Lift Station MCC Room	229	Fixed
L-3	Chlorine Bldg.	265	Operable
L-4	Digester Bldg.	246	Fixed

END OF SECTION

SECTION 10390

MISCELLANEOUS SPECIALTIES

PART 1 GENERAL

1.01 DESCRIPTION

A. Furnish and install miscellaneous specialties at the locations indicated on the Drawings or specified.

B. Provide the following:
1. One flagpole
2. Cast Metal Letters

1.02 SUBMITTALS

A. Shop Drawings shall be submitted in accord with Section 01340.

PART 2 PRODUCTS

2.01 FLAGPOLE

A. Flagpole shall be 6063-T6 extruded aluminum alloy tube. Total length shall be 33 feet (10 m), with 19 feet 6 inches (5.95 mm) straight butt, 6 inches (.152m) O.D., and the remaining length tapered to 3-1/2 (.089 m) inches O.D. Pole shall have a smooth uninterrupted exterior surface throughout and shall be fabricated in one piece.

2.02 CAST METAL LETTERS

A. Cast aluminum letters as indicated on the Drawings shall be cast of certified #5-214 alloy aluminum ingots recommended for anodizing and sound castings. Letters shall be Style No. 301 as manufactured by Spanjer Brothers, Inc. or Style No. 261 as manufactured by Spencer Industries, Inc. Letters shall be flush mounted, 12 inches high, 8 inches average width, width of stroke 1-3/8 inches and 1-1/8 inches deep.

B. Letter faces shall be finished to a fine grain satin finish. Edges shall be filed and ground smooth. Minimum of two coat applications of manufacturer's best clear retardant shall be given to the finished surface.

C. Letters shall be mounted on two aluminum backing strips at top and bottom of the letters. The backing strips shall provide a firm mounting surface for the letters, and will be attached to the exterior face of each building.

D. Signs, as shown on the Drawings, shall be furnished bilingual with equivalent size for both English and Arabic.

ART 3 EXECUTION

.01 INSTALLATION

A. Flagpole shall be installed by anchor bolting to concrete base at the location and as indicated on the Drawings.

B. Aluminum letters shall be installed in accordance with the manufacturer's recommendations for flush mounting on the various buildings as directed by the Owner.

END OF SECTION

SECTION 11000

MECHANICAL EQUIPMENT GENERAL

PART 1 GENERAL

.01 RELATED WORK

A. Divisions 11, 14 and 15: Equipment and System Specifications.

.02 MANUFACTURER'S RESPONSIBILITIES

A. Provide field representative to assist with mechanical checkout of equipment and systems as specified in individual equipment specifications.

B. Check installation for conformance to manufacturer's instructions.

C. Adjust or modify equipment for safe and proper operation.

D. Prepare written approval of installation after completion of mechanical checkout.

E. Prepare equipment test procedure for field performance test.

F. Provide field representative to assist with the performance test of the equipment and systems as specified in individual equipment specifications.

G. Adjust or modify equipment during the performance test as necessary to achieve design performance.

H. Prepare written verification of satisfactory completion of performance test.

.03 OWNER'S RESPONSIBILITIES

A. Make available sufficient sewage to conduct those performance tests requiring sewage. Contractor to provide and pay cost of any process media other than sewage.

B. Pay costs of analytical testing of process media.

.04 PROCESS MEDIA ANALYSIS

A. Process media will be tested by an independent testing agency for conformance to design criteria in Contract Documents.

B. If the process media does not conform to design criteria to the extent that the equipment and system cannot meet the performance criteria, the Engineer may elect one of the following methods to complete the performance test:

1. Modify the process media or obtain a new source until the media does conform to design criteria. Costs for modification or replacement of the media and additional testing to verify conformance to design criteria will be paid by the Owner.
2. Engineer may authorize modification of the performance criteria to a proportional equivalent. Adjustments in the design criteria will be established by the Engineer, and agreed upon in writing by the Owner, Contractor and Manufacturer. The costs of modifications to the equipment or system required by adjusting the design criteria will be paid by the Contractor.

1.05 SYSTEM TEST PROCEDURE

A. Contractor to coordinate the test procedures for all the equipment comprising a particular system.

B. Contractor to prepare procedures to test the full operational and specified performance range of the equipment and the system.

C. Costs of all test procedure preparation, inspections, field service, mechanical start up, process start up and performance test shall be borne by the Contractor and shall be included in the contract cost.

1.06 SUBMITTALS

A. Submit the following in accord with Section 01340:
1. Equipment test procedures for the four phases of testing (reference Paragraph 3.02A).
2. System test procedure and schedule a minimum of two weeks in advance of the performance test.
3. Copies of performance test data and test records.

B. Submit Operating and Maintenance Manual revisions according to Section 01730. Reflect actual operating conditions during the performance test.

C. Submit to Engineer written verification, prepared by equipment manufacturers, of satisfactory completion of the following:
1. Installation and mechanical checkout.
2. Performance test.

PART 2 PRODUCTS

2.01 EQUIPMENT

A. Construct equipment of materials for conditions of exposure and of strengths to withstand stresses occurring during shipping, installation, testing and intended operations.

B. Manufacture parts to tolerances and dimensions shown on Shop Drawings. Make corresponding parts on identical machines interchangeable. Provide clearances for inspection, adjustment and repair of equipment.

C. Exposed surfaces shall be finished in appearance. Grind exposed welds smooth. Round or chamfer corners of structural shapes for personnel protection.

D. Provide miscellaneous parts and materials required for a complete installation.

2.02 GREASE FITTINGS

A. Type: button head, one size for all equipment.

2.03 LUBRICANTS

A. Flushing oil: manufacturer's recommended, not detrimental to lubricating oil.

B. Oil and grease: manufacturer's recommended.

2.04 ANCHOR BOLTS AND BEARING PLATES

A. Manufacturer shall design anchor bolts including size, length of embedment, number and location and shall supply templates, for setting. Contractor shall supply and install anchor bolts required by Equipment Manufacturer.

B. Material: as specified in individual equipment specifications.

C. Manufacturer shall design and supply bearing plate required for equipment.

2.05 GROUT

A. Type: conform to Section 03001,

2.06 TOOLS AND ACCESSORIES

A. Provide special tools and appliances required to adjust, maintain, operate and repair equipment.

B. Label each tool with equipment number for which it is used.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install and set equipment level, plumb, true and in location as shown on Drawings. Conform to manufacturer's intallation instructions unless otherwise specified in equipment sections.

B. Complete equipment installation with controls, safety devices and auxiliary support systems necessary to start the equipment and verify that the equipment operates correctly.

C. Remove temporary bracing and supports.

D. Remove coatings and oils used for protection during shipment and installation if the coatings and oils are detrimental to the equipment operation.

E. Flush and fill lubricated systems in accord with manufacturer's instructions. Provide lubricants for same.

F. Install temporary connections and devices required to fill, operate, checkout and drain the system.

G. Align equipment to manufacturer's tolerances.

H. Drain, flush, and refill lubrication when required in accord with manufacturer's instructions.

3.02 EQUIPMENT START UP PROCEDURE

A. Once the mechanical equipment has been installed, and is complete with all auxiliary and support systems, and is ready for operation, the Contractor shall initiate the start up procedure. The equipment start up procedure shall consist of the following phases and shall be performed in this sequence:
1. Equipment Manufacturer's check out. Phase I
2. Mechanical start up. Phase II
3. Process start up. Phase III
4. Typical performance tests. Phase IV

B. The first three phases will be performed on all mechanical equipment, Phase IV applies only to the mechanical equipment and system for which it is specifically specified.

C. The Contractor shall include the cost for Equipment Manufacturer check out, Mechanical start up, Process start up and Performance tests, including the provision of all chemicals, bypass pumping and other items necessary to complete the start up procedure.

D. Sewage shall not be used for Equipment Manufacturer's checkout or Mechanical start up.

E. The Contractor shall include the cost for all "Non Process Water" (white water) needed for Equipment Manufacturer's check out and Mechanical start up and clean water needed for aeration testing.

F. Non process water (white water) shall be defined as tap water, river water or any other water not contaminated with sewage, septage, or any other detrimental chemical.

G. Unless defined differently in the equipment specification, process media shall be defined as fluid (sewage) to which equipment will be exposed during normal operation conditions.

3.03 EQUIPMENT MANUFACTURER'S CHECKOUT

A. The Contractor shall provide the services of equipment manufacturer's qualified field representative and supporting personnel for the equipment furnished and installed under this Contract, where specified in the equipment specification, to perform the following:
   1. Inspection installation work by the Contractor to determine compliance with equipment erection methods and procedures recommended by the manufacturer.
   2. Advise the Contractor during equipment checkout, mechanical start-up, process start-up and performance testing of the equipment and systems supplied by the equipment manufacturer.
   3. Submit written approval of the equipment installation to the Engineer after satisfactory completion of mechanical start-up of the equipment by the Contractor.
   4. Conduct the process start-up including and providing personnel necessary to operate, adjust, calibrate and tune the equipment and systems into operating service in accordance with the design criteria described in each detailed equipment Specification.
   5. Conduct performance tests, if specified for in Equipment Specification, to demonstrate compliance with design criteria and performance guarantee set forth in the Specifications.

3.04 MECHANICAL START UP

A. Upon completion of the Equipment Manufacturer's check out phase, the Contractor shall mechanically check out the equipment to verify that the equipment functions correctly under "non-process" conditions. The equipment shall be fine-tuned, adjusted, water tested and in general, completely checked out before the equipment and support systems are considered ready for process start up.

B. The Contractor will be responsible for coordinating this effort and providing all support services and facilities necessary for this phase of the Work.

C. The equipment will not be considered ready for Process start up until the Engineer is satisfied that the equipment has been satisfactorily checked out and successfully passed a "non-process" test run.

D. Certificate of Completion required for initiation of the Maintenance Period will not be issued until all equipment has successfully completed this Phase of the equipment start up procedure.

3.05 PROCESS START UP

A. Once all equipment necessary for Plant Operation, including controls and instrumentation has successfully completed mechanical start up and the support systems can deliver the process media, the Contractor shall start up the equipment under process conditions and conduct performance tests to verify compliance with the Specifications.

B. The Contractor shall provide the necessary supervision and technical personnel and services required to perform the work. The Owner shall coordinate this phase of the work with the Contractor and provide all necessary support services and facilities to assist the Contractor in performing the work.

C. The equipment shall be considered ready for a performance test only after the Contractor has demonstrated to the Engineer that the equipment can operate continuously, without mechanical interruption under process flow conditions for up to 5 days, or a such lesser time as may be mutually agreeable to the Engineer and Contractor.
   1. After it has been determined that the equipment will operate satisfactorily under process conditions, the performance test shall be made by the Contractor to verify that the equipment can meet the requirements outlined in the Specification.

3.06 PERFORMANCE TESTS

A. Performance test called for in the individual equipment specified shall be performed by the Contractor no later than the end of the third quarter of the one-year maintenance period.

B. Performance test procedures shall be prepared by the Contractor and the Equipment Manufacturer and shall be approved (in writing) by the Engineer before performance tests are conducted.

C. In the event that the process media does not conform to the design criteria of the Specifications to the extent that the equipment cannot meet the specified requirements, then the Engineer and Contractor may mutually adjust the design criteria to an equivalent basis in order that equipment performance can be evaluated. Any adjustment in the design criteria and equipment performance Specifications will be established by the Engineer and agreed to by the Engineer and Contractor in writing.

D. If the equipment is rejected for failure to meet performance requirements, the Contractor will modify or replace such equipment with other equipment capable of meeting performance at no cost to the Owner.

3.07 PERFORMANCE TEST FAILURE

A. If the system fails to meet the performance criteria, modify or replace defective equipment and system components.

B. Obtain manufacturer's written authorization for modifications to equipment stating that guarantees will not be voided by modifications.

C. Obtain Engineer's written authorization for modifications to the system or equipment before making changes.

D. Conduct another performance test.

E. Modifying or replacing equipment and the system retesting because of performance test failure shall be at no cost to Owner.

F. If the Contractor fails to correct any defects or deviations, or if the replaced equipment, when tested, shall fail to meet the guarantees or specified requirements, the Owner, notwithstanding his having made partial payment for work and materials which have entered into the manufacture of such equipment, may reject that equipment and order the Contractor to remove it from the premises at the Contractor's expense.

3.08 EQUIPMENT REJECTION

A. If the equipment which causes the performance test failure is not corrected or if the system is again tested and fails, Engineer may reject the equipment.

B. Provide use of rejected equipment at no cost to Owner until alternate equipment can be installed. Provide temporary facilities required to maintain correct system operation.

C. Remove rejected equipment.

D. Install replacement equipment according to the equipment specification.

3.09 INSPECTION

A. Submit a certificate of final inspection and approval to Engineer from the "Inspection Authority" having jurisdiction, for equipment where inspection is required by law.

3.10 SYSTEM ACCEPTANCE

A. After successful completion of Phase III and IV of the equipment start up procedure and completion of the Maintenance Period, including inspection and cleaning, the Owner will designate in writing the systems are accepted.

B. Owner will assume responsibility for the systems operation and maintenance after acceptance is executed.

3.11 CLEANING

A. Clean equipment and system components.

B. Touch-up factory applied finishes which are damaged. Use primer and finish coatings identical to factory applied coatings.

3.12 EXTRA STOCK

A. Provide quantities of each type and grade lubricant used for equipment necessary for one year operation of equipment after completion of the one year maintenance period.

B. Upon completion of the one year maintenance period, the Contractor shall supply the following and deliver to the location specified by the Owner.
   1. Chlorine: 30-1 metric ton cylinders including deposit on cylinders.
   2. Polymer: 4 metric tons in 22 kg bags.

END OF SECTION

SECTION 11201

SLUICE GATES, SLIDE GATES AND STOP GATES

PART 1 GENERAL

1.01 RELATED WORK

A. Section 05500: Metal Fabrications

B. Section 11000: Mechanical Equipment General

1.02 DESIGN CRITERIA

A. Conform to the Schedule attached to the end of this Section.

1.03 REFERENCE STANDARDS

A. American Society for Testing and Materials:
1. ASTM A126: Gray Iron Castings for Valves, Flanges and Pipe Fittings
2. ASTM A276: Stainless and Heat-Resisting Steel Bars and Shapes
3. ASTM B21: Naval Brass Rod, Bar and Shapes
4. ASTM B98: Copper-Silicon Alloy Rod, Bar and Shapes
5. ASTM B138: Manganese Bronze Rod, Bar and Shapes
6. ASTM B584: Copper Alloy Sand Castings for General Applications

B. American Water Works Association:
1. AWWA C501: AWWA Standard for Sluice Gates

1.04 SUBMITTALS

A. Submit shop drawings in accord with Section 01340.

PART 2 PRODUCTS

2.01 GENERAL

A. Materials: Manufacturer's standard for service conditions unless specified otherwise.

B. Aluminum: conform to Section 05500.

C. Anchor bolts: Stainless steel

2.02 SLIDE GATES

A. Design gates for throttling or adjustable weir service.

B. Materials: minimum 1/4" thick.

C. Guides: self supporting, extruded aluminum, dual slot design. Primary slot to accept disc plate and secondary

slot wide enough to accept disc reinforcing ribs. Design guides for maximum rigidity with mounting holes maximum 18 inches on center. Extend guides above operating level.

D. Frame invert: An angle welded to lower ends of guides. Form a seating surface for resilient seal mounted on the disc.

E. Yoke to support the operating benchstand: formed by two angles welded to provide a one-piece rigid frame. Arrange yoke so disc and stem may be removed without disconnecting the yoke.

F. The disc or sliding member: aluminum plate, reinforced as required to prevent deflection in excess of 1/360 of the span under maximum head.

G. Resilient seal: specially molded, shaped to produce minimum 3/4 inch vertical seating surface to contact the seating surface of the guide. Mount seal on bottom of disc to provide flush bottom closure.

H. Gate operator: hand-wheel, benchstand mounted on the yoke or side mounted crank on the frame.

I. Bench stand: Fully enclosed equipped with roller bearings above and below operating nut and a mechanical seal around operating nut.

J. Operating stem: Type 304 stainless steel, minimum 1-1/2 inch diameter designed with L/r of less than 200, to withstand at least twice the rated output of the benchstand. Connect stem to the disc by means of cast aluminum stem connector, threaded and bolted to the stem and welded to the disc.

2.03 SLUICE GATES

A. Materials:
1. Iron castings for wall thimble, frame, slide, guides, stem guides and floorstands: ASTM A126, Class B.
2. Bronze castings for wedges, thrust nut, operating nut and couplings: ASTM B584, Alloy No. 865.
3. Bronze for seat facings in frame and disc: ASTM B21, Alloy No. 482 extruded.
4. Bronze for stems: ASTM B138, Alloy No. 675.
5. Stainless steel for stems and fasteners: ASTM A276, Type 304.
6. Bronze for fasteners: ASTM B98, Alloy No. 655.

B. Provide wall thimbles and flat or flanged frames. Thimbles to be metric size as shown on Contract Drawings and metric pipe bells where required.

C. Operating stems: bronze or stainless steel, rising stem type.

D. Floorstand: geared, crank operated, suitable for hand and portable electric crank operation. Gear Housing: weatherproof high strength cast iron pedestal with an internally threaded bronze operating nut to match operating stem threading. Provide tapered roller bearings and mechanical seals around the operating nut and pinion shaft. Design gearing to support loads. Provide lubrication fittings for bearings. Provide plastic operating stem covers mounted on top of the floorstand.

E. Reduction gear cases: machined, equipped with tapered roller or needle bearings and sealed around reduction shafts. Design for maximum crank effort not to exceed 40 lbs.

F. Stem guides: cast iron, bronze bushed, mounted on cast iron brackets, adjustable in two directions and spaced ten feet on center, maximum. Provide stem guides where the distance from the centerline of the gate to the base of the floorstand exceeds ten feet.

G. Slide: cast iron, fully bronze mounted of one-piece frame construction with integrally cast vertical and horizontal ribs. Machine dovetailed grooves on the seating face of slide. Drive bronze seat facings into grooves and machine to a 63 micro-inch finish. Machine a tongue on both sides, extending the full length of the slide, on all sides with a 1/16 inch clearance maintained between the slide tongue and the gate guide groove. Cast wedge pads for side, top, and bottom wedges when required, integrally with the slide and machine to receive wedges.

H. Guides: cast iron, one piece, designed to withstand the total thrust of water pressure and the wedging action. Machine contact surfaces and a groove the length of the guide to allow 1/16 inch clearance between the slide tongue and guide groove. Provide guide length to retain and support at least one-half of slide in the full open position. Attach guides to frame with silicon bronze or stainless steel studs and nuts. Dowell guides to prevent motion between the guides and the frame. Attach bronze wedge seats to machined pads on the guides.

I. Wedges: cast bronze, machined on contact surfaces and keyed to cast iron pads to maintain adjustment by preventing rotation or lateral motion. Attach wedges to slide with silicon bronze studs and nuts and silicon bronze adjusting screws with lock nuts.

J. Position indicator: counter type in enclosure for outdoor installation.

K. Provide two portable electric gate operators suitable for operation on 220 Volt, 50 Hz. Portable to be mounted on tripod.

L. All gates shall meet leak requirements of AWWA C501.

2.04 STOP GATES

A. Stop Plate: recessed bottom, aluminum plate with extruded aluminum guide frame forming a u-slot suitable for casting in concrete or face mounted as shown on Drawings.

B. Stop plate size: determined by manufacturer to suit the channel installation with allowances for depth of frame.

C. Lifting handle: manual type, attached to stop plate.

D. Stop plate reinforcement: to withstand a seating head the full height of stop plate.

PART 3 EXECUTION

3.01 PREPARATION

A. Measure channels and openings to verify dimensions for flush mounted gates and plates.

B. Provide wall thimbles and recessed mounting gates and plates for setting in formwork before placing concrete.

3.02 INSTALLATION

A. Conform to manufacturer's instructions and Section 11000.

B. Install flush mounted gates and plates with anchor bolts and grout frame perimeter solid against channel.

C. Test sluice gates for leakage. Conform to AWWA C501 for allowable leakage. Submit two copies of test reports to Engineer.

3.03 AT-1

Location:	Aeration Tanks
Type:	Sluice Gate
Size, inches:	42"x42"
Frame mounting:	Flat Frame
Seating Head, ft.:	15'
Wall Thimble:	Type F
Operator:	Offset

3.04 AT-2

Location:	Aeration Tanks
Type:	Sluice Gate
Size, inches:	42"x42"
Frame mounting:	Flat Frame
Unseating Head, ft.:	15'
Wall Thimble:	Type F
Operator:	Offset

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3.05 AT-3

Location:	Aeration Tanks
Type:	Sluice Gate
Size, inches:	42"x42"
Frame mounting:	Flat Frame
Seating Head, ft.:	15'
Wall Thimble:	Type F
Operator:	Offset

3.06 AT-4

Location:	Aeration Tanks
Type:	Slide Gate
Size, inches:	40" wide
Frame mounting:	Flush
Seating Head, ft.:	8'
Operator:	Self-contained

3.07 AT-5

Location:	Aeration Tanks
Type:	Slide Gate
Size, inches:	40" wide
Frame mounting:	Flush
Seating Head, ft.:	8'
Operator:	Self-contained

3.08 AT-6

Location:	Aeration Tanks
Type:	Slide Gate
Size, inches:	40" wide
Frame mounting:	Flush
Seating Head, ft.:	8'
Operator:	Self-contained

3.09 AT-7

Location:	Aeration Tanks
Type:	Slide Gate
Size, inches:	40" wide
Frame mounting:	Flush
Seating Head, ft.:	8'
Operator:	Self-contained

3.10 AT-8

Location:	Aeration Tanks
Type:	Sluice Gate
Size, inches:	42"x42"
Frame mounting:	Flat Frame
Unseating Head, ft.:	15'
Wall Thimble:	Type F
Operator:	Offset

3.11 AT-9

Location:	Aeration Tanks
Type:	Sluice Gate
Size, inches:	24"x24"
Frame mounting:	Flat Frame
Seating Head, ft.:	15'
Wall Thimble:	Type F--500 mm diameter pipe
Operator:	Offset

3.12 AT-10

Location:	Aeration Tanks
Type:	Sluice Gate
Size, inches:	24"x24"
Frame mounting:	Flat Frame
Seating Head, ft.:	15'
Wall Thimble:	Type F--500 mm diameter pipe
Operator:	Offset

3.13 PC-1

Location:	Primary Clarifier
Type:	Stop Gate
Size, meters:	.610 w x 1.245 h
Frame mounting:	Recessed
Seating Head, ft.:	3'

3.14 PC-2

Location:	Primary Clarifier
Type:	Stop Gate
Size, meters:	.610 w x 1.245 h
Frame mounting:	Recessed
Seating Head, ft.:	3'

3.15 PC-3

Location:	Primary Clarifier
Type:	Sluice Gate
Size, inches:	20'x20'
Frame mounting:	Flat Frame
Seating Head, ft.:	18'
Wall Thimble:	Type F--500 mm diameter pipe
Operator:	Offset

3.16 TF-1

Location:	Trickling Filter Lift Station
Type:	Sluice Gate
Size, inches:	36"x36"
Frame mounting:	Flat Frame
Seating Head, ft.:	13'
Wall Thimble:	Type F
Operator:	Offset

3.17 TF-2

Location:	Trickling Filter Lift Station
Type:	Sluice Gate
Size, inches:	36"x36"
Frame mounting:	Flat Frame
Seating Head, ft.:	13'
Wall Thimble:	Type F
Operator:	Offset

3.18 TF-3

Location:	Trickling Filter Lift Station
Type:	Sluice Gate
Size, inches:	18"x18"
Frame mounting:	Flat Frame
Seating Head, ft.:	14'
Wall Thimble:	Type F
Operator:	Offset

3.19 TF-4

Location:	Trickling Filter Lift Station
Type:	Sluice Gate
Size, inches:	18"x18"
Frame mounting:	Flat Frame
Seating Head, ft.:	14'
Wall Thimble:	Type F
Operator:	Offset

3.20 CL-1

Location:	Chlorine Contact Tanks
Type:	Sluice Gate
Size, inches:	42"x42"
Frame mounting:	Flat Frame
Seating Head, ft.:	11'
Wall Thimble:	Type F--12"
Operator:	Offset

3.21 CL-2

Location:	Chlorine Contact Tanks
Type:	Sluice Gate
Size, inches:	42"x42"
Frame mounting:	Flat Frame
Seating Head, ft.:	11'
Wall Thimble:	Type F--12"
Operator:	Offset

3.22 CL-3

Location:	Chlorine Contact Tanks
Type:	Sluice Gate
Size, inches:	42"x42"
Frame mounting:	Flat Frame
Seating Head, ft.:	11'
Wall Thimble:	Type F--12"
Operator:	Offset

3.23 CL-4

Location:	Chlorine Contact Tanks
Type:	Sluice Gate
Size, inches:	42"x42"
Frame mounting:	Flat Frame
Seating Head, ft.:	11'
Wall Thimble:	Type F
Operator:	Offset

3.24 CL-5

Location:	Chlorine Contact Tanks
Type:	Sluice Gate
Size, inches:	42"x42"
Frame mounting:	Flat Frame
Seating Head, ft.:	11'
Wall Thimble:	Type F
Operator:	Offset

3.25 HT-1

Location:	Storm Water Holding Tanks
Type:	Sluice Gate
Size, inches:	18"x18"
Frame mounting:	Flat Frame
Seating Head, ft.:	13'
Wall Thimble:	Type F
Operator:	Offset

3.26 HT-2

Location:	Storm Water Holding Tanks
Type:	Sluice Gate
Size, inches:	18"x18"
Frame mounting:	Flat Frame
Seating Head, ft.:	13'
Wall Thimble:	Type F
Operator:	Offset

3.27 IS-1

Location:	Influent Structure
Type:	Stop Gate
Size, meters:	1.22 w x 1.38 h
Frame mounting:	Recessed
Seating Head, ft.:	5'

3.28 IS-2

Location:	Influent Structure
Type:	Stop Gate
Size, meters:	1.22 w x 1.38 h
Frame mounting:	Recessed
Seating Head, ft.:	5'

3.29 IS-3

Location:	Influent Structure
Type:	Stop Gate
Size, meters:	1.22 w x 1.38 h
Frame mounting:	Recessed
Seating Head, ft.:	5'

3.30 IS-4

Location:	Influent Structure
Type:	Stop Gate
Size, meters:	1.22 w x 1.38 h
Frame mounting:	Recessed
Seating Head, ft.:	5'

3.31 IS-5

Location:	Influent Structure
Type:	Stop Gate
Size, meters:	1.22 w x 1.38 h
Frame mounting:	Recessed
Seating Head, ft.:	5'

3.32 IS-6

Location:	Influent Structure
Type:	Stop Gate
Size, meters:	1.22 w x 1.38 h
Frame mounting:	Recessed
Seating Head, ft.:	5'

3.33 IS-7

Location:	Influent Structure
Type:	Slide Gate
Size, inches:	36" wide
Frame mounting:	Recessed
Seating Head, ft.:	5'
Operator:	Self-contained Side Mounted Crank

3.34 IS-8

Location:	Influent Structure
Type:	Slide Gate
Size, inches:	36" wide
Frame mounting:	Recessed
Seating Head, ft.:	5'
Operator:	Self-contained Side Mounted Crank

3.35 IS-10

Location:	Influent Structure
Type:	Sluice
Size, inches:	36" x 36"
Frame mounting:	Flat Frame
Seating Head, ft.:	3'
Wall Thimble::	Type F
Operator:	Offset

3.36 IS-11

Location:	Influent Structure
Type:	Sluice Gate
Size, inches:	24" x 24"
Frame mounting:	Flat Frame Future, not provided this Contract
Seating Head, ft.:	Future, not provided this Contract
Wall Thimble::	Type F
Operator:	Future, not provided this Contract

3.37 IS-12 Future

Location:	Influent Structure
Type:	Sluice Gate
Size, inches:	24 x 24
Frame mounting:	Flat Frame, Future, not provided this Contract
Seating Head, ft.:	Future, not provided this Contract
Wall Thimble:	Type F
Operator:	Future, not provided this Contract

END OF SECTION

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SECTION 11214

VERTICAL TURBINE PUMP

PART 1 GENERAL

1.01 RELATED WORK

A. Section 11000: Mechanical Equipment General

B. Section 16151: Process Motors

1.02 DESIGN DATA

A. Conform to the Schedule at the end of this Section.

B. Pump will be located outdoors and be installed in effluent sump of Chlorine Contact Tank. Pump will supply utility water to the Aeration Basin spray headers.

C. Design pumps for continuous operation at any point over the full operating range.

D. Where a pump operates under two sets of conditions, design and guarantee pump at both sets of conditions.

E. Pumps shall have a decreasing head-capacity characteristic curve between shut-off and maximum capacity.

F. Select pump motors to prevent motors from overloading at any point on pump curve, from shut off head to the full range of the impeller, using the installed impeller.

1.03 SHOP TESTS

A. Test pumps in accord with Hydraulic Institute's procedures at the manufacturer's plant before shipment.

B. Test pumps for rated speeds, head, capacity, efficiency and brake horsepower, and at such conditions of head and capacity to verify the performance curve.

1.04 SUBMITTALS

A. Submit Shop Drawings, pump data and Certificates of shop tests in accord with Section 01340.

B. Provide pump data showing the following:
1. Head
2. RPM
3. Frame
4. Combined weight of pump and motor
5. Impeller diameter
6. Largest spherical solid that can be passed
7. Area of the eye of impeller in square inches
8. Performance curves with operation points clearly marked.

9. Maximum hp motor that could be utilized
10. Largest allowable impeller

C. Submit operation and maintenance manual in accord with Section 01730.

1.05 GUARANTEE

A. Provide manufacturer's guarantee based on specified design conditions.

PART 2 PRODUCTS

2.01 PUMP MATERIALS

A. Materials not specified: manufacturer's standard materials of construction, corrosion resistant to chlorinated water.

B. Machine bolts, nuts and cap screws: hex head type. Do not use hardware or parts requiring special tools or wrenches for maintenance.

2.02 PUMP CONSTRUCTION

A. Design and construct pumps to permit rapid and economical maintenance and to allow as much interchangeability of parts as possible.

B. Unspecified details of design and construction: manufacturer's standard.

2.03 PUMP DISCHARGE HEAD

A. Pump discharge head: cast iron with flanged discharge connections above the supporting floor.

B. Provide two lifting lugs on discharge head, having capacity to support weight of entire pump.

C. Design discharge head to accept and support pump motor.

D. Provide openings for access to the stuffing box and shaft coupling.

E. Head Shaft: stainless steel. Provide head shaft as the top section of the lineshaft where that passes through the stuffing box. Arrange shafting to permit disconnecting of the motor above the stuffing box without disturbing pump discharge head.

F. Base Plate: Fabricated steel to span the opening in the support structure.

G. Provide a tap on the pump discharge to supply seal water to the pump packing.

2.04 STUFFING BOX

A. Stuffing Box: through bore type, aligned on a separate bearing housing.

B. Stuffing box shall contain adjustable split type packing gland, graphited asbestos packing rings and lantern ring.

C. Provide a factory installed seal water connection from pump discharge.

2.05 SHAFTING

A. Lineshaft: open type, maximum section length five feet, connected by threaded couplings.

B. Shaft sleeves: renewable.

C. Shaft bearing: synthetic rubber, provided at each column connection.

2.06 DISCHARGE COLUMN

A. Discharge column: steel pipe epoxy coated inside and outside, maximum section length five feet, with threaded connections.

B. Bolt bearing retainers between ends of the discharge column at connections.

2.07 PUMP BOWLS

A. Pump bowl: flanged and bolted type.

B. Impellers: enclosed type, secured to the shaft with tapered collets.

C. Pump bowls and wear rings: replaceable.

D. Suction bell: cast iron with a basket strainer.

E. Provide sleeve bearing in each bowl, lubricated by the pumped liquid.

PART 3 EXECUTION

3.01 INSTALLATION

A. Conform to manufacturer's instructions and Section 11000.

B. Install pumps.

C. Start pumps in accord with Section 11000.
1. Provide manufacturer's representative to assist with start-up.

D. Train Owner's personnel in accord with Section 01735.
1. Provide minimum 8 hours training time.

3.02 SPARE PARTS

A. Provide the following spare parts for each pump:
1. Five sets of packing.

3.03 UTILITY WATER PUMP PUMP NO. P-04A

A. Operating Conditions:

1. Rated Capacity, gpm:	320
2. Suction Head, feet:	
3. Discharge Head, feet:	
4. Total Dynamic Head, feet:	72
5. Operating Range, gpm:	320-160
6. Maximum Pump Speed, rpm:	
7. Liquid Pumped:	Chlorinated Water
8. NPSH, feet:	
9. Specific Gravity:	1.0
10. Temperature, deg. F.:	
11. pH:	6-8
12. Max. Diam. Spherical Solids, in.:	
13. Length Below Base, feet:	
14. Submergence Required, feet:	
15. Number Required:	One

B. Performance:

1. Proposed Impeller Diam., in.:	
2. Max. Impeller Diam., in.:	
3. Design Efficiency and bhp:	
4. Stages and rpm:	
5. Manufacturer:	
6. Model Number:	
7. Performance Curve Number:	

C. Construction:

	Type	Material
1. Bowl:		
2. Impeller:	Enclosed	
3. Pump Shaft:		
4. Column Bearings:		Synthetic Rubber
5. Casing Wear Ring:		
6. Impeller Wear Ring:		
7. Packing:		Graphite Asbestos
8. Disch Head Bearing:		
9. Frame:		
10. Frame Adapter:		
11. Disch Hd. Brg. Housing:		
12. Base:	Plate	Steel
13. Discharge Head:	Fabricated	C-1
14. Lantern Ring:		
15. Impeller Nut or Screw:		

16. Impeller Key: _____ _____
17. Deflector: _____ _____
18. Coupling: _____ _____
19. Coupling Guard: _____ _____
20. Lubrication: _____ Water
21. Bearing Retainers: _____ _____

D. Motor:
1. Volts/Phase/Hertz: 380/3/50
2. Horsepower: _____

E. Remarks:
1. Pump and motor combination shall be non-overloading over entire pump curve.
2. Pump discharge pressure shall be at Pump Discharge Flange, Pump Manufacturer shall add column Lost and Static Head from water surface elevation to end of Discharge Flange.

END OF SECTION

SECTION 11217

SEAL WATER SYSTEMS

PART 1 GENERAL

1.01 RELATED WORK

A. Section 01735: Equipment System Demonstrations

B. Section 11000: Mechanical Equipment General

C. Section 16151: Process Motors

1.02 DESIGN DATA

A. Design each System to deliver 20 gpm at 50 psi

1.03 SUBMITTALS

A. Submit Shop Drawings in accord with Section 01340.

B. Submit Operation and Maintenance Manuals in accord with Section 01730.

1.04 SYSTEM DESCRIPTION

A. Each system will be used to supply pump seal water for various pumps throughout the Project.

B. Location:
1. ME-400 is located in the Trickling Filter Pump Station.
2. ME-401 is located in the Digester Building.
3. ME-402 is located in the Sludge Transfer Pumping Station.

C. Each System to consist of:
1. Open Storage Tank.
2. Float Valves (2), 1 utility, 1 city water
3. Turbine Pumps (2)
4. By-Pass Piping.
5. Relief Valve.
6. Feedwater Flow and Pressure Control Valves (2 required).
7. Pressure Switch.

PART 2 PRODUCTS

2.01 STORAGE TANK

A. Type: Vertical Open Top.

B. Material: Galvanized Steel.

C. Size: 22 inch diameter x 38.5 inch high.

2.02 FLOAT VALVES

A. Size: 1 inch diameter

B. Float Material: Copper

C. Provide 6 inches air break between bottom of water inlet line and maximum tank water surface.

2.03 PUMPS

A. Type: Turbine

B. Each system consisting of:
1. Two Pumps: One operating and one standby.
2. Motor: Conform to Section 16151.
3. Cast Iron Base With Pump and Motor Mounted.
4. Flexible Coupling between pump and motor shafts.

2.04 SUCTION AND BY-PASS PIPING

A. Material: Steel

B. By-Pass to include relief valve and return from discharge to suction pipe.

2.05 RELIEF VALVE

A. Size: 3/4 inch

2.06 PRESSURE CONTROL VALVES

A. Size: 1 inch

B. Install on tank inlet line.

C. Type: Adjustable, spring operated to reduce line pressure to 40 psi. Range of inlet pressure 40 to 80 psi.

2.07 PRESSURE SWITCH

A. Type: Dry contact to close on low pressure.

B. NEMA 4 Enclosure.

C. Install in pump discharge.

2.08 ASSEMBLY

A. Factory assemble system complete, ready for installation.

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PART 3 EXECUTION

3.01 INSTALLATION

A. Conform to manufacturer's instructions and Section 11000.

B. Install each seal water system.

C. Start each seal water system in accord with Section 11000.
   1. Manufacturer's representative is not required for start-up.

END OF SECTION

SECTION 11218

UTILITY WATER SYSTEM

PART 1 GENERAL

1.01 RELATED WORK

A. Section 11000: Mechanical Equipment General.

B. Section 13445: Instrumentation and Control for Package Systems.

C. Section 16151: Process Motors.

1.02 SYSTEM DESCRIPTION

A. Provide a utility water pumping system to be located outdoors in the chlorine contact tank effluent sump as shown on the Contract Drawings, complete with all required accessories and appurtenances for operation.

B. Provide system capable of automatically providing constant pressure of 77 PSIG at the discharge flange of the system, at a flow rate 0 to 500 GPM with two pumps operating and a minimum suction pressure of 0 PSIG Provide complete pump shutdown during low flow conditions while maintaining constant system pressure with a pressure tank capable of storing a minimum of 30 gallons of usable water and maintaining system pressure.

1.03 QUALITY ASSURANCE

A. Complete system shall be furnished by one manufacturer.

1.04 SUBMITTALS

A. Submit Shop Drawings in accordance with Section 01340.

B. Submit Operation and Maintenance Manuals in accordance with Section 01730.

PART 2 PRODUCTS

2.01 EQUIPMENT

A. The System shall consist of the following:
1. Three constant speed vertical turbine pumps (two operating plus one standy-by). Designations P-04B, P-04C, P-04S.
2. Pump motors.
3. Pressure Tank.
4. Pressure regulating valves.
5. Control System.

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2.02 VERTICAL TURBINE PUMPS

A. Provide three pumps for the system, two operating, and one spare. Designations P-04B, P-04C, P-04S.

B. Type: multi-stage, open line shaft.

C. Material: corrosion resistant to chlorinated water.

D. Discharge Head:
   1. Capable of supporting the weight of complete pump and provide mounting for motor.
   2. Provide above floor level flanged discharge connection.
   3. Provide adequate openings for access to stuffing box and shaft coupling.
   4. Provide seal water piping from discharge elbow to the stuffing box factory installed.
   5. Provide lifting lugs, having capacity to support complete assembly.

E. Bowl Assembly.
   1. Consisting of:
      a. Bowl, flanged type
      b. Wear Ring, Replacable
      c. Impeller, enclosed type, secured to shaft by tapered collets.
      d. Sleeve bearings, lubricated by the pumped liquid.
      e. Suction Bell with basket strainer.

F. Discharge Column
   1. Maximum 5 feet long sections with threaded connections and couplings.
   2. Material: steel, epoxy coated, inside and outside.

G. Shaft Bearings:
   1. Material: synthetic rubber.
   2. Held in place at column connections by the column ends.
   3. Provide bearing at each column connection.

H. Line Shaft
   1. Maximum length per section, 5 feet.
   2. Provide renewable shaft sleeves at column bearing locations.
   3. Provide threaded connections and couplings between sections.

I. Stuffing Box
   1. Type: through bore, aligned on separate bearing housing.
   2. Containing the following:
      a. Split type packing gland.
      b. Minimum 5 rings graphited asbestos packing.
      c. Lantern ring.
   3. Provide seal water connection.

J. Head Shaft.
   1. Material: stainless steel.
   2. Provided as the top section of the line shaft between motor shaft and line shaft, passing through the stuffing box.

K. Base Plate:
   1. Material: steel
   2. Type: Fabricated.
   3. Size: Sufficient to span the opening in the support structure.

2.03 PRESSURE TANK

A. Capacity: 170 gallons.

B. Type: hydrocumulator with replaceable flexible membrane, separating air and water, factory precharged.

C. Designed, stamped and constructed in accordance with ASME code for unfired pressure vessels.

D. Provide base or legs suitable for bolting to concrete foundation.

E. Insulate exterior surfaces and nozzles with 1 inch thick siliceous fiber and cover insulation with 0.016 inch thick weather resistant corrugated aluminum moisture barrier jacket.

2.04 PRESSURE REGULATING VALVES

A. Provide one valve per pump.

2.05 CHECK VALVES

A. Type: Spring loaded, non-slam.

B. Provide one valve per pump.

2.06 INSTRUMENT AND CONTROL SYSTEM

A. The system shall comply with the requirements of Section 13445, except as follows:
   1. The panel shall be NEMA 4 construction.

B. The system shall sense pressure and sequence the pumps via remote starters to maintain pressure and maintain minimum flow to avoid temperature build up.

C. Provide the following minimum field control devices:
   1. Flow switches.
   2. Pressure switches.
   3. Temperature sensors (one per pump).
   4. Bypass valve.

D. Provide post mounted control panel containing but not limited to:

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1. On the front face:
   a. Hand-off-auto selector for each pump.
   b. Alarm/malfunction indicator lights.
   c. Power on indication.
   d. Lead/lag/stand-by selection.
2. Internal:
   a. Fuse protection.
   b. Logic relays
   c. Alarm relays
   d. Temperature/bypass logic.
   e. Field connection terminals.

PART 3 EXECUTION

3.01 INSTALLATION

A. Conform to manufacturer's instructions and Section 11000.

B. Install utility water system.

C. Start pump in accord with Section 11000.
   1. Provide manufacturer's representative to assist with start-up.

D. Train Owner's personnel in accord with Section 01735.
   1. Provide minimum 8 hours training time.

END OF SECTION

SECTION 11234

CHEMICAL DISPENSING SYSTEM (CHLORINE)

PART 1 GENERAL

1.01 RELATED WORK

A. Section 13440: Instrumentation General.

B. Section 13441: Instrumentation Functional Descriptions.

C. Section 13442: Instrumentation Equipment.

D. Section 13444: Instrumentation Installation.

E. Section 15060: Piping Materials .

F. Section 16010: Electrical General

1.02 SYSTEM DESCRIPTION

A. The basic system shall consist of:
1. Chlorine gas withdrawal from scale mounted containers. One ejector withdraws from each chlorinator.

B. Provide cylinder cross over system with alarm contacts for chlorine. Provide block and by-pass valves as required.

C. Provide expansion protection and relief valves as required.

D. Provide CL_2 leak detector(s).

E. Provide mounting blocks for 50 containers in storage.

F. Provide a local panel CP-100 for a local annunciator with pacing flow indication and remote terminations.

G. Conform to Section 13441 for functional control description.

H. Instrumentation components are described in Section 13442.

I. The system is shown schematically on the Drawings with respect to control, equipment and piping arrangements.

J. Provide an alarm system containing all functions shown on the Drawings.

1.03 SUBMITTALS

A. Submit Shop Drawings in accord with Section 01340.

B. Submit Operation and Maintenance Manuals in accord with Section 01730.

C. Submit for approval a complete integrated system drawing indicating all items required for a functional system. Identify all components and equipment being supplied and the extent of pre-piping. Submit for approval a complete integrated wiring schematic and interconnection diagram. Identify all devices with tag numbers and manufacturer item or serial number.

D. Provide data or factory order sheets, and outline drawings of all components.

E. Partial submittals will be rejected unless prior approval for piecemeal submittals has been obtained from the Engineer.

1.04 CONDITIONS

A. The system supplier shall coordinate the chemical system with existing conditions and the instrumentation control system.

B. Conform to the Chlorine Institute Standard.

1.05 SHIPPING

A. Protect, crate, and ship equipment and sub-assemblies to the Project site as a complete system.

PART 2 PRODUCTS

2.01 SUBSTITUTIONS

A. Substitutions: Items and methods of same function and performance are acceptable in conformance with Section 01630.

B. Engineer's acceptance of substitutes does not relieve the system supplier of responsibility for providing an operating system.

2.02 GENERAL

A. Provide equipment of the latest proven design.

B. Annunciator, analyzer, leak detector, controllers and other Instrumentation are specified in Section 13442.

C. Coordinate controls for project uniformity.

2.03 VACUUM REGULATOR

A. Regulator: suitable for mounting as indicated on the data sheet, equipped with a vacuum gage.

B. For non cylinder mounted regulators, provide a 220V heated trap as an integral part of the regulator to protect the unit from liquid chlorine.

2.04 AUTOMATIC CHANGEOVER (VACUUM WITHDRAWAL)

A. Valve system: vacuum changeover from an exhausted to a full chemical source.

B. Provide positive shut off for the exhausted source which does not require resetting after the exhausted source is replaced.

C. Equip the system with switches which activate when a chemical source is empty. The switches shall have dry contact for remote annunciation.

D. Provide wall mounting brackets for valve control system.

2.05 DISPENSER (CHLORINATOR)

A. Dispenser: vacuum operated differential flow type.

B. The control valve actuator shall be controlled by two 4-20 madc signals.
   1. Primary signal will be from a flow element and the secondary signal (trim) from a residual control system. (Trim is future)
   2. Basic control power: 220V AC. 50 Hz

C. Control valve: manually adjustable on loss of power with 20:1 control range, and ±4 percent accuracy.

D. Provide a vacuum indicator and a flow rate indicator calibrated in Metric units visible from the front of the dispenser.

E. Provide excess vacuum and vacuum loss switches to activate remote alarms.

F. Dispenser housing: free standing polyester impregnated fiberglass corrosive resistant enclosure.

2.06 EXPANSION SYSTEM (IF REQUIRED)

A. Rupture disc: pre-formed Monel, rupture pressure of 2700 kPa, with a 4000 kPa rated bolted flanged support housing.

B. Expansion tank: minimum capacity equal to 30 percent of the volume of the pipe system being protected, 2700 kPa rating.

C. Pressure switch: diaphragm seal protected, 7-1400 kPa operating range initially set at 15 kPa, 5 amp 117 volt 50 Hz rated contact. Contacts shall open on a rise in pressure.

2.07 EJECTOR ASSEMBLY

A. The ejector assembly shall consist of:
   1. Variable orifice type ejector with back flow preventor on the gas line

2. Water pressure gage
3. Vacuum gage
4. Water strainer
5. Water flow indicator
6. Water pressure regulator.

B. The operating conditions are specified on the system application data and shown on the Drawings.

2.08 DIFFUSERS

A. Conform to the system application data and the Drawings.

2.09 MANIFOLD AND HOSES

A. Provide chlorine container pipe manifold, valves and flexible hoses in the arrangement shown on the Drawings. The Contractor shall fabricate and install manifold support from vendor drawings.

2.10 SCALES

A. Provide four separate above-the-floor dual-cylinder-type scales.

B. Ton container scales: roller cradle type with adjustable zero load cells which read out on a wall mounted dial. Provide scales with empty alarm contacts.

2.11 FACTORY ASSEMBLY

A. Pre-assemble cabinets.
1. Install and factory test piping.
2. Arrange for field connections via bulkhead fittings, couplings, or flanges at the shell of the cabinet.
3. Label each connection with phenolic or metal wired on tag. (e.g. "GAS IN", "WATER IN", "DRAIN").

B. When more than two electrical devices are mounted in a cabinet, wire devices to a terminal block, properly enclosed, with terminal identification corresponding to the shop drawings for connection to field devices or power.

C. When cabinets are mounted adjacent to one another, pre-wire interconnection wiring.

D. Pre-assemble field equipment in sub-assemblies hand tight to permit disassembly and reassembly in its final location. Tag the sub-assembly to identify where final assembly is required.

2.12 TON CYLINDER LIFT BEAM

A. Lifting beam: beam with lifting eye and end hooks specifically designed to handle ton cylinders with a minimum shock load capacity of 150% normal load.

2.13 CRADLE BLOCKS

A. Blocks: treated hardwood, pre-drilled for anchor bolts.

B. Provide block system consisting of four end blocks and pairs of center blocks equal in number to the number of containers being supplied or as shown on the Drawings. Arrange center blocks to provide a minimum of 3 inch clearance between containers.

2.14 SAFETY EQUIPMENT

A. Provide OSHA or NIOSH approved emergency breathing apparatus manufactured by Mine Safety Appliances, Scott, or equal, consisting of:
1. Oxygen type system with suitable mask for chlorine service
2. One extra oxygen tank and harness

B. Oxygen tanks: 30 minutes capacity.

C. House the apparatus in a weatherproof enclosure with a windowed access door equipped with a seal to detect entry.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accord with the Chlorine Institute standards and practices and system supplier's instructions.

B. The supplier shall coordinate his system with the installation and make any and all field inspections required to certify that the system is properly installed.

C. The supplier shall provide the service of a factory trained, qualified technician and/or engineer to final inspect, calibrate and commission the entire system in accord with Section 13444.

D. The supplier shall submit to the Engineer a start-up report including all start-up calibration data. The data shall include flow rates, pressure, control settings and calibrations.

3.02 CHEMICAL DISPENSING SYSTEM APPLICATION DATA

A. Conform to the following system application requirements.

B. CHLORINE APPLICATION SYSTEM

1. Application
   a. Wastewater and Septage Chlorination
2. Flow Rates
   a. Process cu m/day: 106,430 Peak + Septage Odor Control
   b. CL_2 kg/h: 17 + (38.5 kg/h for septage)
3. Ejector
   a. Number required: 3
   b. Location: Remote
   c. Water Pressure Avail: 310 kPa
   d. Solution Line Size: 50 mm
   e. Back Pressure: 100 kPa @ 290 l/m
   f. Booster Pump Required: No
4. Diffuser
   a. Refer to Contract Drawings.
5. Chemical Supply
   a. Ton Cylinders with Scales w/alarm contacts and 2 cylinders each side per system.
6. Expansion Chambers
   a. Number Required: as required by Manufacturer.
7. Rupture Disc
   a. Number Required: as required by Manufacturer.
8. Dispensers
   a. Number Required: 3
   b. Size kg/h: 40
   c. Control Valve: manufacturer's standard
   d. Chemical Flow Transmitter: Not required
9. Vacuum Regulator
   a. Mounting: Wall
10. Accessories:
   a. Emergency Breathing Apparatus
   b. Lifting beam
   c. Storage Blocks
   d. Two Leak Detectors

END OF SECTION

SECTION 11312

CENTRIFUGAL PUMPS

PART 1 GENERAL

1.01 RELATED WORK

A. Section 01735: Equipment System Demonstrations

B. Section 11000: Mechanical Equipment General

C. Section 16151: Process Motors

1.02 DESIGN DATA

A. Conform to the Schedule at the end of this Section.

B. Design pumps for continuous operation at any point over the full operating range.

C. Where a pump operates under two sets of conditions, design and guarantee pump at both sets of conditions.

D. Pumps shall have a decreasing head-capacity characteristic curve between shut-off and maximum capacity.

E. Select pump motors to prevent motors from overloading at any point on pump curve, from shut off head to the full range of the impeller, using the installed impeller.

1.03 SHOP TESTS

A. Shop test all centrifugal pumps except sump pumps.

B. Test pumps in accord with Hydraulic Institute's Standards at the manufacturer's plant before shipment.

C. Test pumps for rated speed, head, capacity, efficiency, brake horsepower, and cavitation at such conditions of head and capacity to verify the performance curve.

D. If more than one pump is specified for the same application, test only one pump.

E. Test must be run on pump that is being supplied for this project. Testing of a prototype pump is not acceptable.

F. Pump must be tested at the speed which will be required for actual operation in the field.

1.04 REFERENCE STANDARDS

A. American Petroleum Institute (API)
1. Standard 610: Centrifugal Pumps for General Refinery Service.

1.05 SUBMITTALS

A. Submit Shop Drawings, pump data and Certificates of shop tests in accord with Section 01340.

B. Provide pump data showing the following:
1. Head
2. RPM
3. Frame
4. Combined weight of pump and motor
5. Impeller diameter
6. Largest spherical solid that can be passed
7. Area of the eye of impeller in square inches
8. Performance curves with operation points clearly marked.
9. Maximum hp motor that could be utilized
10. Largest allowable impeller

C. Submit operation and maintenance manual in accord with Section 01730.

1.06 GUARANTEE

A. Provide manufacturer's guarantee based on specified design conditions.

PART 2 PRODUCTS

2.01 PUMP MATERIALS

A. Materials not specified: manufacturer's standard materials of construction for liquid being pumped.

B. Machine bolts, nuts and cap screws: hex head type. Do not use hardware or parts requiring special tools or wrenches for maintenance.

2.02 PUMP CONSTRUCTION

A. Design and construct pumps to permit rapid and economical maintenance and to allow as much interchangeability of parts as possible.

B. Unspecified details of design and construction: manufacturer's standard.

2.03 CASING

A. Design pressure: 1-1/2 times the shut-off condition for the maximum diameter impeller.

B. Mark direction of impeller rotation on the casing.

2.04 SHAFTS

A. Design shafts to transmit full driver horsepower required by the maximum diameter impeller with which the pump can

be fitted when pumping the fluid with the specific gravity shown on Data Sheet, or water, whichever is heavier.

B. Shaft seal: conventional packing as specified on Pump Data Sheet.

2.05 BEARINGS

A. Type: Anti-friction in accord with AFBMA standards.

B. Rated life: L_{10}, 100,000 hour.

2.06 IMPELLER

A. Type and design: as designated by the Hydraulic Institute for specified speeds capable of passing solids specified in Schedule.

B. Impeller finish: machined outside surface and smoothly finished on faces in contact with the pumped fluid.

C. Provide external impeller adjustment.

D. Impeller to be designed to handle solids as specified on pump schedule.

2.07 STUFFING BOXES

A. Type: integral with the pump casing and equipped with lantern rings.

B. Provide screwed inlet and outlet connections for seal water. Arrange connections to be accessible for installation, maintenance, and routing of piping.

C. Throat bushings: locked in place, renewable.

D. Design stuffing box to permit use of mechanical seals or packing without re-machining.

2.08 GLANDS

A. Type: split, designed for use with bolts.

B. Gland fasteners: studs screwed into pump casing or bolts.

C. Provide space for adjustment or replacement of packing without removing or dismantling any part other than the gland.

2.09 PACKING

A. Type: graphite impregnated asbestos installed by the pump manufacturer.

B. Provide a minimum of five rings of packing.

2.10 COUPLING

A. Type: flexible, provided by pump manufacturer for connection of pump and motor shafts.

B. Bore, key-seat, and match-mark both ends of coupling. Mount on the pump prior to shipment. Shrink fits are not permitted.

C. Provide minimum service factor recommended by manufacturer for specified service.

2.11 BASE

A. Design base to support the assembled weight of the pump, and motor and withstand operating stresses.

B. Vertical Dry Pit Pumps: Heavy duty base, bolted directly to the volute with integrally cast lateral members to maintain rigidity of the legs. Provide suction elbow with cleanout port bolted directly to a common casing/base flange.

C. Horizontal Pump: Provide base with drain rim. Support pump and motor with mounting fixtures along the periphery of the pump casing.

2.12 SELF PRIMING PUMPS

A. All openings, internal passages, and internal recirculation ports shall be large enough to permit the passage of a sphere 3 inches in diameter. Screens or any internal devices that create a maintenance nuisance or interfere with priming and performance of the pump shall not be permitted.

B. Pump must be capable of a reprime lift of 10 feet at the selected speed and impeller diameter. Reprime lift is defined as the static height of pump suction centerline above liquid that pump will prime; and delivery within three minutes on liquid remaining in the pump casing after a delivering pump is shut down with the suction check valve removed. Certified reprime performance test data, prepared by the pump manufacturer, shall be submitted ot the Engineer prior to shipment.

C. Each pump shall be equipped with one automatic, non clog, air release valve, designed to permit the escape of air to the atmosphere during initial priming or unattended repriming cycles. Upon completion of the priming or repriming cycle, the valve shall close to prevent recirculation. Valves shall provide visible indication of valve closure, and shall operate solely on discharge pressure. Valves which require connection to the suction line shall not be acceptable.
   1. All valve parts exposed to sewage shall be constructed of cast iron, stainless steel, or similar corrosion

resistant materials. Diaphragms, if used, shall be of fabric-reinforced neoprene or similar inert material.
2. A cleanout port, 3 inches or larger in diameter, located on the front of the casing, shall be provided for ease of inspection cleanout, and service.
3. Valves shall be field adjustable for varying discharge heads.

2.13 MOTOR

A. Conform to Section 16151.

2.14 BALANCING

A. The entire rotating assembly (impeller and shaft) shall be statically and dynamically balanced such that undue vibration or other unsatisfactory characteristics will not result when the pump is in operation.

PART 3 EXECUTION

3.01 INSTALLATION

A. Conform to manufacturer's instructions and Section 11000.

B. Install all pumps.

C. Start pump in accord with Section 11000.
1. Provide manufacturer's representative to assist with start-up.

D. Train Owner's personnel in accord with Section 01735.
1. Provide minimum 40 hours training time total for all centrifugal pumps under this specification.

3.02 SPARE PARTS

A. Provide the following spare parts for each pump:
1. One spare impeller.
2. One set of bearings and seals.
3. Three sets of packing gland and parts, if specified.
4. Three sets of mechanical seals, if specified.

3.03 SEPTAGE TRANSFER PUMPS PUMP NO. P-01A&B

A. Operating Conditions:

1. Rated Capacity, gpm:	125
2. Suction Head, feet:	-9.00 (Lift)
3. Discharge Head, feet:	
4. Total Dynamic Head, feet:	30 maximum
5. Operating Range, gpm:	
6. Maximum Pump Speed, rpm:	
7. Liquid Pumped:	Septage
8. NPSH, feet availability:	16.3
9. Specific Gravity:	1.0+
10. Temperature, deg. F.:	
11. pH:	
12. Min. Diam. Spherical Solids, in.:	2.5
13. Length Below Base, feet:	
14. Submergence Required, feet:	
15. Number of Pumps Required:	Two

B. Performance:

1. Proposed Impeller Diam., in.:	
2. Max. Impeller Diam., in.:	
3. Design Efficiency and bhp:	
4. Stages and rpm:	
5. Manufacturer:	Gorman-Rupp
6. Model Number:	
7. Performance Curve Number:	

C. Construction:

	Type	Material
1. Casing:		C-I
2. Impeller:	Non Clog	C-I
3. Pump Shaft:		Steel
4. Suction Cover:	Removable	C-I
5. Casing Wear Ring:		
6. Impeller Wear Ring:		
7. Packing:		
8. Outboard Bearing:		
9. Frame:		
10. Frame Adapter:		
11. Bearing Housing:		C-I
12. Base:		Steel
13. Lantern Ring:		
14. Impeller Nut or Screw:		
15. Impeller Key:		
16. Deflector:		
17. Coupling:		
18. Belt Guard:		Steel
19. Seal, Mechanical:	Double	Mfgr's Standard
20. Lubrication:		Grease

D. Motor:

1. Volts/Phase/Hertz:	380/3/50
2. Horsepower:	

E. Remarks:

1. Pump self-priming and belt drive, mounted on common base.

3.04 DILUTION PUMP PUMP NO. P-03

A. Operating Conditions:

1.	Rated Capacity, gpm:	800
2.	Suction Head, feet:	-11.9 Suction Lift
3.	Discharge Head, feet:	
4.	Total Dynamic Head, feet:	30
5.	Operating Range, gpm:	
6.	Maximum Pump Speed, rpm:	
7.	Liquid Pumped:	Sewage
8.	NPSH, feet availability:	13
9.	Specific Gravity:	
10.	Temperature, deg. F.:	
11.	pH:	
12.	Min. Diam. Spherical Solids, in.:	2-1/2
13.	Length Below Base, feet:	
14.	Submergence Required, feet:	
15.	Number of Pumps:	One

B. Performance:

1.	Proposed Impeller Diam., in.:	
2.	Max. Impeller Diam., in.:	
3.	Design Efficiency and bhp:	
4.	Stages and rpm:	
5.	Manufacturer:	Gorman-Rupp
6.	Model Number:	
7.	Performance Curve Number:	

C. Construction:

		Type	Material
1.	Casing:		C.I.
2.	Impeller:	Non Clog	C.I.
3.	Pump Shaft:		Steel
4.	Suction Cover:	Removable	C.I.
5.	Casing Wear Ring:		
6.	Impeller Wear Ring:		
7.	Packing:		
8.	Outboard Bearing:		
9.	Frame:		
10.	Frame Adapter:		
11.	Bearing Housing:		C.I.
12.	Base:		Steel
13.	Lantern Ring:		
14.	Impeller Nut or Screw:		
15.	Impeller Key:		
16.	Deflector:		
17.	Coupling:		
18.	Belt Guard:		Steel
19.	Seal, Mechanical:	Double	Manufacturer's Standard
20.	Lubrication:		Grease

D. Motor:

1.	Volts/Phase/Hertz:	380/3/50
2.	Horsepower:	

E. Remarks:
   1. Pump to be belt drive, mounted on common base.
   2. Pump to be self priming.

3.05 TRICKLING FILTER LIFT PUMPS PUMP NO. P-100 A,B,C,D & S

A. Operating Conditions:

1. Rated Capacity, gpm:	See Remark #1
2. Suction Head, feet:	
3. Discharge Head, feet:	
4. Total Dynamic Head, feet:	See Remark #1
5. Operating Range, gpm:	See Remark #1
6. Maximum Pump Speed, rpm:	
7. Liquid Pumped:	Wastewater
8. NPSH, feet available:	27 at max. flow
9. Specific Gravity:	1.0+
10. Temperature, deg. F.:	Ambient
11. pH:	6-8
12. Min. Diam. Spherical Solids, in.:	3
13. Length Below Base, feet:	
14. Submergence Required, feet:	
15. Number of Pumps Required:	Five

B. Performance:

1. Proposed Impeller Diam., in.:	
2. Max. Impeller Diam., in.:	
3. Design Efficiency and bhp:	
4. Stages and rpm:	
5. Manufacturer:	
6. Model Number:	
7. Performance Curve Number:	

C. Construction:

	Type	Material
1. Casing:		C.I.
2. Impeller:	Non Clog	C.I.
3. Pump Shaft:	Vertical	Steel
4. Suction Cover:		
5. Casing Wear Ring:		Chrome Steel
6. Impeller Wear Ring:		Chrome Steel
7. Packing:	Water Lub.	Graphited Asbestos
8. Outboard Bearing:		
9. Frame:		
10. Frame Adapter:		
11. Bearing Housing:		C.I.
12. Base:		C.I.
13. Lantern Ring:		
14. Impeller Nut or Screw:		
15. Impeller Key:		
16. Deflector:		
17. Coupling:	Flexibility	Manufacturer's Standard
18. Coupling Guard:		Manufacturer's Standard
19. Seal, Mechanical:	N/A	N/A
20. Lubrication:		Grease

D. Motor:

1. Volts/Phase/Hertz:	380/3/50
2. Horsepower:	

E. Remarks:

1. The Trickling Filter Pumps System shall consist of five pumps divided into two separate systems of two pumps each with a common spare. Each system can operate independently of the other, but shall have the same operating range.
2. Each pump shall be driven by a two-speed motor.
3. Operating range of one system (two pumps).
   a. One pump running at low speed to produce 500 gpm at 48'.
   b. Two pumps running at low speed to produce a total flow of 900 gpm at 50'.
   c. One pump running at high speed to produce a flow of 1600 gpm at 55' pump will be throttled.
   d. Two pumps running at high speed to produce a total flow of 3200 gpm at 59' pump will be throttled.

3.06 TRICKLING FILTER RECYCLE PUMPS PUMP NO. P-101 A, B & S

A. Operating Conditions:

1. Rated Capacity, gpm:	2300
2. Suction Head, feet:	
3. Discharge Head, feet:	
4. Total Dynamic Head, feet:	55
5. Operating Range, gpm:	
6. Maximum Pump Speed, rpm:	1458
7. Liquid Pumped:	Sewage
8. NPSH, feet available:	
9. Specific Gravity:	1.0+
10. Temperature, deg. F.:	Ambient
11. pH:	6-8
12. Min. Diam. Spherical Solids, in.:	3"
13. Length Below Base, feet:	
14. Submergence Required, feet:	
15. Number of Pumps Required:	Three

B. Performance:

1. Proposed Impeller Diam., in.:	
2. Max. Impeller Diam., in.:	
3. Design Efficiency and bhp:	
4. Stages and rpm:	
5. Manufacturer:	
6. Model Number:	
7. Performance Curve Number:	

C. Construction:

	Type	Material
1. Casing:		C.I.
2. Impeller:	Non Clog	C.I.
3. Pump Shaft:	Vertical	Steel
4. Suction Cover:		
5. Casing Wear Ring:		Chrome Steel
6. Impeller Wear Ring:		Chrome Steel
7. Packing:	Water Lub.	Graphited Asbestos
8. Outboard Bearing:		
9. Frame:		
10. Frame Adapter:		
11. Bearing Housing:		C.I.
12. Base:		C.I.
13. Lantern Ring:		
14. Impeller Nut or Screw:		
15. Impeller Key:		
16. Deflector:		
17. Coupling:	Flexibility	Manufacturer's Standard
18. Coupling Guard:		Manufacturer's Standard
19. Seal, Mechanical:	N/A	N/A
20. Lubrication:		Grease

D. Motor:

1. Volts/Phase/Hertz:	380/3/50
2. Horsepower:	

3.07 SLUDGE WASTING PUMP PUMP NO. P-103 A & S

A. Operating Conditions:

1.	Rated Capacity, gpm:	300
2.	Suction Head, feet:	
3.	Discharge Head, feet:	
4.	Total Dynamic Head, feet:	23
5.	Operating Range, gpm:	
6.	Maximum Pump Speed, rpm:	
7.	Liquid Pumped:	Secondary Sludge
8.	NPSH, feet:	
9.	Specific Gravity:	1.0+
10.	Temperature, deg. F.:	Ambient
11.	pH:	6-8
12.	Min. Diam. Spherical Solids, in.:	2-1/2
13.	Length Below Base, feet:	
14.	Submergence Required, feet:	
15.	Number of Pumps Required:	Two

B. Performance:

1.	Proposed Impeller Diam., in.:	
2.	Max. Impeller Diam., in.:	
3.	Design Efficiency and bhp:	
4.	Stages and rpm:	
5.	Manufacturer:	
6.	Model Number:	
7.	Performance Curve Number:	

C. Construction:

		Type	Material
1.	Casing:		C.I.
2.	Impeller:	Non Clog	C.I.
3.	Pump Shaft:	Vertical	Steel
4.	Suction Cover:		
5.	Casing Wear Ring:		Chrome Steel
6.	Impeller Wear Ring:		Chrome Steel
7.	Packing:	Water Lub.	Graphited Asbestos
8.	Outboard Bearing:		
9.	Frame:		
10.	Frame Adapter:		
11.	Bearing Housing:		C.I.
12.	Base:		
13.	Lantern Ring:		
14.	Impeller Nut or Screw:		
15.	Impeller Key:		
16.	Deflector:		
17.	Coupling:	Flexible	Mfgr's Standard
18.	Coupling Guard:		Mfgr's Standard
19.	Seal, Mechanical:	N/A	N/A
20.	Lubrication:		

D. Motor:

1.	Volts/Phase/Hertz:	380/3/50
2.	Horsepower:	

3.08 SLUDGE RECYCLE PUMPS PUMP NO. P-102 A, B, C, D & S

A. Operating Conditions:

1.	Rated Capacity, gpm:	See Remark #1
2.	Suction Head, feet:	
3.	Discharge Head, feet:	See Remark #1
4.	Total Dynamic Head, feet:	
5.	Operating Range, gpm:	
6.	Maximum Pump Speed, rpm:	
7.	Liquid Pumped:	Secondary Sludge
8.	NPSH, feet:	
9.	Specific Gravity:	1.0+
10.	Temperature, deg. F.:	Ambient
11.	pH:	6-8
12.	Min. Diam. Spherical Solids, in.:	3"
13.	Length Below Base, feet:	
14.	Submergence Required, feet:	
15.	Number of Pumps Required:	Five

B. Performance:

1.	Proposed Impeller Diam., in.:	
2.	Max. Impeller Diam., in.:	
3.	Design Efficiency and bhp:	
4.	Stages and rpm:	
5.	Manufacturer:	
6.	Model Number:	
7.	Performance Curve Number:	

C. Construction:

		Type	Material
1.	Casing:		C.I.
2.	Impeller:	Non Clog	C.I.
3.	Pump Shaft:	Vertical	Steel
4.	Suction Cover:		
5.	Casing Wear Ring:		Chrome Steel
6.	Impeller Wear Ring:		Chrome Steel
7.	Packing:	Water Lub.	Graphited Asbestos
8.	Outboard Bearing:		
9.	Frame:		
10.	Frame Adapter:		
11.	Bearing Housing:		C.I.
12.	Base:		
13.	Lantern Ring:		
14.	Impeller Nut or Screw:		
15.	Impeller Key:		
16.	Deflector:		
17.	Coupling:	Flexibility	Mfgr's Standard
18.	Coupling Guard:		Mfgr's Standard
19.	Seal, Mechanical:	N/A	N/A
20.	Lubrication:		

D. Motor:

1.	Volts/Phase/Hertz:	380/3/50
2.	Pumps will be taking suction from air mixed wet well.	

E. Remarks:

1. Sludge Recycle Pumping System shall consist of five pumps divided into two separate systems of two pumps each with a common spare. Each system shall operate independently of the other, but shall have the same range.
2. Each pump shall be driven by a two speed motor.
3. Operating range of one system (one or two pumps). The two speed drives and a control valve will be used to provide the necessary flows:
   a. 1st Pump at Low Speed 400 gpm to 800 gpm. 400 gpm at 14 feet - Throttle Pump 850 gpm at 26 feet - Pump unthrottled
   b. 1st Pump at high speed 900 gpm to 1250 gpm. 900 gpm at 28 feet - Throttle Pump 1250 gpm at 44 feet - Pump unthrottled.
   c. Two pumps at high speed 1400 gpm to 1850 gpm 1400 gpm at 35 feet - Pumps throttle 1850 gpm at 52 feet - Pumps unthrottled.

3.09 PLANT DRAIN PUMPS PUMP NO. P-02 A&B

A. Operating Conditions:

1. Rated Capacity, gpm:	1000
2. Suction Head, feet:	Flooded
3. Discharge Head, feet:	
4. Total Dynamic Head, feet:	76
5. Operating Range, gpm:	
6. Maximum Pump Speed, rpm:	1458
7. Liquid Pumped:	Sewage
8. NPSH, feet availability:	28
9. Specific Gravity:	1.0+
10. Temperature, deg. F.:	
11. pH:	6-8
12. Min. Diam. Spherical Solids, in.:	3
13. Length Below Base, feet:	
14. Submergence Required, feet:	
15. Number of Pumps Required:	Two

B. Performance:

1. Proposed Impeller Diam., in.:	
2. Max. Impeller Diam., in.:	
3. Design Efficiency and bhp:	
4. Stages and rpm:	
5. Manufacturer:	
6. Model Number:	
7. Performance Curve Number:	

C. Construction:

	Type	Material
1. Casing:	Vertical	C.I.
2. Impeller:	Non Clog	C.I.
3. Pump Shaft:	Vertical	Steel
4. Suction Cover:		
5. Casing Wear Ring:		
6. Impeller Wear Ring:		
7. Packing:	Water Lub.	Graphited Asbestos
8. Outboard Bearing:		
9. Frame:		
10. Frame Adapter:		
11. Bearing Housing:		C.I.
12. Base:		C.I.
13. Lantern Ring:		
14. Impeller Nut or Screw:		
15. Impeller Key:		Steel
16. Deflector:		
17. Coupling:	Flexibility	Mfgr's Standard
18. Coupling Guard:		Mfgr's Standard
19. Seal, Mechanical:	N/A	N/A
20. Lubrication:		Grease

D. Motor:

1. Volts/Phase/Hertz:	380/3/50
2. Horsepower:	

E. Remarks:
1. Pumps will take suction from air mixed wet well.

3.10 PLANT DRAIN PUMPS PUMP NO. P-02C

A. Operating Conditions:

1.	Rated Capacity, gpm:	500
2.	Suction Head, feet:	Flooded
3.	Discharge Head, feet:	
4.	Total Dynamic Head, feet:	56
5.	Operating Range, gpm:	
6.	Maximum Pump Speed, rpm:	1458
7.	Liquid Pumped:	Raw Sewage
8.	NPSH, feet availability:	27
9.	Specific Gravity:	1.0+
10.	Temperature, deg. F.:	Ambient
11.	pH:	6-8
12.	Min. Diam. Spherical Solids, in.:	2-1/2"
13.	Length Below Base, feet:	
14.	Submergence Required, feet:	
15.	Number of Pumps Required:	One

B. Performance:

1.	Proposed Impeller Diam., in.:	
2.	Max. Impeller Diam., in.:	
3.	Design Efficiency and bhp:	
4.	Stages and rpm:	
5.	Manufacturer:	
6.	Model Number:	
7.	Performance Curve Number:	

C. Construction:

		Type	Material
1.	Casing:	Vertical	C.I.
2.	Impeller:	Non Clog	C.I.
3.	Pump Shaft:	Vertical	Steel
4.	Suction Cover:		
5.	Casing Wear Ring:		
6.	Impeller Wear Ring:		
7.	Packing:	Water Lub.	Graphited Asbestos
8.	Outboard Bearing:		
9.	Frame:		
10.	Frame Adapter:		
11.	Bearing Housing:		C.I.
12.	Base:		C.I.
13.	Lantern Ring:		
14.	Impeller Nut or Screw:		
15.	Impeller Key:		Steel
16.	Deflector:		
17.	Coupling:	Flexible	Mfgr's Standard
18.	Coupling Guard:		Mfgr's Standard
19.	Seal, Mechanical:	N/A	N/A
20.	Lubrication:		Grease

D. Motor:

1.	Volts/Phase/Hertz:	380/3/50
2.	Horsepower	

E. Remarks:

1. Pumps will take suction from air mixed wet well.

3.11 SECONDARY SCUM PUMP PUMP NO. P-104 A&B

A. Operating Conditions:

1. Rated Capacity, gpm:	150
2. Suction Head, feet:	
3. Discharge Head, feet:	
4. Total Dynamic Head, feet:	37
5. Operating Range, gpm:	
6. Maximum Pump Speed, rpm:	
7. Liquid Pumped:	Scum
8. NPSH, feet:	
9. Specific Gravity:	1.0+
10. Temperature, deg. F.:	Ambient
11. pH:	6-8
12. Min. Diam. Spherical Solids, in.:	2-1/2
13. Length Below Base, feet:	
14. Submergence Required, feet:	
15. Number of Pumps Required:	Two

B. Performance:

1. Proposed Impeller Diam., in.:	
2. Max. Impeller Diam., in.:	
3. Design Efficiency and bhp:	
4. Stages and rpm:	
5. Manufacturer:	
6. Model Number:	
7. Performance Curve Number:	

C. Construction:

	Type	Material
1. Casing:	Submersible	C.I.
2. Impeller:		C.I.
3. Pump Shaft:		Steel
4. Suction Cover:		
5. Casing Wear Ring:		
6. Impeller Wear Ring:		
7. Packing:		
8. Outboard Bearing:		
9. Frame:		
10. Frame Adapter:		
11. Bearing Housing:		
12. Base:		
13. Lantern Ring:		
14. Impeller Nut or Screw:		
15. Impeller Key:		
16. Deflector:		
17. Coupling:		
18. Coupling Guard:		
19. Seal, Mechanical:		
20. Lubrication:		

D. Motor:

1. Volts/Phase/Hertz:	380/3/50
2. Horsepower:	

E. Remarks:

1. Pump to be a submersible non clog type with pump manufacturer supplying guide rails for raising and

lowering pump plus 30 feet of waterproof electrical cable.

2. Contractor to provide 30 feet of chain and attach to pump for raising and lowering pump.
3. Pump to be provided with discharge elbow and hydraulic flange connection to pump to allow for removal without dewatering sump.

3.12 SUMP PUMP PUMP NO. P-400

A. Operating Conditions:

1. Rated Capacity, gpm:	20
2. Suction Head, feet:	
3. Discharge Head, feet:	
4. Total Dynamic Head, feet:	27
5. Operating Range, gpm:	
6. Maximum Pump Speed, rpm:	
7. Liquid Pumped:	Wash Down and Sludge
8. NPSH, feet:	
9. Specific Gravity:	1.0+
10. Temperature, deg. F.:	Ambient
11. pH:	7
12. Min. Diam. Spherical Solids, in.:	1-1/2
13. Length Below Base, feet:	
14. Submergence Required, feet:	
15. Number of Pumps:	One

B. Performance:

1. Proposed Impeller Diam., in.:	
2. Max. Impeller Diam., in.:	
3. Design Efficiency and bhp:	
4. Stages and rpm:	
5. Manufacturer:	
6. Model Number:	
7. Performance Curve Number:	

C. Construction:

	Type	Material
1. Casing:	Submersible	C.I.
2. Impeller:	Non Clog	C.I.
3. Pump Shaft:		
4. Suction Cover:		
5. Casing Wear Ring:		
6. Impeller Wear Ring:		
7. Packing:		
8. Outboard Bearing:		
9. Frame:		
10. Frame Adapter:		
11. Bearing Housing:		
12. Base:		
13. Lantern Ring:		
14. Impeller Nut or Screw:		
15. Impeller Key:		
16. Deflector:		
17. Coupling:		
18. Coupling Guard:		
19. Seal, Mechanical:		
20. Lubrication:		

D. Motor:
   1. Volts/Phase/Hertz: 220/1/50
   2. Horsepower: _____

E. Remarks:
   1. Pump to be submersible, supplied with level control to turn pump on and off and 20 feet of PVC power cord.

3.13 SUMP PUMP PUMP NO. P-401

A. Operating Conditions:

1. Rated Capacity, gpm:	20
2. Suction Head, feet:	
3. Discharge Head, feet:	
4. Total Dynamic Head, feet:	15
5. Operating Range, gpm:	
6. Maximum Pump Speed, rpm:	
7. Liquid Pumped:	Wash Down/Septage
8. NPSH, feet:	1.0+
9. Specific Gravity:	
10. Temperature, deg. F.:	Ambient
11. pH:	7
12. Min. Diam. Spherical Solids, in.:	1-1/2"
13. Length Below Base, feet:	
14. Submergence Required, feet:	
15. Number of Pumps Required:	One

B. Performance:

1. Proposed Impeller Diam., in.:	
2. Max. Impeller Diam., in.:	
3. Design Efficiency and bhp:	
4. Stages and rpm:	
5. Manufacturer:	
6. Model Number:	
7. Performance Curve Number:	

C. Construction:

	Type	Material
1. Casing:	Submersible	C.I.
2. Impeller:	Non Clog	C.I.
3. Pump Shaft:		
4. Suction Cover:		
5. Casing Wear Ring:		
6. Impeller Wear Ring:		
7. Packing:		
8. Outboard Bearing:		
9. Frame:		
10. Frame Adapter:		
11. Bearing Housing:		
12. Base:		
13. Lantern Ring:		
14. Impeller Nut or Screw:		
15. Impeller Key:		
16. Deflector:		
17. Coupling:		
18. Coupling Guard:		
19. Seal, Mechanical:		
20. Lubrication:		

D. Motor:

1. Volts/Phase/Hertz:	220/1/50

2. Horsepower: _____

E. Remarks:
1. Pump to be submersible, supplied with level control to turn pump on and off and 20 feet of PVC power cord.

3.14 SUMP PUMP PUMP NO. P-402 & P-403

A. Operating Conditions:

1. Rated Capacity, gpm:	20
2. Suction Head, feet:	
3. Discharge Head, feet:	
4. Total Dynamic Head, feet:	28
5. Operating Range, gpm:	
6. Maximum Pump Speed, rpm:	
7. Liquid Pumped:	Wash Down
8. NPSH, feet:	
9. Specific Gravity:	1.0+
10. Temperature, deg. F.:	Ambient
11. pH:	7
12. Min. Diam. Spherical Solids, in.:	1-1/2
13. Length Below Base, feet:	
14. Submergence Required, feet:	
15. Number of Pumps Required	Two

B. Performance:

1. Proposed Impeller Diam., in.:	
2. Max. Impeller Diam., in.:	
3. Design Efficiency and bhp:	
4. Stages and rpm:	
5. Manufacturer:	
6. Model Number:	
7. Performance Curve Number:	

C. Construction:

	Type	Material
1. Casing:	Submersible	C.I.
2. Impeller:	Non Clog	C.I.
3. Pump Shaft:		
4. Suction Cover:		
5. Casing Wear Ring:		
6. Impeller Wear Ring:		
7. Packing:		
8. Outboard Bearing:		
9. Frame:		
10. Frame Adapter:		
11. Bearing Housing:		
12. Base:		
13. Lantern Ring:		
14. Impeller Nut or Screw:		
15. Impeller Key:		
16. Deflector:		
17. Coupling:		
18. Coupling Guard:		
19. Seal, Mechanical:		
20. Lubrication:		

D. Motor:

1. Volts/Phase/Hertz:	220/1/50
2. Horsepower:	

E. Remarks:

1. Pump to be submersible, supplied with level control to turn pump on/off and 20 feet of PVC Power Cord.

3.15 SUMP PUMP PUMP NO. P-404 & 405

A. Operating Conditions:

1. Rated Capacity, gpm:	20
2. Suction Head, feet:	
3. Discharge Head, feet:	
4. Total Dynamic Head, feet:	26
5. Operating Range, gpm:	
6. Maximum Pump Speed, rpm:	
7. Liquid Pumped:	Wash Down/Sludge
8. NPSH, feet:	
9. Specific Gravity:	1.0+
10. Temperature, deg. F.:	Ambient
11. pH:	7
12. Min. Diam. Spherical Solids, in.:	1-1/2
13. Length Below Base, feet:	
14. Submergence Required, feet:	
15. Number of Pumps Required	Two

B. Performance:

1. Proposed Impeller Diam., in.:	
2. Max. Impeller Diam., in.:	
3. Design Efficiency and bhp:	
4. Stages and rpm:	
5. Manufacturer:	
6. Model Number:	
7. Performance Curve Number:	

C. Construction:

	Type	Material
1. Casing:	Submersible	C.I.
2. Impeller:	Non Clog	C.I.
3. Pump Shaft:		
4. Suction Cover:		
5. Casing Wear Ring:		
6. Impeller Wear Ring:		
7. Packing:		
8. Outboard Bearing:		
9. Frame:		
10. Frame Adapter:		
11. Bearing Housing:		
12. Base:		
13. Lantern Ring:		
14. Impeller Nut or Screw:		
15. Impeller Key:		
16. Deflector:		
17. Coupling:		
18. Coupling Guard:		
19. Seal, Mechanical:		
20. Lubrication:		

D. Motor:

1. Volts/Phase/Hertz:	220/1/50
2. Horsepower:	

E. Remarks:

1. Pump to be submersible, supplied with level control to turn pump on/off and 20 feet of PVC Power Cord.

3.16 SUMP PUMP PUMP NO. P-406

A. Operating Conditions:

1. Rated Capacity, gpm:	20
2. Suction Head, feet:	
3. Discharge Head, feet:	
4. Total Dynamic Head, feet:	31
5. Operating Range, gpm:	
6. Maximum Pump Speed, rpm:	
7. Liquid Pumped:	Wash Down/Septage
8. NPSH, feet:	
9. Specific Gravity:	
10. Temperature, deg. F.:	Ambient
11. pH:	7
12. Min. Diam. Spherical Solids, in.:	2"
13. Length Below Base, feet:	
14. Submergence Required, feet:	
15. Number of Pumps Required	One

B. Performance:

1. Proposed Impeller Diam., in.:	
2. Max. Impeller Diam., in.:	
3. Design Efficiency and bhp:	
4. Stages and rpm:	
5. Manufacturer:	
6. Model Number:	
7. Performance Curve Number:	

C. Construction:

	Type	Material
1. Casing:	Submersible	C.I.
2. Impeller:	Non Clog	C.I.
3. Pump Shaft:		
4. Suction Cover:		
5. Casing Wear Ring:		
6. Impeller Wear Ring:		
7. Packing:		
8. Outboard Bearing:		
9. Frame:		
10. Frame Adapter:		
11. Bearing Housing:		
12. Base:		
13. Lantern Ring:		
14. Impeller Nut or Screw:		
15. Impeller Key:		
16. Deflector:		
17. Coupling:		
18. Coupling Guard:		
19. Seal, Mechanical:		
20. Lubrication:		

D. Motor:

1. Volts/Phase/Hertz:	220/1/50

2. Horsepower _____

E. Remarks:
1. Pump to be submersible, supplied with level control to turn pump on/off and 20 feet of PVC Power Cord.

3.17 SUMP PUMP PUMP NO. P-407

A. Operating Conditions:

1.	Rated Capacity, gpm:	20
2.	Suction Head, feet:	
3.	Discharge Head, feet:	
4.	Total Dynamic Head, feet:	23
5.	Operating Range, gpm:	
6.	Maximum Pump Speed, rpm:	
7.	Liquid Pumped:	Wash Down/Septage
8.	NPSH, feet:	
9.	Specific Gravity:	
10.	Temperature, deg. F.:	Ambient
11.	pH:	7
12.	Min. Diam. Spherical Solids, in.:	2"
13.	Length Below Base, feet:	
14.	Submergence Required, feet:	
15.	Number of Pumps Required	Two

B. Performance:

1.	Proposed Impeller Diam., in.:	
2.	Max. Impeller Diam., in.:	
3.	Design Efficiency and bhp:	
4.	Stages and rpm:	
5.	Manufacturer:	
6.	Model Number:	
7.	Performance Curve Number:	

C. Construction:

		Type	Material
1.	Casing:	Submersible	C.I.
2.	Impeller:	Non Clog	C.I.
3.	Pump Shaft:		
4.	Suction Cover:		
5.	Casing Wear Ring:		
6.	Impeller Wear Ring:		
7.	Packing:		
8.	Outboard Bearing:		
9.	Frame:		
10.	Frame Adapter:		
11.	Bearing Housing:		
12.	Base:		
13.	Lantern Ring:		
14.	Impeller Nut or Screw:		
15.	Impeller Key:		
16.	Deflector:		
17.	Coupling:		
18.	Coupling Guard:		
19.	Seal, Mechanical:		
20.	Lubrication:		

D. Motor:

1.	Volts/Phase/Hertz:	220/1/50

2. Horsepower _____

E. Remarks:
1. Pump to be submersible, supplied with level control to turn pump on/off and 20 feet of PVC Power Cord.

3.18 HOT WATER CIRCULATING PUMP NO. P-112

A. Operating Conditions:

1. Rated Capacity, gpm:	25
2. Suction Head, feet:	
3. Discharge Head, feet:	
4. Total Dynamic Head, feet:	27
5. Operating Range, gpm:	
6. Maximum Pump Speed, rpm:	1750
7. Liquid Pumped:	200 deg. F Hot water
8. NPSH, feet:	
9. Specific Gravity:	
10. Temperature, deg. F.:	200 deg. F
11. pH:	7
12. Min. Diam. Spherical Solids, in.:	
13. Length Below Base, feet:	
14. Submergence Required, feet:	
15. Number of Pumps Required	See note #5

B. Performance:

1. Proposed Impeller Diam., in.:	
2. Max. Impeller Diam., in.:	
3. Design Efficiency and bhp:	
4. Stages and rpm:	
5. Manufacturer:	
6. Model Number:	
7. Performance Curve Number:	

C. Construction:

	Type	Material
1. Casing:	Inline	C.I.
2. Impeller:	Enclosed	Cast Iron Steel
3. Pump Shaft:		
4. Suction Cover:		
5. Casing Wear Ring:		
6. Impeller Wear Ring:		
7. Packing:		
8. Outboard Bearing:		
9. Frame:		
10. Frame Adapter:		
11. Bearing Housing:		
12. Base:		
13. Lantern Ring:		
14. Impeller Nut or Screw:		
15. Impeller Key:		
16. Deflector:		
17. Coupling:		
18. Coupling Guard:		
19. Seal, Mechanical:		
20. Lubrication:		

D. Motor:

1. Volts/Phase/Hertz:	220/1/50

•914

2. Horsepower _____

E. Remarks:
1. Pump to be provided with motor bracket.
2. Pump and motor combination to be non overloading over entire pump curve.
3. Mechanical seal to be carbon steel ring, remite seat, and stainless steel spring.
4. Provide three extra mechanical seals as spare parts.
5. Provide one pump for installation and two pumps as shelf spares. Spare pumps to be boxed for long term storage.

END OF SECTION

SECTION 11313

PLUNGER PUMPS

PART 1 GENERAL

1.01 RELATED WORK

A. Section 01735: Equipment System Demonstrations

B. Section 11000: Mechanical Equipment General

C. Section 16151: Process Motors

1.02 DESIGN CRITERIA

A. Design pumps for intermittent or continuous operation at any point within the full operating range.

B. Where pumps operate under two sets of conditions, design pump for operation at conditions requiring the larger horsepower. Pump shall operate satisfactorily at the other condition.

1.03 SHOP TESTS

A. Test pumps in accord with Hydraulic Institute's procedures.

B. Test pumps for speeds, head, capacity, efficiency, and brake horsepower and at such conditions of head and capacity to verify performance curves.

1.04 SUBMITTALS

A. Submit Shop Drawings, pump data and Certificates of shop tests in accord with Section 01340.

B. Provide the following pump data:
1. Head.
2. RPM.
3. Frame.
4. Combined weight of pump and motor.
5. Piston diameter.
6. Largest spherical solid that can be passed.
7. Performance curves with operation points clearly marked.
8. Maximum hp motor that could be utilized.
9. Stroke setting vs. volume per stroke chart.

C. Submit operation and maintenance manual in accord with Section 01730.

1.05 GUARANTEE

A. Provide manufacturer's guarantee based on design conditions as specified.

PART 2 PRODUCTS

2.01 PUMPS

A. Type: duplex or triplex as specified in schedules .

2.02 CYLINDERS AND BODY

A. Type: one piece, cast

B. Packing: minimum five rings, 3/4 inch.

2.03 SHAFTS

A. Shafts: Turned, ground, and polished steel.

B. Support shafts in self-aligning grease relubricated ball bearings.

2.04 PLUNGER

A. Fasten to connecting rod with hardened polished steel wrist pin, sealed from pumped liquid with plugs at both ends.

B. Machine finish plungers.

2.05 CONNECTING ROD

A. Type: one piece, cast with integral eccentric strap, babbit lined.

B. Wrist pin bearing: bronze journal.

C. Take-up shims for eccentric straps: brass.

D. Overload protection: integral shear pin for eccentric flange.

E. Stroke: variable length, zero to full length in a minimum of 12 increments. Provide calibrated scale for stroke settings reading in volume units/stroke.

2.06 VALVE CHAMBER

A. Type: single, contoured to minimize clogging.

B. Location: on suction and discharge connections for each cylinder, direct flange connection to pump body.

C. Covers: quick opening type.

D. Renewable seats.

E. Ball Valves: Minimum 5-1/8" diameter of lead impregnated synthetic rubber.

2.07 MANIFOLD-SUCTION AND DISCHARGE

A. Material: Cast Iron

B. All flanges integrally cast

C. Provide 1-1/2" sampling valve connection

2.08 AIR CHAMBER

A. Provide one air chamber on each suction and discharge manifold.

B. Provide connections on top for pressure gage.

2.09 BY-PASS

A. Provide by-pass relief manifold with rupture disc between suction and discharge manifolds.

B. Rupture disc: corrosion resistant material.

C. Rupture Disc shall be sized by pump manufacturer.

2.10 SAMPLING VALVES

A. Type: Manifold, quick opening, located on valve chambers.

2.11 MOTOR

A. Conform to Section 16151.

2.12 DRIVE REDUCER

A. Multiple, v-belt drive:
   1. Drive capacity: 150 percent of belt's horsepower rating.
   2. Sheave: heavy, flywheel type keyed to main pump shaft.
   3. Enclosure: steel guard completely enclosing reduction assembly.

B. Gear, fully enclosed, oil lubricated drive:
   1. Design: in accord with AGMA Standards.
   2. Rating: 24 hour continuous operation, thermal and mechanical rating greater than the full load rating of the connected motor at maximum rpm.
   3. Provide flexible coupling shear pin protected for direct connection between reducer output shaft and pump shaft.

2.13 BASE

A. Bracing: design to withstand shock loads.

B. Features: 1-1/2 inch drip gutter, and one inch NPT drain connection.

C. Provide common base for mounting pump, gear drive (if specified) and motor.

2.14 DISCHARGE PRESSURE GAGE

A. Type: diaphragm type, 4-1/2 inches diameter, zero to 150 psi scale.

B. Mounting: on top of discharge air chamber with sample valve.

2.15 SUCTION PRESSURE GAGE

A. Type: compound, diaphragm type 4-1/2 inch diameter, zero to 15 psi pressure and zero to 30 feet vacuum scales.

B. Mounting: on top of suction air chamber.

2.16 AUTOMATIC OILER

A. Pump manufacturer to provide on each pump, an automatic oil lubrication system to consist of a central oil reservoir with solenoid valve to open and allow oil flow when the pump is running.

B. System to be provided with 1/2 gallon oil reservoir, one solenoid valve, necessary oil tubing and be supported from the pump frame.

2.17 ASSEMBLY

A. Completely factory assemble pump, motor and accessories.

PART 3 EXECUTION

3.01 INSTALLATION

A. Conform to manufacturer's instructions and Section 11000.

B. Install pump.

C. Start pump in accord with Section 11000.
1. Provide manufacturer's representative to assist with start-up.

D. Train Owner's personnel in accord with Section 01735.
1. Provide minimum 16 hours training time, total for all Plunger Pumps on the Project.

3.02 SPARE PARTS

A. Provide the following spare parts for each pump:
   1. One set of ball valves (suction and discharge)
   2. Three sets of seats for ball valves (suction and discharge)
   3. Six rupture discs and five shear pins.
   4. Three packing sets.
   5.

3.03 Thickened Sludge Pumps PUMP NO. P-05 A, B, and S

A. Operating Conditions:

1. Rated Capacity, gpm:	184
2. Suction Head, feet:	+16
3. Discharge Head, feet:	
4. Total Dynamic Head, feet:	210
5. Operating Range, gpm:	
6. Maximum Pump Speed, rpm:	
7. Liquid Pumped:	Thickened Sludge
8. NPSH, feet:	Flooded
9. Specific Gravity:	1.0+
10. Temperature, deg. F.:	Ambient
11. pH:	6-8
12. Max. Diam. Spherical Solids, in.:	2-1/2
13. Percent Solids:	5-8%

B. Performance:

1. Proposed Number of Plungers:	Three
2. Plunger Stroke, in. (max./min.):	
3. Strokes per min. (max./min.):	
4. Design Efficiency and bhp:	
5. Manufacturer:	Carter
6. Model Number:	795H
7. Performance Curve Number:	

C. Construction:

	Type	Material
1. Pump Body:		Cast Iron (C/I)
2. Stuffing Box:		
3. Packing Gland		Nickel Alloy C/I
4. Packing:		Graphite
5. Plunger:		Nickel Alloy C/I
6. Connecting Rod:		Cast Iron
7. Conn.Rod Eccentric Brg.:		Babbit
8. Shaft:		Steel
9. Shaft Bearings:		
10. Counter Shaft:		
11. Eccentric:	14 Position	Nickel Alloy C/I
12. Shear Pin:		Mfg. Standard
13. Valve Chamber:		Mfg. Standard
14. Valve Seat:	Replaceable	Mfg. Standard
15. Valve Ball:		Lead Impreg.Rubber
16. Base:		Steel w/drip gutter
17. Air Chamber-Discharge:	8"	Steel
18. Air Chamber-Suction:	8"	Steel
19. Coupling:		

D. Motor:

1. Volts/Phase/Hertz:	380/3/50
2. Horsepower:	20 Min.
3. Drive	Gear

E. Remarks:

1.
2.

3.04 Primary Sludge and Sump Pumps PUMP NO. P-106 A, B, and C

A. Operating Conditions:

1.	Rated Capacity, gpm:	122
2.	Suction Head, feet:	19.5 (max)
3.	Discharge Head, feet:	
4.	Total Dynamic Head, feet:	200 (Max)
5.	Operating Range, gpm:	
6.	Maximum Pump Speed, rpm:	
7.	Liquid Pumped:	Primary Sludge & Scum
8.	NPSH, feet:	Flooded
9.	Specific Gravity:	1.0+
10.	Temperature, deg. F.:	Ambient
11.	pH:	6-8
12.	Max. Diam. Spherical Solids, in.:	2-1/2
13.	Percent Solids:	5%

B. Performance:

1.	Proposed Number of Plungers:	three
2.	Plunger Stroke, in. (max./min.):	
3.	Strokes per min. (max./min.):	
4.	Design Efficiency and bhp:	
5.	Manufacturer:	Carter
6.	Model Number:	795H
7.	Performance Curve Number:	

C. Construction:

		Type	Material
1.	Pump Body:		Cast Iron (C/I)
2.	Stuffing Box:		
3.	Packing Gland		Nickel Alloy C/I
4.	Packing:		Graphite
5.	Plunger:		Nickel Alloy C/I
6.	Connecting Rod:		Cast Iron
7.	Conn.Rod Eccentric Brg.:		Babbit
8.	Shaft:		Steel
9.	Shaft Bearings:		
10.	Counter Shaft:		
11.	Eccentric:	14 Position	Nickel Alloy C/I
12.	Shear Pin:		Mfg. Standard
13.	Valve Chamber:		Mfg. Standard
14.	Valve Seat:		Mfg. STandard
15.	Valve Ball:		Lead Impreg.Rubber
16.	Base:		Steel w/drip gutter
17.	Air Chamber-Discharge:	8"	Steel
18.	Air Chamber-Suction:	8"	Steel
19.	Coupling:	Flex. w/guard	Mfg. Standard

D. Motor:

1.	Volts/Phase/Hertz:	380/3/50
2.	Horsepower:	15 (Min)

3. Drive: Chain

E. Remarks:
1.
2.
3.

3.05 Sludge Transfer Pump PUMP NO. P-107 A, B, and C

A. Operating Conditions:

1. Rated Capacity, gpm:	184
2. Suction Head, feet:	+16
3. Discharge Head, feet:	_____
4. Total Dynamic Head, feet:	160
5. Operating Range, gpm:	_____
6. Maximum Pump Speed, rpm:	_____
7. Liquid Pumped:	- Thickened/digested sludge
8. NPSH, feet:	Flooded
9. Specific Gravity:	1.0+
10. Temperature, deg. F.:	Ambient
11. pH:	6-8
12. Max. Diam. Spherical Solids, in.:	2-q/2
13. Percent Solids:	5%

B. Performance:

1. Proposed Number of Plungers:	Three
2. Plunger Stroke, in. (max./min.):	_____
3. Strokes per min. (max./min.):	_____
4. Design Efficiency and bhp:	_____
5. Manufacturer:	Carter
6. Model Number:	Nickel alloy C/I
7. Performance Curve Number:	_____

C. Construction:

	Type	Material
1. Pump Body:	_____	Cast Iron
2. Stuffing Box:	_____	_____
3. Packing Gland	_____	_____
4. Packing:	_____	Graphite
5. Plunger:	_____	Nickel Alloy C/I
6. Connecting Rod:	_____	Cast Iron (C/I)
7. Conn.Rod Eccentric Brg.:	_____	Babbit
8. Shaft:	_____	Steel
9. Shaft Bearings:	_____	_____
10. Counter Shaft:	_____	_____
11. Eccentric:	14 Position	Nickel Alloy C/I
12. Shear Pin:	_____	Mfg. STandard
13. Valve Chamber:	_____	Mfg. Standard
14. Valve Seat:	Replaceable	Mfg. STandard
15. Valve Ball:	_____	Lead Impreg.Rubber
16. Base:	_____	Steel w/drip gutter
17. Air Chamber-Discharge:	8"	Steel
18. Air Chamber-Suction:	8"	Steel
19. Coupling:	Flex. w/guard	Mfg. STandard

D. Motor:

1. Volts/Phase/Hertz:	380/3/50

2. Horsepower: 15 (Min)
3. Drive Chain

E. Remarks:
1.
2.
3.

END OF SECTION

SECTION 11315

DIGESTER MIXING, HEATING SYSTEM, & GASHOLDER ROOF

PART 1 GENERAL

1.01 RELATED WORK

A. Section 11000: Mechanical General

B. Section 16151: Process motors

C. Section 05120: Structural Steel

D. Section 09900: Painting

E. Section 13445: Instrumentation and Control for Packaged System

1.02 DESCRIPTION OF INSTALLATION

A. The anaerobic digestion system shall be a single stage digester, treating underflow from a sludge thickener. Primary and secondary sludges will be combined and settled in the thickener prior to being pumped to the digester.

B. Sludge will be withdrawn from the digester and transferred to a sludge holding/thickening tank before being applied to the sand drying beds.

C. Gas from the digester shall be used for heating of the digester tank and heating of the Digester Building.

1.03 DESIGN DATA

A. Design of the Digester Mixing and Heating System and performance guarantee of the system shall be based on the parameters specified herein.

Number of tanks	One
Digester tank diameter	26 meters
Tank Construction	Concrete
SWD (meters)	6
Free Board (meters)	2.5
Tank Bottom	Sloped (to center)
Type of Roof	Floating Gas Holder
Retention Time at Design Flow	14 days @ Feed TSS of 5%
Influent Flow (m^3/day)	
Minimum	Zero
Design	250
Maximum	670
Total Suspended Solids @ Design Flow mg/l	50,000
Volatile Suspended Solids @ Design Flow mg/l	36,480
Loading	3.5 Kg TSS/d/m^3

B. Mixing Requirements:
   1. Uniform Suspension of solids ± 5% from Arithmetic mean at any point in the tank.
   2. Maximum turnover at Average Loading: 30 minutes.

1.04 SUBMITTALS

A. Submit Shop Drawings in accord with Section 01340.

B. Submit operation and Maintenance Manuals in accord with Section 01730.

1.05 EQUIPMENT TO BE FURNISHED

A. Digester Mixing System
   1. Draft tube
   2. Mixing Pumps P-108 A and B
   3. Nozzles

B. Digester Heating System

C. All components of the Digester Mixing and Heating System as well as the gasholder roof specified herein shall be supplied by one manufacturer, who shall assume responsibility for a complete and operational system.
   1. Sludge recirculation pumps P-109 A and B
   2. Heat exchanger
   3. Boiler ME-107
   4. Hot water circulating pumps P-111 A and B

D. Digester Gas System
   1. Floating gas holder roof
   2. Gas piping accessories

E. Instrument & Control System
   1. Digester operation and safety system including flare
   2. Boiler control system
   3. Hot water circulation controls.

PART 2 PRODUCTS

2.01 DIGESTER MIXING SYSTEM

A. Digester Mixing system shall consist of draft tube, mounted in the digester tank, two mixing pumps (one operating and one spare) located in the Digester Building and mixing nozzles located on the tank walls.

B. The mixing system shall thoroughly mix the contents of the digester tank utilizing mixing nozzles to create a combined horizontal and vertical circulating motion. Mixing nozzles shall also be provided to prevent formation of a scum layer at the liquid surface. (Number, size and location of mixing nozzles shall be determined by the equipment manufacturer.)

C. Mixing rate shall produce a turnover of the digester tank once every 30 minutes.

D. Draft Tube
1. Provide one vertical draft tube, located at the center of the digester tank.
2. Tube shall be fabricated of 3/8" minimum steel plate.
3. Draft tube shall have a minimum diameter of 24 inches. Equipment manufacturer to verify tube diameter. Tube shall be equipped with vortex deflector vanes arranged to deflect scum and sludge liquid feed through three (3) inlet ports near the liquid surface. Deflection vanes shall be oriented to minimize vortexing at the draft tube entrance.

E. Mixing Pump
1. Pumps to be non-clog single elbow axial flow, suitable for handling digested sludge.
2. Provide two pumps (one operating and one spare).
3. Pumps to have a minimum capacity of 7200 gpm. Pump discharge head and motor horsepower to be determined by the equipment manufacturer using the Contract Drawing for determining length of pipe and water surface elevation. Pump and motor combination to be non-overloading over the entire pump impeller range.
4. Pump motor to be 380 volts, 3 Ph, 50 Hz., TEFC, Drip proof
5. Pump shall be supplied with cast iron elbow casing, with a replaceable cast iron liner installed in the elbow in the vicinity of the propeller.
6. Pump shaft shall be AISI 1045 steel with a protection shaft tube. Pump bearings shall be grease lubricated anti-friction type.
7. Stuffing box shall be water lubricated.
8. A handhole for inspection of pump interior shall be provided.
9. Pumps shall be belt driven with guard and adjustable base for overhead mounting.
10. Impeller shall be cast iron.
11. Shaft sleeve shall be 416 stainless steel.

F. Mixing Nozzles
1. Equipment manufacturer shall provide a minimum of two mixing nozzles located near the tank bottom, to cause the mixing action in the digester tank. These nozzles shall be located at the tank periphery.
2. Provide one or more scum breaker nozzles just below the water surface to prevent formation of a scum layer at the liquid surface.
3. The number, size and location of all nozzles shall be determined by the equipment manufacturer.
4. Contractor to provide, install and support all digester internal piping and nozzles. Design of supports is responsibility of equipment manufacturer and Contractor.

2.02 DIGESTER HEATING SYSTEM

A. Digester heating system shall be supplied by the manufacturer of the digester mixing system.

B. Digester heating system shall be designed to heat the contents of the digester tank to 90 degrees F and also provide comfort heating to the Digester Building.

C. Sludge shall be withdrawn from digester by a centrifugal pump, which shall circulate the sludge through a heat exchanger and back to the digester tank. 150 degrees F hot water shall be used as heating medium for the heat exchanger.

D. A gas/oil fired boiler shall be provided to generate hot water for sludge heating and Digester Building comfort heating. Comfort heating water shall be 200 degrees F and sludge heating water shall be tempered to 150 degrees F by blending with return water.

E. Sludge Recirculation Pumps
1. Provide two (one operating and one spare) non-clog centrifugal pumps to circulate sludge to and from sludge heat exchanger.
2. Pumps shall be horizontal, centrifugal, mounted on fabricated base suitable for both pump and motor. Base shall have drip lip.
3. Pump to be capable of handling minimum of 2" O.D. solids.
4. Pump to be connected to motor by flexible coupling and provided with coupling guard.
5. Pump construction shall be in accord with Section 11312.
6. Pumping capacity shall be minimum of 220 GPM. Equipment manufacturer to determine required pump discharge head by using Contract Drawings for determining length of piping and water surface elevations.
7. Pump and motor combination shall be non-overloading over impellers full curve.
8. Pump to operate on 380 volts, 3 phase, 50 Hz.
9. Pump casing shall be constructed of cast iron with cold rolled steel shaft. Pump shall have water flushed packing.

F. Sludge Heat Exchanger
1. Provide one sludge heat exchanger.
2. Heat exchanger shall transfer 1,250,000 BTU/hour to digester contents.
3. Sludge inlet temperature to heat exchanger will be 90 degrees F (32 degrees C). Sludge discharge temperature of 100 degrees F (37.8 degrees C) shall be obtained.
4. Heat supply to the exchanger shall be from a boiler producing 200 degrees F (93.3 degrees C) hot water which shall be mixed, by a temperature regulating

valve to produce a temperature of 155 degrees F (68.3 degrees C) maximum feed to the sludge heat exchanger.

5. Sludge flow to the heat exchanger shall be 250 GPM maximum and hot water flow to be 250 GPM maximum.
6. Heat exchanger shall be spiral type, counter current flow with flanged inlet and outlet connection for both sludge and hot water.
7. Heating water contact with sludge shall not be permitted.
8. Unit shall be self supporting with bottom 2" diameter drain and plug valve.
9. Front cover of heat exchanger to be hinged for easy access for maintenance. Cover to be attached to main body by hook bolts and a gasket to produce a tight seal.
10. Construction to be welded steel.
11. Alternate heat exchanger designs can be offered by equipment manufacturers. Alternate designs must meet the intent and design criteria of the specified system. The contractor is to be responsible for all changes, mechanical, electrical/instrument, and structural, necessitated by the alternate.

G. Boiler

1. The digester mixing system manufacturer shall furnish and the Contractor shall install one hot water boiler as shown on the Contract Drawings.
2. The hot water boiler system shall be designed to be fired on digester gas or No. 2 fuel oil. The fuel burning equipment shall include the necessary accessories for burning of either digester gas or No. 2 fuel oil.
3. Boiler shall provide hot water for the sludge heat exchanger and comfort heating of the Digester Building.
4. Fuel burning system shall be designed and rated for forced draft operation and shall be fully automatic operation.
5. Boiler shall be of cast iron construction and be rated as follows:

Water pressure	30 psiG.
Water Temperature	200 degrees F
Net Output	
Heat required for sludge	1,250,000 Btu/hour
Heat required for Bldg.	225,000 Btu/hour
Total	1,475,000 Btu/hour
Heating Value of Fuel	
Digester gas	600 Btu/cu.ft.
No. 2 fuel oil	140,000 Btu/gal.

6. The boiler burner unit shall conform to the space limitations in the Boiler room, providing sufficient space for firing, cleaning, and maintenance.
7. The entire boiler-burner unit shall be the responsibility of one manufacturer and shall consist of boiler, fuel burner system, controls and trim; all factory mounted and wired.

8. All packaging shall be performed at the boiler manufacturer's plant.
9. The boiler-burner unit shall be ready for field connection to power, fuel oil supply, digester gas supply, water and breeching.
10. Boiler Design:
    a. The boiler shall be a fire tube boiler of wet base design.
    b. Heating surface shall be based on a minimum of 5 square feet per BHP. Boiler shall be constructed and stamped in accord with Section IV of the ASME Boiler and pressure Vessel Code.
    c. Boiler shall be insulated with factory installed, 2" fiberglass insulation, with enamel steel jacket and cover rings at all openings. Insulation shall be U. L. listed and have a fire hazard classification of FHC 25/50. Maximum "k" factor shall be 0.25. Insulation shall have a service temperature of 450 degrees F.
    d. Operating efficiency shall not be less than 80% at maximum firing rate.
    e. Stack temperature shall not be more than 200 degrees F. above water temperature at maximum firing rate.
    f. The boiler shall have integral burner and burner controls.
11. Water pressure gauge; 0-400 k Pa scale.
12. Water pressure relief valve set at 30 psig. Valve shall be in accord with the requirements of applicable codes.
13. Operating control sensing water temperature and manual reset safety high limit control as emergency backup for the operating control.
14. Chemical Treatment System
    a. The Contractor shall provide and install a boiler feed chemical conditioning system. The system shall be connected to the main supply pipe on the boiler.
    b. The Chemical conditioning system shall consist of 100 liter solution tank, metering pump, adjustable between 0 and 5 l/hr., connecting piping. The unit shall be package skid mounted pre-wired with all controls.
    c. The system shall be designed for dosing the following:
        1) 2 g/m³ trisodiumphosphate Na_3PO_4
        2) 12 H_2O per 1 ppm hardness as $CaCo_3 \cdot 7H_2O$ to a surplus of 50 mg Na_2SO_3/l.
    d. The Contractor shall have the local water chemical analyzed to determine the hardness and shall supply chemicals for one year's operation after completion of the Maintenance Period.
    e. The Contractor shall supply two test kits to determine phosphate, sulphite content and pH value.

H. Burner and Fuel Piping

1. The fuel burning equipment shall include the necessary accessories for burning either digester gas or No. 2 fuel oil.
2. The burner shall operate on digester gas until the pressure within the digester drops to 1-1/2 inches W.C. at which time the burner shall automatically refire on oil. The burner shall refire on digester gas once the pressure has reached a minimum of 3-1/2 inches W.C. The use of a gas booster pump to meet these pressure requirements shall not be permitted.
3. The burner shall be equipped with an infrared flame detector.
4. Provide an automatic gas pilot to ignite the gas-oil burner with propane gas.
5. The gas feed line shall consist of an adjustable valve, shutoff valve, pressure regulator, motorized valve, pilot regulator, pilot solenoid valve, and pilot line shutoff. The oil line shall consist of a replaceable oil filter, oil pressure gauge, oil pump and motor, oil pump suction vacuum gauge and check valve.
6. Air for combustion shall be provided by a forced draft fan to insure complete combustion of the fuel. The fan shall be of a capacity of maximum air requirements for combustion. A shut down switch shall be provided.
7. Two positive displacement air transfer pumps, P-112 A and B (from storage tank) lock with pressure gauge, internal relief valve, by-pass back pressure control valves, and drive, rated at 20 gph.

I. Boiler Instruments and Controls: The system shall conform with the requirements of Section 13445 except that no One line diagram is required, no Instrument Loop diagrams are required, and no graphic is required. Motor starters are provided in the motor control center. The system supplier shall refer to the electrical Contract Drawings and provide or arrange for all equipment and wiring required that is not shown on the Contract Drawings.
   1. Boiler Trim: Manual reset low water cut-off alarm switch. Cut-off shall be interlocked with relays to burner circuit.
   2. Water temperature gauge; 10-150 degrees C scale.
   3. Burner Controller. The flame safeguard and programming controller shall be listed by Underwriters Laboratories and approved by Factory Mutual. The controller shall provide a minimum of 30 second pre-purge and 15 second post-purge of the combustion chamber. An infrared scanning device shall sense pilot and main flame presence. The burner controller shall, upon flame failure, automatically close the main fuel and pilot valves within 4 seconds and sound an audible alarm in addition to lighting a visual indicator. The burner controller shall, after an interruption of power, recycle upon fuel valve opening.
   4. Control Panel

a. Control panel shall contain burner controller, branch circuit breakers, magnetic starters for induced draft fan.
b. The Control panel shall be mounted on the side of the boiler so as not to interfere with access to the burner, return breech, or fuel piping. Burner mounted controls will not be acceptable.
c. Control panel shall be a NEMA 12 enclosure with dual swing-out doors. The doors shall be lockable with disconnect switch and handle to insure the doors are closed during operation.
d. The following switches and indicating lamps shall be provided on control panel doors:
   1) Fuel selection switch (gas/auto/oil)
   2) Constant water bath (on/off) switch
   3) Low boiler water indicator lamp
   4) Flame failure alarm horn, alarm horn silencer, and flame failure indicator lamp.
   5) Provide dry contacts for remote indication of boiler run and malfunction

J. Sludge heat exchanger hot water recirculation equipment.
1. Provide an automatic controlled digester heating system which will blend hot water returning from the sludge heat exchanger with makeup water from the boiler to maintain a constant temperature in the digester tank.
2. Digester temperature shall be maintained at 90 degrees F. (32.2 degrees C).
3. Sludge heat exchanger hot water circulating pumps (P-111A and 111B) shall be sized by the equipment manufacturer, end suction centrifugal type with enclosed impeller, double mechanical seals suitable for maximum operating temperature of 250 degrees F. Pump shaft and shaft sleeves shall be stainless steel.
4. Pump capacity shall be 250 GPM, discharge head shall be determined by the equipment manufacturer using the Contract Drawing for determining pipe length and elevation and the loss through its heat exchanger. Pump and motor combination to be non-overloading over impeller full curve.
5. Temperature regulating valves shall be flanged double-seated and suitable for hot water service. Each valve shall have a manual override positioner and integral thermometer with dial range of 10 degrees C to 121 degrees C.
6. provide two sludge heat exchanger hot water circulating pumps, one operating plus one spare.
7. Pumps to operate on 380 volts, 3 phase, 50 Hz.

K. Building heat circulating pump:
1. One water circulating pump (P-112) for building heating shall be provided by the Contractor installed with the boiler system. A line voltage thermostat for control of building heating shall be provided by the Contractor for separate installation and connection to tagged terminals on the digester heater control panel.

L. Miscellaneous:
   1. The system shall include an expansion tank of sufficient capacity for the boiler and heat exchanger, building radiation system with water level gage. Connections shall be provided for make-up water and drainage.
   2. A pressure gage, pressure relief valve, and a temperature-actuated limit thermostat shall be provided.
   3. Indicating thermometers shall be provided at the inlet and outlet of the sludge heat exchanger.

2.03 DIGESTER COVER

A. Provide one floating gasholder digester cover to collect and store digester gas. The gasholder shall be manufactured by the same manufacturer as the digester mixing system.

B. Design basis:

1.	Digester tank diameter	26 meters
2.	Gas storage volume	45,000 ft^3
3.	Normal operating pressure	6-8 inches wc

C. The dome portion of the gasholder shall not be included in the volume calculations, nor shall the cylindrical portion enclosed within the uppermost 8 inches of skirt (equivalent to the inches of water column operating gas pressure). Sufficient skirt length shall be provided to enclose the specified net gas storage volume in the cylindrical section immediately below these excluded sections. In addition, the skirt shall be extended by a margin sufficient to insure against loss of stored gas volume.

D. The gasholder shall produce a uniform pressure throughout its vertical travel.

E. The gasholder shall be provided with the following:
   1. Three 24" diameter manholes with bolted and gasketed cover(s)
   2. One 36" diameter manhole with bolted and gasketed cover
   3. One 12" diameter gas bonnet with cover to extend to 4" above the bottom of the rim plate.
   4. One 8" diameter sample tube with slip-on cover.
   5. One 500 watt dome light in explosion proof case.
   6. Two sloping type sight glasses with wipers.
   7. One pressure vacuum relief vent with flame arrestor.

F. The gasholder shall be constructed of a minimum 1/4 inch thick steel plate, top and sides.

G. Top plates shall be supported by a network of arched radial beams, rim angles, intermediate radial and ring beAms as necessary for stiffness. A minimum of 18 arched radial beams shall be provided. Beams shall have a radius

of two times the tank diameter. Top plates shall be continuously welded to the top beams.

H. Side plates shall be adequately supported, braced and reinforced.

I. All welding, both shop and field, shall be shielded arc type conforming to the latest standards of American Welding Society for gas-tight structures.

J. Gasholder Design
   1. Gasholder and its restraints system shall be designed for a wind loading of 32 pounds per square foot of projected area reduced 50% for an unbalanced snow load of 6-1/4 pounds per square foot on one quarter of the dome area.
   2. The dome shall be designed for a dead load of 35 pounds per square foot plus a uniform live load of 50 pounds per square foot over the entire area and a 2" water column vacuum or a 10" water column internal pressure, whichever is higher.
   3. The gasholder shall include steel reinforcements located at the outer periphery for supporting poured in place concrete ballast to cause an 8" water column pressure for gas storage.
   4. Maximum allowable stresses in the structural members under the above loading or under the loading imposed when the cover is floated shall not exceed the allowable stresses in the A.I.S.C. sspecifications for the design, fabrication and erection of structural steel buildings.
   5. Gasholder shall be designed and constructed of convenient sub-assemblies which have been set up and previously assembled in the shop, match-marked, and knocked down for shipment. Manufacturer shall furnish erection diagram and complete assembly instructions.
   6. The gasholder and its restraint system shall be designed so it shall not jam in its travel length or rotate due to external loads.

K. The gasholder shall be a center guide type. Guide arrangement shall include an outer and inner column with the inner column to serve also as the Draft Tube.

L. The center guide outer column shall be of I-beam construction welded to the center of the gasholder dome, fitted with a cast iron ring bearing at the bottom of such size as to slide over the inner column, and including tie rods from the rim angle to the ring bearing.

M. The center guide inner column shall be 24 inches diameter of 3/8 inch minimum thick steel plate, with a rigid welded steel base anchored to the tank bottom, including a cast iron column cap to provide a bearing surface over which the outer column slides and to provide anchorage for the tie rods extending from the tank wall. A stop welded to the column shall be provided to limit the vertical travel of the gasholder at maximum water level.

N. Gasholder Accessories:

1. Sight Glasses: Two sloping face Sight Glass Assemblies shall be furnished so that the Digester liquid surface can be observed. Each assembly shall be gas tight and shall consist of an insert which can be welded to the Steel Dome. Each Sight Glass shall be safety glass, 1/4 inch thick by 1'-0" outside diameter and shall have a clear opening of 10-3/4".
2. Dome Light: One 500 watt Dome Light shall be included in explosion-proof case having an explosion-proof Pyrex Prismatic Globe complete with receptacle brackets, heat shield, inserts which can be welded to the anchored Steel Dome, explosion-proof plug and receptacle with 20' of neoprene covered heavy duty cord and fittings for connecting the Dome Light to the receptacle. The light shall be removable without loss of gas pressure.
3. Pressure and Vacuum Relief Assembly: Pressure and Vacuum Relief Assembly shall be furnished for the Digester and shall consist of a membrane seating vacuum and adjustable pressure relief valve made of aluminum with a Flame Arrester.

O. Paint gasholder in accordance with Section 09900.

2.04 SEDIMENT TRAPS

A. Provide one 4" in line sediment trap, 12,600 SCFH min. sludge gas capacity at 1.0" W.C. pressure drop Varec Fig. 233 with sight glass, Varec Fig. 218.

B. Storage Capacity: 6 Gallons min. sediment and 6 gallons min. condensate.

2.05 DRIP TRAPS

A. Provide six Drip Traps.

B. Ball float , automatic operated, needle valve type 1" NPT inlet, outlet connection, Varec Fig. 245.

C. Drip traps on sediment traps to have maximum 5 psig working pressure.

2.06 THERMAL VALVE AND FLAME TRAP ASSEMBLY

A. Provide two 4" outside diameter flame trap assemblies, Varec Fig. 450, with 4" size 125 lb. ANSI flanged connections, suitable for installing in horizontal or vertical pipe lines.

B. Thermal valve portion: fusible element release and spring operated plug type shut-off valve. Fusible element shall release at 260 degrees F. gas temperature and shall be replaceable without disassembling the valve. Include a sight glass to permit visual observation of plug position indicator. Construction: cast aluminum throughout except for stainless steel spring.

C. Flame trap: housing constructed of cast aluminum. Bank assembly: all aluminum, arranged for easy removal from the housing to facilitate inspection and cleaning of net free area through the bank assembly.
   1. Net free area through the bank assembly: not less than 4 times that of the corresponding size standard pipe.

2.07 FLAME CHECKS

A. Provide one 1/2" Flame Check Valve.

B. Flame arresting element to be compressed woven wire.

C. Pipe connections to be threaded.

D. Varec Fig. 52.

2.08 GAS FLOW

A. Provide two 4" diameter gas flow meters.

B. Meters to have capacity of 7200 CFH at pressure drop of 0.5" W.C.

C. Meter to be supplied with flanged ends.

D. Meter to be Rockwell Gas meter, Turbo-meter Mark II.

2.09 GAS MANOMETER

A. Provide three gas manometers all mounted on a common panelboard.

B. Manometers to be Varec Fig. 217.

2.10 REGULATOR

A. Provide one 4" size 125 lb. ANSI flanged connections.

B. Pressure relief portion: back pressure (upstream control) regulator valve acctuated by a spring loaded diaphragm, Varec Fig. 386.
   1. The spring barrel shall include a glass enclosed pointer and scale to indicate relief setting, arranged to permit setting adjustments without disassembling the diaphragm housing.
   2. Construction: cast aluminum throughout except for stainless steel moving parts and molded synthetic rubber fabric reinforced diaphragm. Varec Fig. 239
   3. Setting Range: from 2" to 12" W. C.

2.11 WASTE GAS BURNER (VAREC 239)

A. Provide one burner with a 4" size NPT waste gas connection, for mounting on roof of Digester Building.

B. Pilot: ring type, develop a flame curtain completely surrounding the gas nozzle.

C. Provide baffles in the ignition chamber to direct all gas through the curtain flame.

D. Provide shutter type air-gas mixture adjustment.

E. Pedestal: insulated internally, shall enclose the pilot gas line and shall include a base plate suitable for mounting on a concrete or steel support.

F. Pilot gas line: 1/2" NPT size.

G. Provide pilot observation and igniting port on the ignition chamber.

H. Burner Construction: steel throughout, except for the special heat resistant iron alloy pilot ignition ring, cast iron cover and frame of pilot ignition port and stainless steel orifices of pilot gas supply.

I. Provide an automatic pilot ignition system consisting of a pressure switch located on the gas line upstream from the relief valve.
   1. The pressure switch shall activate a solenoid valve in the pilot supply line.
   2. The pressure of gas will be relieved by the ignitor, and the ignitor shall automatically spark the pilot flame, in turn igniting the main burner.
   3. The pilot line shall be provided with a flame cell.
   4. Pressure switch and solenoid to be explosion-proof Class 1, Group D, Division 2.
   5. The system shall be 220 V 50 Hz 1 phase.
   6. Mount and wire the system per manufacturer's instructions.

J. If required by the waste gas burner manufacturer, the Contractor shall provide and install a secondary stack on the waste gas burner.

2.12 PRESSURE RELIEF VALVES

A. Provide two 2" diameter, pressure relief valves, Varec Fig. 700-81, 125 lb. flanges.

B. Each valve shall have a flow capacity of 7,000 ft 3/hr.

C. Construction shall be aluminum with replaceable synthetic rubber seat insert.

D. Adjustment of valve operating pressure shall be by lead weights.

2.13 THERMAL VALVE AND FLAME TRAP ASSEMBLY

A. Provide two 4" diameter thermal valve and flame trap assemblies, Varec Fig. 450.

B. Assembly to be suitable for installation in vertical or horizontal piping.

C. Thermal Valve:
   1. Valve shall have fusible element release and spring operated plug type shut-off.
   2. Fusible element shall release at 260 degrees F gas temperature and shall be replaceable without disassembling the valve.
   3. Provide a sight glass to permit visual observation of plug position indicator.
   4. Valve shall be cast aluminum with stainless steel spring.

D. Flame Trap:
   1. Housing shall be cast aluminum.
   2. The bank assembly shall be all aluminum and shall be arranged for easy removal from housing to facilitate inspection and cleaning.
   3. Net free area through bank assembly shall be not less than four times that of the corresponding size standard pipe.
   4. All grids of bank shall be individual corrugated stamped and rectangular shaped sheets arranged for individual removal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Contractor shall install and erect the equipment specified in this specification.

B. After field erection the gas holder shall be tested for gas tightness at a pressure of 10" W.C. Gas tightness shall be tested by filling the tank with water and trapping air beneath the cover plates. All welded seams shall be checked for leaks by using a soap solution as a testing agent.

3.02 FIELD PERFORMANCE TEST

A. Perform a field performance test on the digestion tank mixing equipment prior to the final acceptance of the equipment. The test shall demonstrate that the digestion tank mixing equipment is capable of maintaining the entire tank contents at a uniform concentration. The performance test shall be run on the digester tank with all of the associated mixing and heating equipment installed and operable.

B. Sixty days prior to the start of test, submit to the Engineer for approval detailed drawings and procedures for performing the test including piping and instrumentation drawings for any temporary connections required.

C. Successful mixing shall be if the mean volatile solids concentration of any sample point in the tank does not vary from the mean solids concentration in the entire tank by plus or minus 5%.

D. The field test shall be performed on the digester tank filled with digesting waste to its normal operating level.

E. Sample the tank after the anaerobic digestion process has reached a steady-state condition. The tank shall be producing sludge gas a minimum of 30 days prior to commencing the test.

F. Notify the Engineer seven days prior to commencing the test. The test shall be run for seven days with the digester operating as specified.

G. Arrange sampling procedures so that at least 12 sampling locations are sampled once every eight hours. Remove samples from the tank through the means provided on the roof in sufficient quantity to allow subsequent analysis as specified.

H. Perform sample analysis by an independent laboratory approved by the Engineer. All samples shall be analyzed for percent volatile solids in accordance with the current recommended test of U.S. EPA Standard Methods.

I. At the end of the seven day test period, compute the mean volatile solids concentration for::
   1. each of the 12 sample locations from the 21 samples collected at each sample location,
   2. the entire tank from all of the samples collected.

J. If the digestion tank mixing equipment fails to meet the requirements for successful performance specified, make alterations, modification, additions, and corrections as required to enable the equipment to meet the requirements of the test.

3.03 SPARE PARTS

A. Provide the following spare parts, delivered to the Project Site:
   1. Three sets of packing for each pump.
   2. Two sets of drive belts for each Mixing Pump.
   3. One temperature Regulator.
   4. One pressure relief valve.

END OF SECTION

SECTION 11331

MECHANICALLY CLEANED BAR SCREEN

PART 1 GENERAL

1.01 RELATED WORK

A. Section 11000: Mechanical Equipment General.

B. Section 16151: Process Motors.

1.02 SYSTEM DESCRIPTION

A. Two mechanically cleaned climber type bar screens installed outdoors for removal of bulk solids from the incoming sewage.

B. The rack assembly, when not in operation, shall be positioned out of the path of water flow in the channel. Design that requires the rack assembly (sprockets, chains, rack) to be in the water path when not in operation will not be acceptable.

1.03 DESIGN CRITERIA

A. Conform to Schedule attached to the end of this Section.

1.04 SUBMITTALS

A. Submit shop drawings in accord with Section 01340.

B. Submit operation and maintenance manual in accord with Section 01730.

1.05 REFERENCE STANDARDS

A. American Society for Testing and Materials:
1. ASTM A36: Structural Steel.
2. ASTM A276: Stainless and Heat-Resisting Steel Bars and shapes.

PART 2 PRODUCTS

2.01 DESCRIPTION OF EQUIPMENT

A. Each bar screen shall consist of the following:
1. Bar Rack
2. Dead Plate
3. Side Frames
4. Pin Rack
5. Rake Assembly
6. Wiper Arm
7. Drive
8. Controls

B. The equipment furnished shall positively clean and remove debris from incoming sewage by means of a bar rack to retain debris and a climbing rake to remove and elevate the debris to a discharge mechanism.

C. The bar rack shall be cleaned by the rake engaging the bar rack from the front (upstream side) at the channel invert and removing debris on its upward travel.

2.02 STEEL

A. Structural Steel: Conform to Section 05120.

B. Thickness: Minimum 1/4 inch.

C. For wetted parts: Stainless steel, ASTM A276, Type 316.

D. For other parts: ASTM A36.

2.03 IRON CASTINGS

A. Conform to ASTM A48.

B. Material: close grained gray iron.

2.04 ANCHOR BOLTS

A. Material: stainless steel.

2.05 BAR RACK

A. Design to withstand forces of screen blinding sufficient to cause three foot head differential.

B. Material: stainless steel bars; 1/2" x 5/16" x 2" trapezoidal bars with 1" clear openings between.

C. Separate bars with stainless steel spacers welded in place at ends of bars.

D. Extend full width of channel from bottom of channel to one foot, minimum, above the maximum water depth.

E. Connect to dead plate and design for anchorage to channel floor.

F. Construct to allow bar rack removal without additional disassembly of bar screen components.

2.06 DEAD PLATE

A. Material: stainless steel plate.

B. Provide minimum 1/4 inch steel lip on dead plate at discharge point.

C. Bolt to side frames.

D. Extend from top of bar rack to discharge point within the bar screen housing.

2.07 SIDE FRAMES

A. Side frames: Steel plate construction formed to a channel section, reinforced to support the required loads.

B. Frames shall be fastened to the concrete channel.

2.08 PIN RACK

A. Provide pin rack designed to mesh with the two cogwheels of hardened steel in each side frame, consisting of steel bolts fitted with hardened and ground steel bushings and rollers.

2.09 RAKE ASSEMBLY

A. Remove debris from bar rack with a stainless steel rake assembly designed to mesh with bar rack.

B. Rake Assembly: Consists of a formed section ten inches deep, minimum, with a shelf and tines attached to the rake arm. Support rake-arm assembly by main drive shaft and attach to cogwheels which rotate on and are supported by the pin rack.

C. Hold rake-arm assembly against bar rack by coil spring.

D. Maintain alignment of the rake-arm assembly with guide follower rollers which travel in guide tracks attached to the side frame.

E. Design rake to climb over and be free of an object encountered that cannot be removed. After the object has been bypassed, the rake shall again mesh with and continue to clean the bar rack.
   1. Provide positive overload protection against an object which is too large to be bypassed by mounting the drive on a spring restrained rotating support.
   2. If the load on the rake carriage mechanism increases beyond a predetermined value, the drive and linkage shall rotate, causing a limit switch to stop the drive.
   3. When the overload condition has been corrected, the drive may again be operated by manual pushbutton activation.

F. Design bar screen mechanism to be reversed by manually operated electric controls. Provide spring loaded switch to allow operator to reverse the rake assembly free of the object which has caused the overload.

2.10 WIPER ARM

A. Design wiper to pivot to allow cleaning of the rake on each pass.

B. Cushioned wiper shall travel to the rest position by shock absorbers.

2.11 DRIVE

A. Conform to Section 16151.

B. The drive shall have a minimum capacity of 1.5 horsepower. The motor shall contain an integral spring loaded electro-mechanical disc brake released by energization of the operating coils simultaneously with starting the motor.

2.12 CONTROLS

A. Conform to Section 13445 except as follows:
1. Enclosures: explosion proof.
2. No motor interface--all starters furnished.

B. Operation:
1. Manual-Run (Stop) independent of timers and level switches.
2. Automatic-Cycle periodically (adjustable) on a 24-hour repeating cycle or on high upstream level (switch operation).

C. For each bar screen provide the following:
1. One limit switch to stop screen rake in a position which will minimize potential jamming when screen is started again.
2. One emergency float switch with mounting bracket, brass rod, and copper float.
3. One master control panel (CP-51A&B), factory assembled, wired, piped, and tested containing the following:
   a. On front face
      1) Hand operated switch with forward, reverse, off and automatic positions for local control.
      2) Power on indication.
      3) Malfunction indication.
      4) Main disconnect operation.
   b. Internal
      1) Circuit Breaker Disconnect.
      2) Motor Starter with Overload Protection.
      3) Timer.
      4) Logic Relays.
      5) Intrinsic safe relays.
      6) Field Terminals.
   c. Auxiliary dry contacts for remote use
      1) Motor Run.
      2) Malfunction alarm.
   d. Alarm points
      1) Malfunction (shear pin, torque limit).

PART 3 EXECUTION

3.01 INSTALLATION

A. Conform to manufacturer's instructions and Section 11000.

B. Install bar screen.

C. Start bar screen in accord with Section 11000.
   1. Provide manufacturer's representative to assist with start-up.

D. Train Owner's personnel in accord with Section 01735.
   1. Provide minimum 8 hours training time.

3.02 SPARE PARTS

A. Provide the following spare parts for each bar screen:
   1. Two sets of cogwheels.
   2. Rollers and bushings for ten feet of pin rack.
   3. Two limit switches.
   4. Two wiper blades.
   5. One timer.
   6. One float switch assembly
   7. 12 lamps (indicating).

3.03 BAR SCREEN EQUIPMENT NO. ME-01A&B Number Required: 2

A.	Channel	
	1. Depth, ft.:	See Contract Dwgs.
	2. Width, ft.:	4
	3. Material:	Concrete
B.	Fluid	
	1. Type:	Raw Sewage
	2. Min. Flow (thru each screen);,; mgd:	1.20
	3. Avg. flow (thru each screen), mgd:	2.98
	4. Max. flow (thru each screen), mgd:	12.82
	5. Maximum depth, ft. Downstream:	3.50
	6. Min. Depth Ft. Downstream:	2.00
C.	Bar Rack	
	1. Incline from horizontal, deg.:	80
	2. Clear opening between bars, in.:	1"
D.	Discharge	
	1. Height above top of channel, ft.:	See Contract Drawings.
E.	Motor	
	1. Volts/Phase/Hz.:	380/3/50
	2. Horsepower:	

END OF SECTION

SECTION 11353

MIXERS

PART 1 GENERAL

1.01 RELATED WORK

A. Section 11000: Mechanical Equipment General.

B. Section 16151: Process Motors.

1.02 DESIGN CRITERIA

A. Conform to schedules at the end of this Section.

B. Design mixers for 24 hour per day continuous operation in an outdoor environment.

1.03 SUBMITTALS

A. Submit Shop Drawings and Certificates of shop tests in accord with Section 01340.

B. Submit Certificate in accord with Section 01340 stating that the gear reducer is designed to the applicable AGMA standards.

C. Submit Operation and Maintenance Manuals in accord with Section 01730.

D. Submit design and location detail drawing and calculations of all necessary baffles. Include material definition and method of mounting.

PART 2 PRODUCTS

2.01 MATERIALS OF CONSTRUCTION

A. Manufacturer's standard for media in which mixer is immersed, unless otherwise specified.

2.02 GEAR REDUCER

A. Design and rate in accordance with AGMA standards and the following. Provide AGMA nameplate.

B. Service Factor: 2.5, except as follows:
1. If the rating element is other than a high speed bearing, provide a 3.0 service factor for that element.
2. If gear reducer has integral independent bearing support construction, provide a minimum 1.5 service factor.

C. Bearings: anti-friction, adapter type, shaft bearings, grease lubricated with grease inlet and relief accessible from mounting surface.
   1. Output shaft bearing L_{10} rating: 370,000 hours.
      a. If gear reducer has integral independent bearing support construction, the other bearings in the speed reducer shall have a bearing L_{10} rating of 25,000 hours. Provide minimum 100,000 hours.
   2. All other bearings L_{10} rating: 200,000 hours.

D. Gearing life factor: 100 million cycles.

E. Totally enclosed helical or spiral gears, quality eight, minimum, in accordance with AGMA 390.02.

F. Output shaft: self-supporting when mixer shaft bearings are removed.

G. Provide dry well around output shaft to prevent oil leakage from the reducer along the shaft.

H. Base gear and bearing life on sum of continuous and transient loads except starting loads.

2.03 LUBRICATION OF GEAR REDUCER

A. Type: splash.

B. Provide readily viewable sight glass oil level indicator and dipstick device.

C. Provide oil drain plug, located at the low point of the gear reducer so oil can be removed without lifting or dismantling mixer assembly.

D. Provide breather above possible oil foam level.

2.04 MIXER SHAFT

A. Maximum Rotational speed: 40 percent of the first critical speed of the shaft and impeller assembly. 80% of the first critical speed of the shaft and impeller assembly will be allowed with properly designed stabilizers on the impeller shaft.

B. Maximum deflection: 1/4" per ten feet when rotated by hand.

C. Cut keyway in shaft to allow vertical adjustment of the impeller.

D. Design shaft to be removable from gear reducer without disturbing the internal gearing.

E. Provide thrust bearing independent of gear reducer to support entire weight of mixer shaft and impeller assembly.

2.05 IMPELLER

A. Design: such that dynamic balancing is not required.

2.06 ANCHORS

A. Anchor bolts, nuts and washers: stainless steel.

2.07 MOTOR

A. In accord with Section 16151.

2.08 BAFFLES

A. The Contractor shall provide and install all baffles required by the mixer manufacturer. The quantity, location, design, and support of the baffles shall be detailed by manufacturer.

2.09 ASSEMBLY

A. Mount motor and gear reducer on common base.

B. Connect motor and gear reducer with flexible coupling, protected by OSHA approved guard.

C. Connect gear reducer output shaft to mixer shaft with flexible coupling protected by OSHA approved guard.

D. Locate couplings and bearings above mounting platform.

E. Provide gasket for gas tight seal between mounting base and assembly base.

2.10 FINISH

A. Factory finish mixer assembly in accord with manufacturer's standard for service conditions.

PART 3 EXECUTION

3.01 INSTALLATION

A. Conform to manufacturer's instructions and Section 11000.

B. Install baffles and mixers.

C. Start mixers in accord with Section 11000.
   1. Provide manufacturer's representative to assist with start-up.

D. Train Owner's personnel in accord with Section 01735.
   1. Provide minimum 8 hours training time.

3.02 SPARE PARTS

A. Provide the following spare parts for each mixer:
   1. One set of gears for gear reducer.
   2. One set of bearings and seals for gear reducer.

3.03 Chlorine Mixers MIXER NO. ME-04A&04B

A.	Operating Conditions:	
	1. Tank Dimensions, feet:	14.99x10.00x18.0
	2. Free Board, feet:	7.52
	3. Tank Side Water Depth, feet:	10.47
	4. Flow Rate, Maximum, gpm:	5804
	5. Fluid:	Wastewater & 10 ppm CL_2 Solution
	6. Specific Gravity:	1.00
	7. Viscosity, SSU:	
	8. Temperature, deg. C.:	
	9. Concentration:	10 ppm CL_2
	10. pH:	
	11. Duty:	Continuous
	12. Mounting:	Platform
	13. Type of Mixing:	Dissolving
	14. Number of Mixers Required	Two
B.	Performance:	
	1. Pumping Rate, gpm:	
	2. Tip Velocity, fpm:	
	3. Output Shaft, rpm:	
	4. Manufacturer:	
	5. Model Number:	
C.	Construction:	
	1. Shaft Material:	Rubber Coated Steel
	2. Shaft Diameter:	Manufacturer to determine
	3. Shaft Length:	See Contract Drawings
	4. Impeller Material:	Rubber Coated Steel
	5. Impeller Diameter:	Manufacturer to determine
	6. No. and Type Impeller:	Manufacturer to determine
	7. Stabilizer:	Manufacturer to determine
	8. Type of Lubrication:	
	9. Base Plate Material:	Steel
D.	Motor:	
	1. Volts/Phase/Cycles:	380/3/50
	2. Horsepower:	

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3.04 Septage Tank Mixers MIXER NO. ME-03A&03B

A.	Operating Conditions:	
	1. Tank Dimensions, feet:	32.8x29.52x13.10
	2. Free Board, feet:	3.26 to under side of roof
	3. Tank Side Water Depth, feet:	9.84 to 3.00'
	4. Fluid:	Septage
	5. Specific Gravity:	1.0+
	6. Viscosity, SSU:	
	7. Temperature, deg. C.:	
	8. Concentration:	
	9. pH:	
	10. Duty:	Continuous
	11. Mounting:	Platform
	12. Type of Mixing:	Solids Suspension
	13. Number of Mixers Required	Two
B.	Performance:	
	1. Pumping Rate, gpm:	
	2. Tip Velocity, fpm:	
	3. Output Shaft, rpm:	
	4. Manufacturer:	
	5. Model Number:	
C.	Construction:	
	1. Shaft Material:	Steel
	2. Shaft Diameter:	Manufacturer to determine
	3. Shaft Length, meters:	See Contract Drawings
	4. Impeller Material:	Steel
	5. Impeller Diameter:	Manufacturer to determine
	6. No. and Type Impeller:	See Remark #1
	7. Stabilizer:	
	8. Type of Lubrication:	
	9. Base Plate Material:	Steel
D.	Motor:	
	1. Volts/Phase/Cycles:	380/3/50
	2. Horsepower:	

E. Remarks:

1. Septage will contain stringy and fibrous type of material,. Mixer impeller to be provided with sweptback blades and mixer to be supplied with restraining ring to prevent shaft deflection.

END OF SECTION

SECTION 11354

POLYMER SYSTEM

PART 1 GENERAL

1.01 RELATED WORK

A. Section 11000: Mechanical Equipment General.

B. Section 13445: Instrumentation and Control for Packaged Systems.

C. Section 16151: Process Motors.

1.02 SYSTEM DESCRIPTION

A. The Polymer System will be housed in the Digester Building and will feed polymer solution to the flocculator well of the final clarifiers.

B. Dry polyelectrolyte material will be manually added from bags into the storage hopper, and manually put into a 0.25% solution by the eductor and fed into the mixing/storage tanks.

C. One mixing/storage tank will be used for make-up and aging while the other is being used for dispersing the solution to the metering pumps.

D. The five metering pumps will be divided into two separate systems consisting of two pumps each with a common spare. Each system will be designed to operate independently of the other, but shall have the same operating range.

E. Each pump system shall be designed to deliver a minimum of 8 gph to a maximum of 160 gph.

F. The Polymer System shall consist of the following components:
1. Two mixing/storage tanks.
2. Two dry polymer feeders.
3. Two clamp on mixers.
4. Five metering pumps.
5. Water network.
6. Control System.

G. The system shall be supplied as a package unit by one manufacturer, complete with interconnecting piping, instrumentation, and controls.

1.03 SUBMITTALS

A. Submit Shop Drawings in accord with Section 01340.

B. Submit Operation and Maintenance Manual in accord with Section 01730.

PART 2 PRODUCTS

2.01 MIXING/STORAGE TANKS

A. Capacity: 1850 gallons each. Two required.

B. Dimensions: 83 inches diameter by 68 inches straight side.

C. Material: ASTM A276, Type 304 stainless steel, minimum thickness, 12 gage (2.66 mm).

D. Bottom: Dished.

E. Provide mixer mounting pad.

F. Top edge of tank to be reinforced with knuckle radius.

G. Provide 2 inch NPT overflow and 3 inch NPT outlet.

H. Provide 3 inch stainless steel standpipe extending 66 inches long up 1 inch from the knuckle radius. Position to 2 inch from the inside wall and support by stainless steel brackets, to house the two level switches.

I. Support legs, four required, adjustable.

2.02 DRY POLYMER FEEDERS

A. Each to consist of the following:
1. Hopper with lid.
   a. Capacity: 1-3/4 cubic feet
   b. Material: ASTM A276, Type 304 stainless steel.
2. Feed Trough:
   a. Material: ASTM A276, Type 304 stainless steel
3. Provide vibrators for hopper and feed trough.
4. Heating Device: infra red light.
5. Eductor: non-fouling, adjustable.
   a. Material: high density polyethylene
   b. Minimum throat diameter: 1-3/8 inches (35 mm).
6. Provide water network capable of 30 gpm through the eductor consisting of:
   a. 1 inch bronze ball valve.
   b. 1 inch solenoid valve.
   c. Flow control valve.
   d. 7 foot hose assembly.
7. Support stand: pre-fabricated steel frame to support entire feeder.
8. Electric service to feeder shall be 220 V, 1 phase, 50 Hz.

2.03 MIXERS

A. Type: propellers with stabilizing ring on bottom propeller and clamp mount.

B. Material: shaft and propellers: ASTM A276, Type 304 stainless steel.

C. Motor: 1-1/2 HP Minimum 380 Volt Three Phase, 50 Hz.

D. Mixer rpm: 420

2.04 FEED PUMPS

A. Type: Metering, positive displacement diaphragm, hydraulically actuated.

B. Capacity: 8 GPH minimum to 80 GPH maximum at 120 PSIG maximum pressure pumping polyelectrolytes up to 5000 centipoise.

C. Materials:
1. Diaphragm, hypalon.
2. All other parts in contact with polymer to be ASTM A276, Type 316 stainless steel.

D. Provide single ball type check valves on suction and discharge.

E. Provide back pressure valve on each discharge.

F. Provide pulsation dampener on each discharge piping.

G. Pumps shall be capable of dry lift self-priming with a suction lift equivalent to 16 feet of water and capable of running dry indefinitely.

H. The discharge assembly shall be self-venting so as to deliver entrapped air into the discharge pipeline.

I. Drive Assembly.
1. Provide built-in adjustable relief valve in the hydraulic drive to protect drive.
2. Provide flexible coupling with guard between motor and pump shaft.
3. Provide full closure for all gearing and operating mechanism.

2.05 CONTROL SYSTEM

A. The control system shall conform with the requirement of Section 13445 except as follows:
1. No One-Line diagrams are required.
2. No graphic is required.
3. No motor control interface (all starters provided).

B. The system shall consist of:
1. Field devices provided, installed and wired, including, but not limited to, level switches, water flow indicators with valves, pressure gauges (metric).
2. Water valves installed and wired.
3. Motors wired.
4. Control Panel(s) containing:
   a. On the face: operational controls and status indication for each motor, low level alarm indication, fill controls, and main disconnect.

b. Internal to the Panel(s): motor starters, motor protection, control logic and alarm relays, field device and power terminals.
c. Dry contacts for each motor run indication and low level alarm.

C. Completely assemble, wire, test and document control system prior to shipment.

D. Two 380/220 volt, 3 phase, 50 hertz power sources will be available.

PART 3 EXECUTION

3.01 INSTALLATION

A. Conform to manufacturer's instructions and Section 11000.

B. Install polymer system.

C. Start polymer system in accord with Section 11000.
1. Provide manufacturer's representative to assist with start-up.

D. Train Owner's personnel in accord with Section 01735.
1. Provide minimum 8 hours training time.

3.02 SPARE PARTS

A. Provide the following spare parts:
1. Two sets of ball check valves for each pump.
2. Two pulsation dampeners.
3. One back pressure valve.

END OF SECTION

SECTION 11361

PRIMARY CLARIFIER

PART 1 GENERAL

1.01 RELATED WORK

A. Section 11000: Mechanical Equipment General

B. Section 16151: Process Motors

1.02 DESCRIPTION OF INSTALLATION

A. The Clarifier shall treat raw sewage which has passed through a mechanically cleaned bar screen and an aerated grit chamber.

B. Two complete mechanisms, including longitudinal and cross collections, shall be provided to fit into rectangular concrete tanks. The tanks will be of common wall construction. Each mechanism shall have separate drives; common drives are not acceptable.

1.03 SYSTEM DESCRIPTION

A. The longitudinal sludge collector shall convey the settled sludge to a sludge hopper located at the influent end of the tank and on its return shall move the scum to the scum collector and operate at a speed of 2 fpm.

B. A cross collector in the sludge hopper shall convey the sludge to a sludge pocket and operate at a speed of 2 fpm, from which the sludge will be withdrawn by Plunger Pumps.

C. The clarifier mechanism in each tank shall be independent of other mechanisms.

D. Longitudinal and cross collectors shall have interchangeable drive chains, sprockets and bearings.

1.04 SUBMITTALS

A. Submit Shop Drawings in accord with Section 01340.

B. Submit Operation and Maintenance Manuals in accord with Section 01730.

PART 2 PRODUCTS

2.01 PRIMARY CLARIFIER

A. Each Primary Clarifier Mechanism shall consist of the following:
1. Longitudinal sludge collector complete with driver.
2. Cross sludge collector complete with driver.

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3. Scum collector and baffles.
4. Effluent weirs and troughs.

2.02 MATERIALS

A. Structural Steel:
1. Material: Conform to ASTM A36.
2. Submerged shapes and plates: Minimum 1/4 inch (6.5 mm) thickness.
3. Match mark structural sub-asemblies for ease of field erection.

B. Aluminum: AA, Alloy 6061-T6.

C. Stainless Steel: ASTM A276, Type 316.

D. Anchor Bolts: Stainless steel.

2.03 SLUDGE COLLECTOR MECHANISM, LONGITUDINAL AND CROSS COLLECTOR

A. The Sludge Collector Mechanisms (both longitudinal and cross collectors) shall be supplied with the following components:

B. Driver:
1. Type: Speed reduction unit with direct drive electric motor on a common (motor and reducer) base mounted directly on the concrete platform.
2. Motor: Conform to Section 16151.
3. Speed reduction unit to be of worm and worm gear type, fully housed, running in oil, with anti-friction bearings throughout.
4. Gear Driver to provide flight velocity of 2 fpm.
5. Provide flexible coupling between motor and speed reduction unit, Falk or approved equal.
6. Provide overload shear pin.
7. Provide electrical overload device with two 220 volt Contacts, single-pole double-throw (SPDT), one for alarm and one to shut off motor prior to excessive overload.
8. Provide galvanized metal guard for all exposed moving parts above operating platform.

C. Drive Chain and Sprockets: Driver to head shaft
1. Type: bushed roller with heat-treated high carbon steel offset side bars, minimum thickness 3/16" case hardened steel pins and bushings, and heat treated high carbon steel rollers.
2. Designed to provide ultimate strength of 20,000 pounds
3. Provide chain tensioner, adjustable from drive platform.
4. Drive sprocket to be 10 tooth minimum, all sprockets to be heat treated to 360 Brinell hardness with 3/16-inch chill depth. Drive sprockets to be split.

D. Shafts:
1. Material: cold rolled solid steel.

2. Type: one continuous piece between bearings, straight and true.
3. Provide keyways where required to insure proper phasing of the sprocket teeth.
4. Design and size to transmit the power required.
5. Full shaft diameter shall be maintained the entire length of the shaft.
6. All shafts shall turn in end bearings.

E. Sprockets; Collector:
1. Material: Cast iron, chilled, with teeth and rims having a Brinell hardness of not less than 375 to a depth of not less than 3/16" 19 tooth minimum headshaft, 13 tooth minimum turn shafts.
2. Provide keyway to shaft where necessary.
3. Provide split type sprockets with chain saving rims minimum 3/4" wide and nuts with stainless steel locking devices for all underwater units.
4. Grind to accurately mesh with chain.
5. Provide bore to match shaft diameter.
6. Sized to sufficiently transmit the required power by equipment manufacturer.

F. Idlers:
1. Provide one free-wheeling sprocket positioned on the shaft by split type set collars.
2. Fix the other sprocket on the shaft.
3. Provide collection chain tension adjustment to take up one chain link on one of bottom idlers with non-corrosive take-up screws.

G. Bearings:
1. Type: Self-aligning, babbitt lined, water lubricated, with split type housing to permit removal of the shaft designed to shed accumulated sludge.
2. Provide grease inserts for lubrication when tank is dewatered.

H. Flights:
1. Material: 3' x 8" nominal size, surfaced four sides, select structural Douglas Fir or select heart redwood, free from knots, cups, cracks, bows and twists.
2. To be drilled and tapped for attachments and wear shoes.

I. Collector Chain:
1. Material: corrosion resistant, copper bearing processed malleable iron, Class 700 pintel type, 80,000 psi ultimate strength and 180-210 Brinell hardness.
2. Dimensions: 6 inch pitch, 3/4 inch pin diameter, 1-1/2 inch barrel diameter, 6 lb/ft and 40,000 pound average ultimate strength.
3. Provide contoured side bars on both sides to ride on sprocket chain saver rim.
4. Connect links with heat treated pins and rivets.
5. Place contoured flight attachment links at ten foot intervals for long collectors and 5' for cross

collectors. Extend flight attachment full depth of flight. Attach flights with four bolts at points where wearing shoes contact bottom rails. Pivoted flight attachments are not permitted.
6. The use of non-metallic chain will not be permitted.
7. All attachment bolts shall be stainless steel.

J. Wearing Shoes:
1. Material: 3/8" thick mild steel, case hardened to minimum Rockwell C of 55.
2. Type: angle type, minimum 6 inch wide.
3. Drill bottom rail wearing shoes to match flight attachment links.
4. Provide four wearing shoes for each flight, two to ride on bottom rails and two to ride on return rails.
5. Return rail shoes shall have guide lug every third flight.

K. Return Rails:
1. Material: steel angle sections, 3-1/2 inch x 5 inch x 3/8 inch minimum dimensions.
2. Support rails with 1/4" steel brackets spaced ten feet on center maximum.

L. Bottom Rails:
1. Material: straight and true steel T rails, minimum 20 lb/ft.
2. Place rails in the floor on chain center line of tank under each collector; screed floor to top of rail.

2.04 SCUM COLLECTOR

A. Design:
1. Provide intermittent removal of scum conveyed to collector by return of longitudinal collector.

B. Collector:
1. Material: 400 mm schedule 20, minimum, steel pipe with longitudinal slots, designed to span width of tank without intermediate support.
2. Mount collector in cast iron flanged wall bearings.
3. Provide grease resistant neoprene seal for bearing at open end of collector only.
4. Provide positive mechanical adjustment.

C. Operating Mechanism:
1. Mechanism shall rotate scum collector to allow scum to enter slots in collector.
2. Type: cast iron worm and worm gear.
3. Provide cast iron floor stand mounted on the walkway.
4. Provide 12 inch diameter aluminum handwheel located 36 inches above walkway, see Contract Drawings for walkway details.
5. Extend steel tubing shaft from handwheel to gearbox.

2.05 EFFLUENT WEIR, TROUGH AND SCUM BAFFLES

A. Weir and Trough:
   1. Material: aluminum or FRP.
   2. Weir: 9 inch, minimum, deep plate with 90 deg. 2-1/2 inches V notches spaced 6 inches on center. Provide 2 inch vertical adjustment.
   3. Trough: 1.25 feet deep from bottom of weir with notches in normal position, self supporting across the width of tank.
   4. Attach weir to trough with a rubber gasket seal.
   5. See Contract Drawings for arrangement of effluent troughs and weirs.

B. Scum Baffle:
   1. Material: Pretreated pine.
   2. Locate baffle downstream of collector attached to tank walls.
   3. Baffle to span tank width.

PART 3 EXECUTION

3.01 INSTALLATION

A. Conform to manufacturer's instructions and Section 11000. Provide manufacturer's services for a total of 8 days on site, in two separate trips, to certify installation and operation.

B. Install clarifier mechanism.

C. Start clarifier in accord with Section 11000.

D. Train Owner's personnel in accord with Section 01735.
   1. Provide minimum 8 hours training time.

3.02 SPARE PARTS

A. The following spare parts shall be delivered to the project site for each clarifier mechanism.
   1. 20 ft. of longitudinal collector chain
   2. 20 ft. of cross collector chain.
   3. 20 sets (2 per set) of wearing shoes.
   4. 6 Plain flights 20' long.
   5. One complete drive assembly with sprockets
   6. One drive chain.

3.03 ASSEMBLY

A. Drive to be shipped assembled complete with motor, coupling, reducer, base and drive sprockets.

B. Shaft to be shipped assembled with sprockets, collars and bearings.

C. Chain to have flight attachments mounted.

3.04 PRIMARY CLARIFIER EQUIPMENT NO> ME-100A, 100B

1.	Tank Width:	6 meters
2.	Tank Length:	36 meters
3.	Tank SWD:	See Contract Drawings
4.	Tank Bottom Slope:	See Contract Drawings
5.	Flow Per Tank (influent):	
	Design (MGD):	1.613
	Peak (MGD):	4.273
	Minimum (MGD):	0.605
6.	Influent TSS:	995 mg/l
7.	Effluent TSS:	325 mg/l
8.	Underflow Per Tank (Peak) MGD:	0.388
9.	Percent Solids Underflow:	4-5%

10. Drive and collector mechanism shall be designed for an operating sludge load of 30 pounds per foot.

END OF SECTION

SECTION 11362

CIRCULAR FLOCCULATOR CLARIFIER

PART 1 GENERAL

1.01 RELATED WORK

A. Section 11000: Mechanical Equipment General

B. Section 16151: Process Motors

1.02 DESIGN CRITERIA

A. Conform to the Schedule attached to the end of this Section.

B. Design for continuous operation.

1.03 REFERENCE STANDARDS

A. Aluminum Association:
1. Alloy and Temper Designation Systems for Aluminum.

B. American Gear Manufacturers Association:
1. AGMA 210.02:
2. AGMA 220.02:
3. AGMA 440.04:

C. American Society for Testing and Materials.
1. ASTM A36: Structural Steel
2. ASTM A276: Stainless and Heat-Resisting Steel Bars and Shapes.

D. Anti-Friction Bearing Manufacturer's Association:
1. AFBMA Standard 9: Load Ratings and Fatigue Life for Ball Bearings.

1.04 DESCRIPTION OF INSTALLATION

A. The Clarifiers shall treat mixed liquor which has passed through a trickling filter and activated sludge aeration basin.

1.05 SUBMITTALS

A. Submit Shop Drawings in accord with Section 01340.

B. Submit Operation and Maintenance Manual in accord with Section 01730.

C. Submit design and location detail drawing and calculations for all necessary baffles. Include material definition and method of mounting.

PART 2 PRODUCTS

2.01 MATERIAL OF CONSTRUCTION

A. Clarifier Mechanism shall consist of the following:
1. Bridge and walkway
2. Center column
3. Center drive mechanisms
4. Motor
5. Overload device
6. Flocculator influent well
7. Flocculator
8. Influent feed pipe and pier
9. Hydraulic sludge collection mechanism
10. Scum skimmer
11. Scum trough
12. Effluent weirs and scum baffles

B. Provide Manufacturer's Standard materials of construction for service conditions unless specified otherwise.

C. Structural Steel:
1. Material: Conform to ASTM A36.
2. Submerged shapes and plates: minimum 1/4 inch (6.5 mm) thickness.
3. Match mark structural sub-assemblies for ease of field erection.

D. Stainless Steel: ASTM A276, Type 316.

E. Aluminum: AA, Alloy 6061-T6.

F. Fiberglass Reinforced Plastic (FRP):
1. Fiberglass content: 30% plus or minus 2%
2. Plates: smooth, resin-rich surface with no glass fibers exposed.
3. Laminates: dense, without voids, dry spots, cracks or crazes with the following physical properties at 73 deg F.
a. Thickness: 1/4 inch min.
b. Ultimate Tensile Strength: 12,000 PSI min.
c. Flexural Strength: 19,000 PSI min.
d. Barcol Hardness: 35
e. Flexural Modulus of Elasticity: 800,000 PSI min.

G. Anchor Bolts: Stainless Steel.

2.02 BRIDGE AND WALKWAY

A. Type: Half Span supported by Center Column, all welded construction.

B. Design:
1. Loads: Design Load, 150 psf live load and dynamic loads of mechanisms, combined.
2. Deflection, Maximum: 1/240 of Span (Half Span Bridge)

C. Bridge Material: Structural Steel Shapes.

D. Walkway:
1. Material: Aluminum Grating
2. Size: Minimum 3 feet (1 meter) wide for access to bridge and 3' clear around gear drive and Flocculator Drive .

E. Handrail and Toeplate
1. OSHA approved both sides of walkway and enclosing mechanism platform.
2. Material: 1-1/2" diameter Schedule 80 clear anodized aluminum pipe with 1/4" thick by 4" wide continuous clear anodized aluminum toe plate of same material and finish .

2.03 CENTER COLUMN INCLUDING CLARIFIER FEED PIPE AND RETURN SLUDGE PIPE

A. Design:
1. Shall serve as influent pipe and be capable of supporting drive, collector mechanism, bridge and walkway, flocculator well and sludge well; no torque load shall be taken by the bridge.
2. Cylindrical in shape and be fabricated of minimum thickness of 3/8" steel plate.
3. Provide series of inlet ports at water surface elevation to distribute influent at low velocity into the flocculator well.
4. Return sludge pipe to have a maximum velocity of 4 ft/sec.

B. Provide anchor bolt location template

C. Top of column to have a drive mechanism mounting plate to be set plumb with the center line

2.04 FLOCCULATOR INFLUENT WELL

A. Material: Fabricated Steel Plate 1/4" Minimum

B. Type: Center feed with peripheral ports at water surface elevation to direct floating material to skimmer, to be supported from bridge assembly.

C. Size: 25 feet diameter by 6.5 feet sidewater depth

2.05 FLOCCULATOR

A. Type: Turbine

B. A minimum of two flocculators shall be provided in each well.

C. Turbine shall produce a velocity gradient of G=60 fps at maximum tip speed of 6 ft/sec.

D. Drive:
   1. mechanical adjustable variable speed.
   2. Three to one speed variation.
   3. Totally enclosed.
   4. Belt or friction type drives will not be accepted.
   5. Service factor of 1.25 based on maximum theoretical horsepower.
   6. Motor, coupling and reducer and base plate to be shop assembled and shipped assembled.

E. Speed Reducer:
   1. Totally enclosed gear reducer, with dust seal, internal gear, pinion, anti-friction ball bearing to run in oil bath.
   2. Service Factor: 1.25 based on maximum theoretical horsepower, in accord with AGMA Standards.
   3. Housing with oil fill, level pipes, drain plug.
   4. Oil change to be accomplished without disassembly of motor, reducer or agitator.
   5. Coupling between motor output shaft and gear reducer.
   6. Mount flocculator drive on bridge.
   7. Flocculator shaft shall be connected to output shaft of gear reducer by rigid coupling.
   8. Turbine shall be keyed to flocculator shaft.

2.06 CENTER DRIVE MECHANISM

A. The center drive mechanism shall consist of gear motor, enclosed gear reducer, main ring gear, and platform for mounting drive on center column and shall be designed and rated for the stall torque of the mechanism.

B. Mount gear motor and gear reducer on drive base plate, interconnected by a single strand roller chain, enclosed by #14 Ga. steel guard.

C. Rate gear motor and gear reducer for stall torque, 24 hour continuous operation, moderate shockloads for stall torque and 1.5 service factor.

D. All spur gearing to be AGMA rated for strength and durability. Use AGMA Standard 210.02 for surface durability, 220.02 for strength rating and 440.04 for worm reducer.

E. Provide minimum two feet (0.60 m) clearance between maximum liquid level and all parts of drive train.

F. Underwater bearings are not acceptable.

G. Gear Motor: Single reduction, oil bath, integral motor, mount chain drive sprocket with keyed taper lock bushing on output shaft.

H. Provide minimum thermal horsepower rating equal to motor horsepower rating.

I. Horizontal chain to large diameter sprocket is not acceptable.

J. Mount chain drive sprocket with keyed taper lock bushing on input shaft of enclosed worm reducer.

K. Provide oil dam around output shaft for positive protection against lubricant leakage.

L. Output shaft bearings life minimum L_{10} rating of 100,000 hours, other bearings minimum L_{10} rating of 17,000 hours. Base bearing ratings on AFBMA Standard 9.

M. The main ring gear shall drive the rotating mechanism and shall be supported by a large diameter ball bearing. The bearings shall include alloy steel load carrying balls at least 1-1/2" diameter. The bearing shall completely support and guide the rotating collector mechanism without guide shoes below the water surface.

N. The main output gear shall have an AGMA rating based on a life of one million cycles for both strength and durability. The companion pinion of the main output gear shall be based on a life of 1×10^7 cycles for both strength and durability criteria. The allowable stress for the AGMA strength rating of the main output gear and companion pinion shall not exceed that as designated by symbol S in the AGMA standards.

O. Drive shall be completely shop assembled with the drive platform, and shipped as an assembly.

2.07 MOTOR

A. Conform to Section 16151.

2.08 OVERLOAD DEVICE

A. Actuate overload device by thrust from gear reducer input shaft.

B. Provide torque scale indicator on mechanism.
1. Type: zero to 100 percent continuous readout.
2. Base indicator on stall torque.
3. Provide 2 - 220 volt, 5 amp, normally closed contacts, one set 100% load, one set 125%, NEMA 4 enclosure.

C. Overload sensors based on direct motor amperage or power consumption are not acceptable.

D. Provide Shear Pin Device.
1. Locate between motor and clarifier mechanism.
2. Design to shear at stall torque
3. Provide 220 volt, 5 amp limit switch with normally closed contacts. Contacts to open when pin shears, NEMA 4 enclosure.

2.09 CLARIFIER MECHANISM

A. Type: Scraper Arm with sludge withdrawal pipes

2.10 SLUDGE COLLECTION MECHANISM

A. Mechanism: hydraulic sludge removal type consisting of a revolving center cage, two truss arms with necessary piping and sludge well and piping.

B. Design Mechanism: To transmit stall torque of the drive unit without damage to the mechanism and ability to sweep in final grout layer on bottom of clarifier tank.

C. Design mechanism to operate continuously with a peripheral speed not to exceed 10 fpm (3.04 meters per minute).

D. Center Cage:
   1. Construct of structural steel shapes.
   2. Suspend from and rotate with the outer bearing race and ring gear of the Drive Unit.

E. Truss Arms:
   1. Construct of structural steel shapes.
   2. Attach to and rotate with center cage with two truss arms oriented 180 degrees apart and extending full diameter of the tank.

F. Sludge Plows:
   1. Equip each truss arm with 1/4 inch thick steel plows, 9 inches deep
   2. Arrange plows to form "V" pocket to convey sludge to withdrawal pipes.
   3. Provide adjustable brass spring squeegees projecting below bottom of Plows.
   4. Number of plows to be determined by equipment manufacturer, location to be staggered - arm to arm.

G. Sludge Withdrawal Pipes:
   1. The number and size of the pipes shall be determined by the equipment manufacturer, with maximum velocity of 3.5 fps.
   2. Pipes: Solid Type I PVC.
   3. Attach sludge withdrawal pipes to truss arms with the inlet at the apex of the sludge plows.
   4. Arrange to deliver sludge to a common sludge well.
   5. Maximum head loss for return sludge system through withdrawal pipes and return column to floor shall not exceed 1.0' at maximum flow.

H. Sludge Well:
   1. Size and design of well shall be determined by equipment manufacturer.
   2. Construct of 1/4 inch minimum (6.5 mm) steel plate.
   3. Provide control valve, at the discharge of each sludge withdrawal pipe, in the sludge well. Each valve to be easily adjustable from the drive platform by a "T" handle wrench.

4. Vertical slip tube will not be acceptable.

2.11 SCUM SKIMMER

A. Provide skimmer to collect and deposit floating scum at the periphery of tank into scum troughs.

B. Support skimmer from the truss arms.

C. Skimmer: hinged skimming blades with a steel wearing plate on its outer edge and neoprene strips on the bottom and inner edges to seal the entrapped scum when discharging into scum trough. Steel wearing plate shall be coil spring loaded for constant pressure to scrape scum baffle.

2.12 SCUM TROUGH

A. Scum trough and beach: welded construction, 1/4 inch minimum (6.5 mm) thick steel plate, with six-inch diameter flanged pipe connection, supported from the tank wall.

2.13 SCUM BAFFLE

A. Scum baffle: Fiberglass or aluminum plate 12 inches wide supported by adjustable brackets anchored to the concrete tank wall, for use with scum skimmer.

2.14 EFFLUENT WEIR

A. Effluent weir: fiberglass or aluminum plate, minimum 18" deep mounted on the concrete with anchor bolts. Weir shall be 2" deep, V-notches, spaced on 6" centers.

B. Provide butt plates at joints.

C. See detail on Contract Drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Conform to manufacturer's instructions and Section 11000. Provide manufacturer's service for a total of 8 days on site in two separate trips to certify installation and operation.

B. Install baffles and clarifier mechanisms.

C. Start clarifiers in accord with Section 11000.
1. Provide manufacturer's representative to assist with start-up.
2. Equipment manufacturer shall conduct field torque test prior to placement of the grout finish on tank floor. Test each truss arm to stall torque independent of the other arm.
3. Embed anchor bolts furnished by the equipment manufacturer in tank floor at points near the outer

portion of truss arms. Anchor bolts shall be suitable for the loads applied during test. Arrange bolts so a single cable is used at the apex of the cables connecting panel points of truss arms.

4. Connect dynamometer or hydraulic cylinder of sufficient capacity with a known piston diameter, complete with pressure gage, to the anchor bolts to determine the horizontal load developed. The required gage reading shall be the specified cut-out torque divided by the distance from the center of the tank to the anchor bolts.
5. Adjust and set overload device to ensure that the sludge collector mechanism will stop. Switch off the drive motor and sound an alarm when a predetermined overload condition occurs in the tank.
6. Conduct test to confirm correct operation of overload device.
7. Cut off anchor bolts flush with tank floor after successful completion of test for each truss arm.
8. When using the dynamometer, the energy will be applied to the system by hand rotating of the motor through the fan.
9. Adjust scum skimmer, scum trough and the skimming blade wiping and sealing strips to ensure the correct volume of scum and effluent will be discharged once every complete revolution of the collection mechanism under normal operating conditions.

D. Train Owner's personnel in accord with Section 01735.
   1. Provide minimum 8 hours training time.

3.02 SPARE PARTS

A. Provide the following spare parts for each clarifier:
   1. Ten shear pins.
   2. One overload limit switch (each type).
   3. One set of squeegees.
   4. One complete set of spare seals, gaskets and high speed bearings for each size reducer.

3.03 FLOCCULATOR CLARIFIER EQUIPMENT NO. ME-102A1,102B1

A. Operating Conditions:	Minimum	Design	Maximum
1. Influent:			
Liquid, mgd:	1.27	2.35	10.45
Suspended solids, ppd:		58,797	
2. Overflow:			
Liquid, mgd:	0.655	1.67	
Suspended solids, ppd:		276	
3. Underflow:			
Liquid, mgd:	0.616	0.690	2.71
Suspended solids, ppd:		57,546	
4. Overflow Rate:			
gals/sq.ft/day:	160	406	1145
5. Weir Loading:			
gals/ft/day:	2456	6224	17,547
6. pH:			6-8
7. Tank diameter, meters:			22
8. Sidewater Depth, meters:			3.8
9. Free Board, meters:			1.473
10. Bottom Slope, in/ft:			1
11. Feed location:			_____
12. Flocc. Well Diam, meters:			7.6
13. Flocc. Well Sidewater Depth, meters:			2.0
14. Flocc. Well Detention time, hrs:			_____
15. Scum Trough location:			See Contract Drawings
16. Skimmer and Scum Baffle:			_____

B. Performance:	
1. Operating Torque, lb.-ft.:	26,035
2. Stall Torque, lb.-ft.:	52,070
3. Alarm Torque, lb.-ft.:	36,449
4. Cut-Out Torque, lb.-ft.:	41,656
5. Max. Peripheral Velocity, fpm:	10
6. Manufacturer:	_____
7. Model Number:	_____

C. Motor:	
1. Volts/Phase/Cycles:	_____
2. Horsepower:	_____

END OF SECTION

SECTION 11363

SLUDGE THICKENER

ART 1 GENERAL

.01 RELATED WORK

A. Section 11000: Mechanical Equipment General

B. Section 16151: Process Motors

.02 DESIGN CRITERIA

A. Conform to the Schedule attached to the end of this Section.

B. Design for continuous operation.

.03 REFERENCE STANDARDS

A. Aluminum Association:
1. Alloy and Temper Designation Systems for Aluminum.

B. American Gear Manufacturers Association.
1. AGMA 210.02:
2. AGMA 220.02:
3. AGMA 440.04:

C. American Society for Testing and Materials.
1. ASTMA A36: Structural Steel
2. ASTM A276: Stainless and Heat-Resisting Steel Bars and Shapes.

D. Anti-Friction Bearing Manufacturer's Association:
1. AFBMA Standard 9; Load Ratings and Fatigue life for Ball Bearings.

1.04 DESCRIPTION OF INSTALLATION

A. Provide two sludge thickener mechanisms ME-104 and ME-08.

B. ME-104 shall mix and settle a combination of primary and secondary sludges, with the underflow being pumped to an anaerobic digester.

C. ME-08 shall thicken single stage anaerobic digested sludge prior to pumping to drying beds.

D. Influent well provided with ME-104 shall serve as a sludge blending well and be supplied with a mechanical mixing system to blend primary and secondary sludges prior to discharging into the thickener.

.05 SUBMITTALS

A. Submit Shop Drawings in accord with Section 01340.

B. Submit Operation and Maintenance Manual in accord with Section 01730.

'ART 2 PRODUCTS

.01 MATERIAL OF CONSTRUCTION

A. Clarifier Mechanism shall consist of the following:
1. Bridge and walkway
2. Center column
3. Center drive mechanisms
4. Motor
5. Overload device
6. Influent well with Mixers
7. Sludge collection mechanism
8. Effluent weirs

B. Provide Manufacturer's Standard materials of construction for service conditions unless specified otherwise.

C. Structural Steel:
1. Material: Conform to ASTM A36.
2. Submerged shapes and plates: minimum 1/4 inch thickness.
3. Match mark structural sub-assemblies for ease of field erection.

D. Stainless Steel: ASTM A276, type 316.

E. Aluminum: AA, Alloy 6061-T6.

F. Fiberglass Reinforced Plastic (FRP):
1. Fiberglass content: 30% plus or minus 2%
2. Plates: smooth, resin-rich surface with no glass fibers exposed.
3. Laminates: dense, without voids, dry spots, cracks or crazes with the following physical properties at 73 deg F.
   a. Thickenss: 1/4 inch min.
   b. Ultimate Tensile Strength: 12,000 PSI min.
   c. Flexural Strength: 19,000 PSI min.
   d. Barcol Hardness: 35
   e. Flexural Modulus of Elasticity: 800,000 PSI min.

G. Anchor Bolts: Stainless Steel.

2.02 BRIDGE AND WALKWAY

A. Type: Half Span supported by Center Column, all welded construction.

B. Design:

1. Loads: Design Load, 150 psf live load and dynamic loads of mechanisms, combined, plus support influent pipe.
2. Deflection, Maximum: 1/240 of Span (Half Span Bridge).

C. Bridge Material: Structural Steel Shapes.

D. Walkway:
1. material: Aluminum Grating
2. Size: Minimum 3 feet wide for access to bridge and 3' clear around gear drive and Flocculator Drive.

E. Handrail and Toeplate
1. OSHA approved both sides of walkway and enclosing mechanism platform.
2. Material: 1-1/2" diameter Schedule 80 clear anodized aluminum pipe with 1/4" thick by 4" wide continuous clear anodized aluminum toe plate of same material and finish.

2.03 CENTER COLUMN

A. Design:
1. Shall be capable of supporting drive, collector mechanism, bridge and walkway, influent well; no torque load shall be taken by the bridge.
2. Cylindrical in shape and be fabricated of minimum thickness of 3/8" steel plate.

B. Provide anchor bolt location template.

C. Top of column to have a drive mechanism mounting plate to be set plumb with the center line.

2.04 INFLUENT WELL

A. ME-104
1. Influent well shall serve as a sludge blending tank to blend primary and secondary sludges.
2. Well to be 9.33' diameter by 5.0' SWD plus 1.5' freeboard and have a closed bottom with a center effluent port.
3. Provide a mechanical variable speed with 3:1 speed change mixing system to thoroughly blend sludges. Quantity, number, size and location of mixers to be determined by the equipment manufacturer. Mixers to be mounted on bridge above.
4. Well shall be a minimum of 1/4" thick steel plate with necessary stiffening members and shall be supported from the bridge assembly.

B. ME-08
1. Influent well shall be of adequate size and design to diffuse the flow into the tank.
2. Well shall be made of minimum 1/4" thick steel plate with necessary stiffening members and be provided with baffled ports opening at the water surface.
3. Support influent well from the bridge assembly.

2.05 INFLUENT PIPE

A. Influent pipe shall be the size shown on the Contract Drawings and shall be supported from the bridge and discharged into the influent well.

2.06 CENTER DRIVE MECHANISM

A. The center drive mechanism shall consist of gear motor, enclosed gear reducer, main ring gear, and platform for mounting drive on center column and shall be designed and rated for the stall torque of the mechanism.

B. Mount gear motor and gear reducer on drive base, interconnected by a single strand roller chain, enclosed by a #14 Ga. steel guard.

C. Rate gear motor and gear reducer for stall torque 24 hour continuous operation, moderate shockloads for stall torque and 1.5 service factor.

D. All spur gearing to be AGMA rated for strength and durability. Use AGMA Standard 210.02 for surface durability, 220.02 for strength rating, and 440.04 for worm reducer.

E. Provide minimum two feet clearance between maximum liquid level and all parts of drive train.

F. Underwater bearings are not acceptable.

G. Gear Motor: Single reduction, oil bath, integral motor, mount chain drive sprocket with keyed taper lock bushing on output shaft.

H. Provide minimum thermal horsepower rating equal to motor horsepower rating.

I. Gear Reducer: totally enclosed, oil bath, horizontal input shaft, vertical output shaft.

J. Mount chain drive sprocket with keyed taper lock bushing on input shaft, of enclosed worm reducer.

K. Provide oil dam around output shaft of enclosed worm reducer for positive protection against lubricant leakage.

L. Output shaft bearings life minimum L_{10} rating of 100,000 hours, other bearings minimum L_{10} rating of 17,000 hours. Base bearing ratings on AFBMA Standard 9.

2.07 MOTOR

A. Conform to Section 16151.

2.08 OVERLOAD DEVICE

A. Actuate overload device by thrust from gear reducer input shaft.

B. Provide torque scale indicator on mechanism.
   1. Type: zero to 100 percent continuous readout.
   2. Base indicator on stall torque.
   3. Provide two 220 volt, 5 amp, normally closed contacts, one set at 100% load, one set at 125%, NEMA 4 enclosure.
   4. Overload sensors based on direct motor amperage or power consumption are not acceptable.
   5. Provide Shear Pin Device locate between motor and clarifier mechanism.
   6. Design to shear at stall torque
   7. Provide 220 volt, 5 amp limit switch with normally closed contacts. Contacts open when pin shears.

2.09 SLUDGE COLLECTION MECHANISM

A. The mechanism shall consist of revolving center cage, two truss arms with sludge plows, and pickets, hopper plows.

B. Design mechanism to transmit stall torque of the drive unit without damage to the mechanism and ability to sweep in final grout layer on bottom of the tank.

C. Design mechanism to operate continuously with a peripheral speed not to exceed 10 fpm.

D. Center Cage
   1. Construct of structural steel shapes.
   2. Suspend from and rotate with the outer bearing race and ring gear of the drive unit.

E. Truss Arms:
   1. Construct of structural steel shapes.
   2. Attach to and rotate with center cage with two truss arms oriented 180 deg apart and extending the full diameter of the tank.
   3. Each arm shall be designed to transmit stall torque of the drive without damage.

F. Sludge Plows:
   1. Plows shall be arranged to progressively convey sludge to an annubar sludge hopper.
   2. Plows to be 9 inches deep by 1/4 inch thick steel plate.
   3. Provide adjustable spring brass squeegees projecting below bottom of plows.
   4. Number and location of plows to be determined by equipment manufacturer.

G. Pickets
   1. Construct of structural pressure treated pine or redwood.
   2. Attach to truss arms and extend 4' above arm.

3. Number, size and location of pickets to be determined by equipment manufacturer.

H. Hopper Plows:
1. Provide four hopper plows to rake annular sludge hopper.

2.10 EFFLUENT WEIR

A. Effluent weir: fiberglass or aluminum plate, minimum 18" deep mounted on the concrete with anchor bolts. Weir shall be 2" deep, V-notches, spaced on 6" centers.

B. Provide butt plates at joints.

C. See detail on Contract Drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Conform to manufacturer's instructions and Section 11000. Provide manufacturer service for a total of 8 days on site in two separate trips to certify installation and operation.

B. Install baffles and thickener mechanisms.

C. Start thickeners in accord with Section 11000.
1. Provide manufacturer's representative to assist with start-up.
2. Equipment manufacturer shall conduct field torque test prior to placement of the grout finish on tank floor. Test each truss arm to stall torque independent of the other arm.
3. Embed anchor bolts furnished by the equipment manufacturer in tank floor at points near the outer portion of truss arms. Anchor bolts shall be suitable for the loads applied during test. Arrange bolts so a single cable is used at the apex of the cables connecting panel points of truss arms.
4. Connect a dynamometer or hydraulic cylinder of sufficient capacity with a known piston diameter, complete with pressure gage, to anchor bolts to determine the horizontal load developed. The required gage reading shall be the specified cut-out torque divided by the distance from the center of the tank to the anchor bolts.
5. Adjust and set overload device to ensure that the sludge collector mechanism will stop. Switch off the drive motor and sound an alarm when a predetermined overload condition occurs in the tank.
6. Conduct test to confirm correct operation of overload device.
7. Cut off anchor bolts flush with tank floor after successful completion of test for each truss arm.

8. When using dynamometer the energy will be applied to the system by hand rotating of the motor through the fan.

D. Train Owner's personnel in accord with Section 01735.
1. Provide minimum 8 hours training time.

3.02 SPARE PARTS

A. Provide the following spare parts for each thickener:
1. Ten shear pins.
2. One overload limit switch
3. One set of squeegees.
4. One complete set of spare seals, gaskets and high speed bearings for each size reducer.

3.03 SLUDGE THICKENER EQUIPMENT NO. ME-08

A. Operating Conditions:	Minimum	Design	Maximum
1. Influent:			
Liquid, mgd:	Zero	0.128	0.355
Suspended solids, ppd:		29,527	
2. Overflow:			
Liquid, mgd:		0.058	
Suspended solids, ppd:		483	
3. Underflow:			
Liquid, mgd:		0.070	0.192
Suspended solids, ppd:		29190	
4. Overflow Rate: gals/sq.ft/day:		23	62
5. Weir Loading: gals/ft/day:		478	1325
6. pH:			6-8
7. Tank diameter, meters:			26
8. Sidewater Depth, meters:			4.8
9. Free Board, Meters:			0.609
10. Bottom Slope, in/ft:			See Contract D.
11. Feed location:			Top, support off bridge

B. Performance	
1. Operating Torque, lb.-ft.:	72800
2. Stall Torque, lb.-ft:	145,450
3. Alarm Torque, lb.-ft:	101,800
4. Cut-Out torque, lb.ft:	116,400
5. Max. Peripheral Velocity, fpm:	10
6. Manufacturer:	_____
7. Model Number:	_____

C. Motor:	
1. Volts/Phase/Cycles:	_____
2. Horsepower:	_____

3.04 SLUDGE THICKENER EQUIPMENT NO. ME-104

A. Operating Conditions:	Miminum	Design	Maximum
1. Influent:			
Liquid, mgd:	Zero	0.382	1.052
Suspended solids, ppd:		54956	
2. Overflow:			
Liquid, mgd:		0.256	0.703
Suspended solids, ppd:		2135	
3. Underflow:			
Liquid, mgd:		0.127	0.348
Suspended solids, ppd:		52,960	
4. Overflow Rate:			
gals/sq.ft/day:		139	385
5. Weir Loading:			
gals/ft/day:		2065	5686
6. pH:			6-8
7. Tank diameter, meters:			18
8. Sidewater Depth,meters:			3.5
9. Free Board, meters:			0.699
10. Bottom Slope,in/ft:			See Contract Dwg.
11. Feed location:			Top, supported off bridge

B. Performance:	
1. Operating Torque, lb.-ft:	34,900
2. Stall Torque, lb.-ft:	69,700
3. Alarm Torque, lb.-ft:	48,800
4. Cut-OUt Torque,lb.-ft:	55,770
5. Max. Peripheral Velocity, fpm:	10
6. Manufacturer:	_____
7. Model Number:	_____

C. Motor:	
1. Volts/Phase/Cycles:	_____
2. Horsepower:	_____

END OF SECTION

SECTION 11371

TRICKLING FILTER MEDIA

PART 1 GENERAL

1.01 RELATED WORK

A. Section 11000: Mechanical Equipment General.

B. Section 11372: Trickling Filter Rotary Distributor.

1.02 DESIGN CRITERIA

A. Conform to the Schedule attached to the end of this Section.

1.03 DESCRIPTION OF INSTALLATION

A. The biofilter media shall be installed in a municipal wastewater treatment plant utilizing the trickling filter process.

B. The media shall be specifically designed for use in a biological treatment process.

C. See Contract Drawings for spacing of media bottom support piers and height of media.

D. The wastewater shall be spread over the media by a rotary distributor.

1.04 QUALITY ASSURANCE

A. Fabricated Modules: Structural strength testing of fabricated modules shall be performed by an independent testing laboratory.

B. Engineer will select for testing at least five modules of each strength or thickness to be used in trickling filters. No fewer than ten modules shall be tested.

C. Tests shall simulate service conditions and conform to the following criteria:
   1. The test sample shall consist of a stack of modules at least two modules high. The arrangement of the stack shall simulate the geometry as placed in trickling filters.
   2. Modules intended for the base layer shall be tested on a simulation of the support system. Modules intended for all other layers shall be tested on a flat base.
   3. Test loads shall be the design load of the media.
   4. The test load shall be applied instantaneously at a temperature of 70-75 degress F.
   5. Maximum allowable compressive deflection of the individual modules shall be two percent.

6. If more than ten percent of the modules tested in any strength gradation exhibit a compressive deflection greater than one percent, or if any one module exhibits a compressive deflection greater than two percent, the Engineer may require the testing of additional modules necessary to determine the structural suitability of the media.
7. If the tests indicate the media is defective, the Engineer may order the Contractor to replace the media with new media meeting the specifications and passing the structural testing.

1.05 REFERENCE STANDARDS

A. American Society for Testing and Materials:
1. ASTM D256-73: Tests for Impact Resistance of Plastics and Electrical Insulating Materials.
2. ASTM D635-81: Test for Rate of Burning and/or Extent and Time of Burning of self-supporting plastics in a horizontal position.
3. ASTM D638-79: Test for tensile properties of thin plastic sheeting.
4. ASTM D747-72: Test for Deflection Temperature of plastics under flexural load.
5. ASTM D792-66: Test for specific gravity and density of plastics.

1.06 SUBMITTALS

A. Submit Shop Drawings and Product Data in accord with Section 01340.

1.07 DELIVERY, STORAGE AND HANDLING

A. Label media modules so the strength and proper placement of modules in trickling filter is readily determinable. If sheet plastic is shipped to the job site for module fabrication, label each sheet so the sheet thickness and strength is readily determinable.

B. Stack modules in shipment and storage on the long face with plastic sheets vertical. Do not stack more than four high, and set modules in each layer perpendicular to those below.

C. Store assembled modules on wooden pallets or on a flat, clean surface to prevent damage to the module edges.

PART 2 PRODUCTS

2.01 MEDIA SHEETS

A. Material: rigid polyvinylchloride (PVC), minimum 15 mil thick sheets, flat and/or corrugated of uniform thickness, free of foreign matter, undispersed raw material, or other manufacturing defects that may affect serviceability.

Media sheets shall conform to the following requirements as determined by the stated test:

1. Specific gravity: 1.4 to 1.6, ASTM D792.
2. Tensile strength: 4000 to 8000 psi, ASTM D638.
3. Flexural modulus: 325,000 to 400,000, ASTM D747.
4. Izod Impact (notch): 0.7 to 1.2 feet lb/in., ASTM D256.
5. Heat Deflection: 150 to 160 degrees F, min. (264 psi test load), ASTM D648.
6. Flammability: Burning time less than 5 seconds and extent of burn, less than 5 millimeters, ASTM D635.

2.02 MEDIA MODULES

A. The trickling filter media shall consist of modules, fabricated from media sheets nominal 24 inches wide x 48 inches long x 24 inches high.

B. Finished modules shall be chemically resistant to the following:
   1. Municipal wastewater.
   2. Micro-organisms that will be attached to the media during service.
   3. Mild concentrations of acids, alkalies, and organic solvents.

C. Maximum service temperature: 135 deg. F. minimum.

D. Design modules to be self-supporting for required media height. Varying sheet thickness for structural strength will be allowed. Finished modules shall conform to the following structural requirements:
   1. Capable of supporting a design load of 40 psi per foot of media height above the module as placed in the trickling filter except as otherwise specified. Under the design load, compressive deflection and long-term creep shall be held to a minimum as specified below.
   2. Minimum bearing capacity: for modules comprising the top and bottom layers of the media 1000 psf; for all other modules 500 psf.
   3. Maximum deflection: one percent under instantaneous test loading at the design bearing capacity.

PART 3 EXECUTION

3.01 FABRICATION

A. The PVC modules may be fabricated either at the manufacturer's production plant or at the jobsite. If on-site fabrication is used, the media manufacturer shall furnish the materials, equipment, and personnel necessary for production of the media.

3.02 INSTALLATION

A. Install Trickling Filter Media in accord with the manufacturer's instructions and Section 11000.

B. Provide direct, continuous, on-site supervision by an authorized representative of the manufacturer during installation of the filter media.

C. Cut, trim, or otherwise form media modules to fit the tank wall and center column. Perform shaping and cutting of the media modules on tarpaulins or a similar working mat to catch the fragments. Remove chips, broken pieces, and other debris falling into the packed media.

D. Prevent damage to the media modules during the installation including that resulting from workmen walking on the media.

E. Place media modules in Trickling Filter to provide the closest possible fit with adjacent modules without damaging media. The media module packing arrangement shall be that recommended by the module manufacturer.

F. Install modules on the long face so media sheets are vertical.

3.03 TRICKLING FILTER MEDIA TANK NO. T-101A&B

A. Trickling Filter

1. Tank inside diameter, ft.(meters):	65.6(20)
2. Media depth, ft.(meters):	24(7.32)
3. Media specific surface area ft^2/ft^3:	27-30

B. Flow Year 1990 (Each Tank) including Constant Recycle of 12500 mg/D

1. Design cu m/day:	18,411
2. Maximum cu m/day:	28,794
3. Minimum cu m/day:	14,793

C. Flow Year 2000 (Each Tank) including Constant Recycle of 12500 mg/D

1. Design cu m/day:	18,763
2. Maximum cu m/day:	29,545
3. Minimum cu m/day:	14,863

END OF SECTION

SECTION 11372

TRICKLING FILTER ROTARY DISTRIBUTOR

PART 1 GENERAL

1.01 RELATED WORK

A. Section 11000: Mechanical Equipment General.

1.02 SUBMITTAL

A. Submit Shop Drawings in accord with Section 01340.

B. Submit Operation and Maintenance Manuals in accord with Section 01730.

1.03 DESIGN DATA

A. Number of Trickling Filters: Two

B. Diameter of trickling filter, feet (meters): 65.6/20

C. Depth of trickling filter bed, feet (meters): 24/7.32

D. Maximum flow to each trickling filter cu m/day: 29,545

E. Minimum flow to each trickling filter cu m/day: 14,863

F. Head lost through rotary distributor at maximum flow, from the top of media surface: 47 inches of water column.

G. Maximum velocity through the arm and center column to be 4 ft/sec.

1.04 DESCRIPTION OF INSTALLATION

A. The Rotary Distributor shall be used to spread a combination of forward and recycled flows over a trickling filter containing plastic backfilter media.

B. Both the forward and recycle flows will be pumped (through a single line) to the Rotary Distributor.

PART 2 PRODUCTS

2.01 ROTARY DISTRIBUTOR

A. The Rotary Distributor shall consist of a center column assembly, distribution arms and nozzles.

2.02 CENTER COLUMN

A. Center column consisting of a stationary center base and a revolving assembly.

1. Stationary center base shall be fabricated of steel with provisions for attaching to concrete foundations.
2. Provide at the top an anti-friction roller bearing to carry the weight of the distributor arms and a grease-lubricated bronze bearing at the bottom. Provide a mechanical type double seal.
3. Mercury seals are not acceptable.

B. Revolving assembly: welded steel and cast iron constructed and designed to carry the loads from the arms and to have outlets for the arm connections. Provide a center column integral with the revolving assembly with attachments at the top for the arm supports.

C. The anti-friction bearings at the top of the column and the lower bearing shall be grease lubricated.

2.03 DISTRIBUTOR ARMS

A. Provide a total of four distribution arms, two primary plus two secondary, to accommodate the variation in flow.

B. The size of each arm shall be determined by the Equipment Manufacturers.

C. Arms: steel pipe, length to extend the full radius of trickling filter bed.

D. The secondary arms shall be provided with overflow boxes with adjustable weirs adjacent to the center column.

E. Support arms from center column by steel rods with turn buckles. Brace arms to one another by adjustable steel rods or cables.

F. Provide a quick acting dump gate at the end of each distributor arm for flushing.

2.04 NOZZLES

A. The flow shall be evenly dosed over the filter bed through individual nozzles attached to the distributor arms.

B. Number and position of nozzles shall be determined by equipment manufacturer.

C. Nozzles: non-clog type, designed for easy cleaning.

PART 3 EXECUTION

3.01 INSTALLATION

A. Conform to manufacturer's instructions and Section 11000.

B. Install trickling filter rotary distributor.

C. Start trickling filter rotary distributor in accord with Section 11000.
   1. Provide manufacturer's representative for 5 days on site in one trip to certify installation and assist with start-up and instruct in operation.

D. Train Owner's personnel in accord with Section 01735.
   1. Provide minimum 8 hours training time.

3.02 SPARE PARTS

A. Provide the following spare parts for each distributor:
   1. 20 nozzles.
   2. 1 set of seals.

END OF SECTION

SECTION 11373

POSITIVE DISPLACEMENT BLOWERS

PART 1 GENERAL

1.01 RELATED WORK

A. Section 11000: Mechanical Equipment General.

B. Section 16151: Process Motors

1.02 DESIGN CRITERIA

A. Conform to the Schedule at the end of this Section.

B. Design blowers for continuous service, and where specified, for outdoor service.

C. Design each complete blower assembly to produce less than 90 dBA sound pressure level measured at a distance of three feet (one meter) from the major outside surface of the blower assembly.

1.03 SHOP TESTS

A. Test one of each type blower to demonstrate compliance with specified performance.

B. Test capacity, discharge pressure, and brake horsepower.

1.04 SUBMITTALS

A. Submit Shop Drawing and Certificates of shop tests in accord with Section 01340.

B. Submit Operation and Maintenance Manuals in accord with Section 01730.

C. Submit three copies of records of measurements of sound pressure levels to Engineer. Identify blower, date, time and blower operating conditions on records.

1.05 INSTALLATION DATA

A. Grit blowers, ME-02A and ME-02B shall supply air to aerated grit tank. Motors and accessories will be installed outdoors on a concrete pad.

B. Wetwell blowers, ME-10 and 106 to be installed indoors.

C. Each blower shall be equipped with inlet filter and silencer supported from blower base.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide manufacturer's standard materials of construction for service conditions unless specified otherwise.

2.02 EQUIPMENT TO BE FURNISHED WITH EACH BLOWER

A. Blower

B. Electric Motor

C. Drive System

D. Base

E. Inlet Filter

F. Inlet Silencer

G. Flexible connections at inlet and discharge

H. Relief/unloading valve

I. Pressure gage

J. Check Valve

K. Butterfly valve

L. Discharge silencer

M. Vibration isolation system

2.03 BLOWER

A. Type: Rotary Positive Displacement, Two Impellers

B. Maximum Tip Speed, 5000 fpm

C. Components
   1. Housing and End Covers
      a. Material: Cast Iron
      b. Ribbed to prevent distortion
      c. Interior surfaces precision ground
      d. Machine openings for exact bearing positioning.
      e. Provide grease fitting and drain plug for drive end bearings.
      f. Provide vent on impeller sides of seals to prevent lubricant leakage into the air stream.
      g. Provide fill and drain plugs in timing gear housing
   2. Impeller
      a. Material: Cast Iron
      b. Type: Straight, two lobe involute type
      c. Timed to operate without seals or rubbing

d. Machined and balanced to operate without vibration.
e. Positively timed by a pair of timing gears.

3. Shaft
   a. Material: Steel
   b. Press fit to impeller
   c. Tapered for timing gear installation
4. Timing Gears:
   a. Type: Spur
   b. Material: Steel
5. Bearings:
   a. Drive End-Grease lubricated double row antifriction
   b. Timing Gear End-Oil lubricated, double row antifriction
6. Bearing Seals:
   a. Positive oil seal designed to prevent lubricant from leaking into air stream

2.04 MOTOR

A. Conform to Section 16151

B. Sized to deliver design flow at a temperature of 25 deg. F.

2.05 DRIVE SYSTEM

A. Type: V-Belt, sliding base variable sheave drive

B. Provide motor slide base for belt adjustment of speed of blower

C. Provide Belt Guard

2.06 BASE

A. Material: Fabricated Steel

B. Capable of mounting and supporting blower, motor and inlet filter, with silencer.

C. Blower inlet filter and silencer to be supported from blower base.

2.07 INLET FILTER

A. Type: Panel with cleanable, replaceable element with weatherhood

B. Sized for 120% of maximum blower volume attainable at the design pressure with the motor provided.

C. Pressure Drop: 0.5 psi maximum combined filter and silencer at design conditions.

2.08 INLET SILENCER

A. Type: Chamber/Chamber Absorption. All welded construction.

B. Sized for 120% of maximum volume attainable at the design pressure with the motor provided.

C. Pressure Drop: 0.5 psi combined filter and silencer at design conditions.

2.09 FLEXIBLE CONNECTIONS

A. Type: Flanged bellows with control rods on discharge

B. Material: Rubber or equal

C. Temperature Rating: 220 deg F

2.10 RELIEF/UNLOADING VALVE

A. Type: Pilot operated

B. Material: Cast Iron

C. Size: To be determined by Blower Manufacturer.

2.11 PRESSURE GAGE

A. Rating: 0 to 15 psi

B. Provide Gage Cock

2.12 CHECK VALVE

A. Type: Wafer Body, low pressure drop

B. Maximum Pressure Drop at blower design capacity: 3 inches w.g.

C. Size: 150 mm for ME-02A&B. 80 mm for ME-10 and 11.

2.13 BUTTERFLY VALVE

A. Type: Wafer Body

B. Rating: 15 psi at 250 deg F.

C. Supply chain operator for valve 6 feet (2 m) above floor

D. Size: 150 mm diameter for ME-02A&B, and 80 mm diameter for ME-10 and 11.

2.14 DISCHARGE SILENCER

A. Type: Chamber/Chamber Absorption all welded construction

B. Size for 120% of maximum volume obtainable at the design pressure with the motor provided.

C. Provide 4 legs for mounting.

2.15 VIBRATION ISOLATION SYSTEM

A. Type: Suitable for mounting on outdoor or indoor concrete pad.

2.16 TEMPERATURE GAGES

A. Provide inlet and outlet temperature gages.

B. Bimetal type 15.25 mm diameter dial.

C. Range: 150% maximum design temperature.

PART 3 EXECUTION

3.01 INSTALLATION

A. Conform to manufacturer's instructions and Section 11000.

B. Install blower.

C. Start blower in accord with Section 11000.
1. Provide manufacturer's representative to assist with start-up.

D. Measure sound pressure level of blowers while operating at full capacity. Adjust blowers, as required, so measured level does not exceed specified limit.

E. Train Owner's personnel in accord with Section 01735.
1. Provide minimum 8 hours training time.

3.02 SPARE PARTS

A. Provide the following spare parts for each blower:
1. Three sets of V-Belts for each blower
2. One set of bearings for each blower

BLOWER SCHEDULE

	ME-02A&B	ME-10	ME-106
Capacity at 14.7 psia & 60 deg. F.:	360 SCFM	155 SCFM	97 SCF
Inlet CFM at 100 deg. F. & 13.35 psia	423 ACFM	-	-
Inlet CFM at 100 deg. F. & 13.55 psia	-	180 ACFM	113 AC
Discharge Pressure psig:	4.0	4.0	8.0
Atmospheric Pressure psia:	13.85	13.85	13.85
Blower Inlet Pressure psia:	13.35	13.55	13.55
Maximum Design Temperature deg. F.	100	100	100
Outlet and Inlet Location:	Side	Side	Side
Minimum Inlet Temperature deg. F.	+25	+25	+25
Service	Outdoors	Indoors	Indoor
Motor	380Volt/ 3 Phase/ 50 Hz.	380Volt/ 3 PHase/ 50 Hz.	380Vol 3 Phas 50 Hz.

END OF SECTION

SECTION 11374

MECHANICAL SURFACE AERATORS

PART 1 GENERAL

1.01 RELATED WORK

A. Section 11000: Mechanical Equipment General.

B. Section 16151: Process Motors

1.02 DESIGN CRITERIA

A. Conform to Schedule attached to the end of this Section.

B. Design aerators for single or combined (two per basin) operation without causing mechanical or electrical overload, or basin surging.

1.03 DESCRIPTION OF INSTALLATION

A. The aerator shall be installed in a concrete aeration basin (two per basin) to increase the dissolved oxygen level of the wastewater.

B. Influent to the aeration basin will have passed through bar screens, primary clarifier and trickling filter, with effluent flowing to the final clarifier.

C. Aerators shall be mounted on a concrete platform.

1.04 QUALITY ASSURANCE

A. Equipment Qualification:
1. Base aerator system design and selection on previous factory tests of equipment of same size.
2. Perform factory aerator oxygenation test(s) as follows:

B. Factory Test:
1. Prepare test method, data, criteria for extrapolation and scale-up, and engineering rationale used to arrive at conclusion that equipment will meet specified performance requirements.
2. Conduct test in accord with the following:
   a. Test one aerator (motor, gear box and turbine) provided for this project. Testing of prototype is not acceptable.
   b. Install one aerator in basin or tank and state size of basin or tank used.
   c. Provide water, tap water quality, substantiated by K L a values relative to triple distilled water.
   d. De-oxygenate water with predissolved sodium sulfite with cobalt, $CoCl_2 \cdot 6H_2O$, catalyst. Use concentrations to accomplish catalysis but not to

interfere with dissolved oxygen concentration determination.

e. Correct dissolved oxygen concentration determination for response rate of dissolved oxygen probes.

f. Maintain water temperature within 20 to 40 degrees C range.

g. Maintain maximum differential temperature between air and water of 10 degrees C.

3. Translate results of test conducted in water into pounds of O_2/HR/HP by means of the following equation and tabulated in data sheet form.

$$N = \frac{(C_s \beta - C_L) N_o (\alpha) 1.024^{(T-20)}}{9.2}$$

Where N = lbs. of O_2/HR/HP at design conditions

N_o = lbs. of O_2/HR/HP at standard conditions

Standard Conditions are:

$\alpha = 1.0 \quad \beta = 1.0 \quad T = 20$ deg. C $\quad C_L = 0$

$$\alpha = \frac{K_L a, \text{ of waste}}{K_L a, \text{ of water}} = \text{oxygen transfer coefficient ratio}$$

$$\beta = \frac{C_s, \text{ of waste}}{C_s, \text{ of water}} = \text{oxygen saturation level ratio}$$

C_s, of water = dissolved oxygen concentration of saturated tap water which contains total dissolved solids equal to that of wastewater at design conditions.

C_L = Dissolved oxygen concentration at design condition.

$K_L a$ = Transfer coefficient.

T = Design Temperature, deg. C.

4. The Contractor and equipment manufacturer shall include in their Tender Price all costs incurred in conducting the factory oxygenation test. The test shall be performed before shipment of aerators and shall be witnessed by the Engineer.

5. During factory test, aerator manufacturer shall demonstrate that aerator meets oxygenation capacity variation of 10% maximum versus specified liquid level variation.

6. From this test the aerator manufacturer shall develop a curve showing the relationship of oxygen transfer and horsepower draw versus impeller submergence.

1.05 SUBMITTALS

A. Submit certified copies of factory test results in accord with Section 01340, and also include engineering data to verify oxygenation capacity vs. liquid level variation.

B. Submit factory test method in accord with Section 01340.

C. Submit shop drawings in accord with Section 01340.

D. Submit operation and maintenance manuals in accord with Section 01730.

E. Submit design and location detail drawing and calculations for all necessary baffles. Include material definition and method of mounting.

PART 2 PRODUCTS

2.01 GENERAL

A. Design complete assembly specifically for aeration, 24-hour continuous outdoor service under AGMA moderate shock loading.

2.02 GEAR REDUCER

A. Type: right angle, spiral bevel or helical gear type specifically designed for 2 speed aerator service. Worm gear reducers are not acceptable, parallel drives are not acceptable.

B. Housing: high grade cast iron or welded steel.

C. Rating: Conform to AGMA standards; attach AGMA nameplate.

D. Support aerator shaft with bearings independent of reducer bearings.

E. Connect aerator shaft and reducer shaft with flexible coupling to minimize shaft deflection of gear reducer. Provide coupling guard.

F. Support impeller shaft on two adapter type anti-friction bearings. Pressed on bearings are not acceptable.
1. Transmit only aerator shaft loads to bearings.
2. Locate bearings 36 inches, minimum, above process liquid in tank.
3. Design impeller shaft bearing so entire weight of vertical impeller shaft and impellers is supported by a thrust bearing.
4. Lubrication: grease, with inlet and relief accessible from mounting surface or permanently lubricated.
5. Provide removable neoprene covers for grease fittings.

G. Reducer lubrication: splash type by gears or slinger rotating on horizontal shaft in oil bath to ensure

positive displacement of oil upward to lubricate critical bearings.

H. Oil level measurement: dipstick.

I. Oil drain: single drain at low point of gear reducer. Maximum residual oil level 1/4 inch.

J. Oil lubricated bearing location: above top of main lubricant drain and minimum 3 inches above bottom of reducer.

K. Provide drywell around impeller shaft to prevent oil leakage down the shaft.
   1. Where oil is normally between the rotating quill and stationary dam, provide minimum 1/2 inch clearance between quill and dam to prevent pumping.

L. Extend oil drain from drive to prevent leakage and spillage during oil changes.

M. Eliminate need for external cooling by exceeding mechanical rating with thermal rating.

N. Provide the following features on gear reducers not having independent bearing support between aerator shaft and low speed shaft of gear reducer.
   1. Minimum AGMA service factor 2.5.
   2. Output shaft bearing life: L_{10}, 375,000 hours.
   3. All other bearing life: L_{10}, 200,000 hours.
   4. Gearing life factor: 100 million cycles.
   5. Provide output shaft bearing span not greater than 25 percent of the distance from bottom bearing centerline to impeller centerline.

2.03 AERATOR SHAFT

A. Material: cold rolled carbon steel, straight, and true.

B. Length: to provide impeller submergence to be determined by equipment manufacturer.

C. Diameter: as required to transmit necessary power.

D. Design shaft and bearing assembly to operate at maximum 0.4 of natural frequency of system.

E. Design shaft and bearing assembly to operate at or below 0.4 of the natural frequency of the system. Operation within range of 0.4 to 0.8 of natural frequency may be allowed provided:
   1. Stablizing devices are provided.
   2. Manufacturer demonstrates, by submittal to Engineer, successful experience with stabilizing devices prior to equipment approval.

F. Provide 18 inches minimum keyway for each impeller.

G. Connect impeller to shaft by positive means. Prevent impeller from slipping when holding device is loosened.

H. Provide vertical adjustment of impellers, in one inch increments. Adjustment range six inches above and six inches below normal setting.

I. Dynamically balance shaft and impeller assembly after fabrication in shop.

2.04 IMPELLER

A. Type: low splash profile turbine type with top side submergence adjustment.

B. The impeller shall be liquid level insensitive type. The impeller design shall be such that a liquid level variation of +2.25 inches; -1.25 inches from the set point shall not result in a change of oxygenation capacity of the aerator by more than 10% of rated capacity (at each speed). Data to support this shall be submitted with the shop drawings.

2.05 BASIN BAFFLES

A. If required by aerator manufacturer, Contractor shall provide and install baffles in basin. Quantity, location, design and support of the baffles shall be provided by aerator manufacturer.

B. Provide baffles of material suitable to service conditions.

2.06 IMPELLER SHAFT COUPLING

A. Type: rigid, flanged.

B. Design: transmit 200 percent full torque, and 150 percent axial load on coupling.

C. Flanges: welded to shafts, turned and faced after welding. Provide registered fit.

2.07 MOTOR

A. Conform to Section 16151, two speed.

2.08 MOTOR-REDUCER COUPLING

A. Type: flexible, torsionally resilient, Falk Type F or equal.

B. Reduce effects of shock and vibration.

C. Minimize effect of parallel, angular, and axial misalignment of motor and gear reducer.

2.09 ASSEMBLY

A. Factory assemble aerators, completely.

PART 3 EXECUTION

3.01 INSTALLATION

A. Conform to manufacturer's instructions and Section 11000.

B. Install baffles and aerators.

C. Test aerators in accord with Section 11000.

D. Start aerators in accord with Section 11000.
   1. Provide manufacturer's representative to assist with start-up.

E. Field Oxygenation Test:
   1. Provide manufacturer's representative to assist with performance test.
   2. Field test one aerator in one of the basins to determine oxygen transfer capacity. The aerator to be tested will be selected by Engineer.
   3. Oxygen transfer test procedure and conditions shall be agreed to by the Contractor and Engineer. The following requirements are mandatory.
      a. Make tests in potable water, of acceptable quality. It is important to note that the aeration basin must not be contaminated with sewage prior to performance of this test.
      b. De-oxygenate water with pre-dissolved sodium sulfite catalyzed with cobalt at concentrations which accomplish catalysis, but which do not interfere significantly with determinations of dissolved oxygen concentration.
      c. If a dissolved oxygen probe is used, the results shall be corrected for the response rate of the probe.
      d. The water temperature shall be between 20 and 40 deg. C. and the differential temperature between air and water shall not exceed 10 deg. C.
   4. Translate results of test into pounds of O_2/HR/HP transferred to the water.
   5. During field test, the manufacturer shall demonstrate that the aerator meets oxygenation capacity variation of 10% maximum versus specified liquid level variation.
   6. Calculate shaft HP for the aerator from actual measurements of voltage and current through each phase of the motor, the power factor, and by taking into consideration the efficiency of the motor.
   7. The Aerator Manufacturer shall furnish the service of a factory representative to conduct the field oxygenation test.
   8. The Contractor shall include in his Tender Price all costs incurred in conducting the field oxygenation

test including supplying the quantity of tap water needed for the test and the service of the manufacturer's personnel necessary to conduct the test.

3.02 SPARE PARTS

A. Provide the following spare parts for each aerator:
   1. Two complete sets of motor bearings.
   2. Two complete sets of grease and oil seals, and gaskets for gear reducers and motors.
   3. One flexible coupling, motor to gear reducer.
   4. One spare gear box prepared for long term storage.

3.03 AERATORS EQUIPMENT NO. ME-101A1, 101A2, 101B1, 101B2

A. Identification:

1. Location:	Aeration Basins
2. Number of basins:	2
3. Number of units per basin:	2

B. Basin:

1. Length, meters:	30
2. Width, meters:	15
3. Sidewater Depth, meters:	3
4. Freeboard, meters:	1.0 to bottom of splash lip.
5. Capacity, cu m/basin:	1,350 cu m
6. Elevation above sea level, meters:	470

C. Forward Flow:

1. Minimum, cu m/day/basin:	2,293
2. Average design, cu m/day/basin:	6,380
3. Maximum, cu m/day/basin:	17,162

D. Field Conditions:

1. Temperature:	15 deg. C winter/25 deg. C summer
2. Oxygen transfer coefficient(alpha):	0.8
3. Oxygen saturation coefficient(beta):	0.9
4. Minimum D.O. entering tank:	0.0 mg/l
5. Minimum D.O. Leaving tank:	2.0 mg/L

E. Oxygen transfer requirements per aerator at high speed:

1. Field Conditions:	40 kg O_2/hr.
2. Standard Conditions:	80 kg O_2/hr.

F. Total oxygen transfer requirements per train at high speed:

1. Field Conditions:	160 kg O_2/hr.
2. Standard Conditions:	320 kg O_2/hr.

G. Minimum Mixing:
When operating at lowest speed aerators shall be capable of maintaining the tank in a completely mixed condition such that the suspended solids and dissolved oxygen concentration of 20 random samples per tank shall not deviate from the arithmetic mean by more than 15 percent.

END OF SECTION

SECTION 11375

AERATOR GRIT DIFFUSER ASSEMBLY

PART 1 GENERAL

1.01 RELATED WORK

A. Section 11000: Mechanical Equipment General

B. Contract Drawings

1.02 DESCRIPTION OF INSTALLATION

A. The aerated grit diffuser will treat raw sewage which will have passed through a mechanically cleaned bar screen.

1.03 SWING TYPE AIR DIFFUSER ASSEMBLY

A. The swing-type air diffuser assembly for the aerated grit chambers shall consist of a swing-jointed mechanism suspending a knee-jointed vertical air feed drop pipe, and a horizontal header pipe with air diffusion nozzles mounted thereon.

B. The assembly shall be designed to permit the vertical air pipe with header and nozzles to be swung up and out of the wastewater in order to be accessible from the tank walk, without the need for drawing down the wastewater level in the tanks.

C. When the assembly is in the raised position, all parts of the air diffuser assembly shall be above and accessible for servicing from the tank walkway. In this position, the nozzle header shall be about 3 ft. 6 in. above the walkway.

1.04 DESIGN DATA

A. Submittals:
1. Shop Drawings in accordance with Section 01340.
2. Operation and Maintenance manuals in accordance with Section 01730.

B. Design Data:

No. of Aerated Grit Tanks	Two
Size of Grit Tank	10m x 3.00m x 3.14m SWD + 1.96M FB
No. of Air Diffuser Assemblies per tank	Two (total of 4)
Process Flow per tank	
Design m3/d	18,330
Peak m3/d	48,562
Min. m3/d	4,585
Air Flow per Tank	180 scfm
Air Flow per Diffuser Assembly	90 scfm

184

351

1. See Contract Drawing for details of tank and diffuser assemblies.

PART 2 PRODUCTS

2.01 MATERIALS

A. Stainless-Steel Pipe and Fittings:
1. All aeration piping shall be Grade 304L conforming to the requirements of ASTM Standard Specification for Stainless and Welded Austenitic Stainless-Steel pipe, Designation A312-72a. Pipe may be seamless or welded. All welding shall be performed by the MIG or TIG process and shall have 100 percent penetration. Butt welding shall be used throughout; lap welding will not be permitted. Spiral welded pipe may be used but must comply with all above requirements. Screwed pipe and grooved end pipe for split-type coupling shall be schedule 40s. A 6-in. length of the schedule 40s pipe shall be welded to a thinner wall pipe, as indicated on the Contract Drawings. Stainless steel pipe and fittings shall be descaled and have an AISI No. 1 finish (annealed and pickled).
2. Flanges shall be in accordance with ASTM A182 GR 304L stainless steel per MSS standard practice SP-51, "150-lb. Corrosion-Resistant Cast Flanges and Flanged Fittings: with full faced compressed asbestos gaskets and Type 304 stainless steel bolts.

2.02 SWING JOINT

A. Each swing-joint shall consist of an air control valve, a cast-iron elbow fitting swing-joint. The swing-joint shall be designed to support the air drop pipe and header assembly.

B. The air control valve shall be mounted on and anchored in the wye-wall coping and connected to the air main by the air supply lateral. part of the assembly shall serve as an anchor for the swing-joint and shall be provided with galvanized steel anchor bolts for setting in the concrete.

C. The elbow fitting part of the swing-joint shall be jointed to the air control valve in such a manner that it can swing about a large diameter pivot bolt. Both parts of the swing-joint shall be fitted with lubricated metallic wearing rings and seal rings which shall produce an airtight joint. The connection between the swing elbow and the air feed drop pipe shall be flanged or screwed.

D. The construction of the elbow shall be such as to provide a recess that will receive the pin connector of the portable hoist specified hereinafter.

E. The swing-joint assembly shall be provided with an approved locking device that will allow the joint to be

locked when the diffuser assembly is in the raised position.

2.03 AIR DROP PIPE ASSEMBLY

A. Each vertical air drop pipe shall consist of two sections of stainless steel pipe schedule 40, joined by a cast-iron knee joint.

B. Connections between pipe and knee joint shall be flanged or screwed.

C. The knee joint shall be equipped with lubricated metallic wearing rings and seal rings to provide an airtight connection.

D. An adjustment screw shall be provided to position the nozzle header when it is lowered into the tank.

E. The drop pipe shall serve as a support and air-supply pipe to the diffuser nozzle header.

F. The lower section of the drop pipe shall terminate with a welded flanged or screwed connection to a cast-iron leveling tee.

G. The leveling tee flanges shall permit a 3-in. up or down adjustment at the end of each header.

H. Drop pipe shall be sized to carry the air flow required by the design data.

2.04 DIFFUSER NOZZLE HEADER

A. Each nozzle header shall comprise two lengths of Schedule 10 stainless steel pipe, flange connected to the leveling tee.

B. The ends of each header shall be closed by a removable bolted end plate provided with a closure gasket.

C. The header shall have drilled holes of the proper size and spacing for the diffuser nozzles and shall have tapped bosses welded to the headers if the nozzles to be furnished required a screwed connection.

D. Threaded boss outlets shall be shaped to fit over the outside diameter of the header and shall be beveled to facilitate proper welding. The outlets shall be fabricated from Type 304L stainless steel.

E. The holes in the header shall be drilled before the outlets are attached and there shall be no protrusions into the airstream at any point. The outlets shall be attached with continuous 100 percent penetration welds.

F. All flange bolts and nuts for the header connections, end plates, and its connection to the drop pipe shall be Type 416 or Type 303 stainless steel.

G. A stainless steel stop and positioning arm shall be provided to properly position the header in relation to the tank wall.

2.05 DIFFUSERS:

A. The air diffuser units shall discharge air around the bottom periphery of a disc which shall be retained in a housing attached to the air header.

B. Each diffuser shall consist of a cast iron diffuser housing with 3/4-inch pipe threaded adapter fitting for attaching to the air header. Each adaptor fitting shall be equipped with an air flow control orifice. A polyvinyl chloride disc shall be mounted in the diffuser housing and be retained in position by a stainless steel cover plate attached to three posts of the housing by stainless steel pins. The disc shall be 3/16 inch outside diameter and 1/4-inch thick.

C. Air flow per diffuser shall be 5.6 cfm.

2.06 PORTABLE HOIST:

A. Provide one portable hoist for raising the air diffusion units on the grit tank. The hoist shall engage a movable member of the swing joint and raise each air diffusion unit by exerting leverage on the movable member. Means shall be provided to hook the hoist in place before the hoisting operation is begun. The chassis shall roll on casters and shall be provided with an operating handle to turn one caster for ease in maneuvering. The hoist shall be designed to attach to the swing diffuser aerator fittings without the use of tools and shall be, when attached, automatically locked in position and shall be easily removed when the aerator is either in the up or down position. The hoist shall be of a manual winch type.

B. A heavy waterproof tarpaulin cover shall be furnished with each of the hoists.

2.07 SPARE PARTS

A. The Contractor shall provide the following spare parts:
1. Twenty diffusers.
2. One swing joint elbow
3. Two knee joints

PART 3 EXECUTION

B. Contractor to install aerator grit diffuser assembly as shown on the Contract Drawings and per equipment manufacturer's instructions.

END OF SECTION

SECTION 11550

TOOLS AND EQUIPMENT

PART 1 GENERAL

1.01 SUBMITTALS

A. Submit catalog information and specifications for tools and equipment in accord with Section 01340.

PART 2 PRODUCTS

2.01 TOOLS AND EQUIPMENT

A. References to specific manufacturer's catalogs have been used for convenience to indicate the type and quality of tools and equipment required. Products of other manufacturers, equal in all respects, will be acceptable.

B. All electrically powered tools and equipment to operate on 220 Volt, 50 Hz electric supply.

PART 3 EXECUTION

3.01 INSTALLATION

A. Place tools in areas designated by Engineer. Remove tools from shipping containers and arrange in tool boxes, cabinets, shelves or storage areas as directed by Engineer.

B. Mount fire extinguishers throughout the buildings spaced at a maximum travel distance of 50 feet and an extinguisher coverage area of 4000 square feet. Provide one fire extinguisher on every floor of every building.

3.02 TOOL AND EQUIPMENT SCHEDULE

A. Provide tools as follows:

RIDGID CATALOG # RT - 165

Quantity	Description
2	6" Ridgid Straight Pipe Wrenches, Heavy Duty
2	8" Ridgid Straight Pipe Wrenches, Heavy Duty
2	10" Ridgid Straight Pipe Wrenches, Heavy Duty
2	12" Ridgid Straight Pipe Wrenches, Heavy Duty
2	14" Ridgid Straight Pipe Wrenches, Heavy Duty
2	18" Ridgid Straight Pipe Wrenches, Heavy Duty
2	24" Ridgid Straight Pipe Wrenches, Heavy Duty
2	36" Ridgid Straight Pipe Wrenches, Heavy Duty
2	48" Ridgid Straight Pipe Wrenches, Heavy Duty
1	#1 1/2 Strap, Ridgid Strap Wrenches
1	#2 1-1/8 Strap, Ridgid Strap Wrenches
1	#2-P 1-1/16 Strap, Ridgid Strap Wrenches for PVC
1	#5 1-3/4 Strap, Ridgid Strap Wrenches
1	#5-P 1-3/4 Strap, Ridgid Strap Wrenches for PVC
2	C-14 Ridgid Chain Wrenches, Heavy Duty
2	C-18 Ridgid Chain Wrenches, Heavy Duty
2	C-24 Ridgid Chain Wrenches, Heavy Duty
1	C-36 Ridgid Chain Wrenches, Heavy Duty
	Ridgid Pipe Threaders & Cutters
1	#1745 Flaring Tool
1	B-1678 Bed 3/4 & 1/2 Conduit, Ridgid Conduit Bender
1	W-6, 6 ft. Wooden Double Step Ladder

RIDGID CATALOG # RT - 165

Quantity	Description
1	W-10, 10 ft. Wooden Double Step Ladder with Safety Shoes
1	W-240, 24 ft. Wooden Extension Ladder with Safety Shoes
1	W-400, 40 ft. Wooden Extension Ladder with Safety Shoes
1	24S Bolt Cutters
2	#1012 Hack Saw Adjustable 10" to 12"
1	#1250 Hole Saw Kit
1	#783 Length 7" Duckbill Snip
1	#785 Length 12-1/2" Duckbill Snip
1	#788 Length 10-1/2" Straight Cut Aviation Snips
1	#787 Length 10-1/2" Left Cut Aviation Snips
1	#786 Length 10-1/2" Right Cut Aviation Snips
2	#624A 24" Aluminum Level

Quantity	Description
	Drive Sets
1	WSM-8C 56 tools in TB-4A metal tool box 1/4" drive set
1	WSB-2 7 tools in cardboard box, 3/8" of set drive set
2	WSB-6D 49 tools in metal tool box, 3/8" drive set
2	WSS-19T 74 tools only (each set) 1/2" drive set
1	WSSP-1 18 tools in TB-15 metal tool box 1/2" of set drive set
1	HNX-130 Adapter 3/4" square female & 1" square male
1	HNX-131 Adapter 3/4 sq. male & 1" sq. female
1	SH-130 Adapter 1/2" sq. female & 3/4" sq. male
1	SH-131 Adapter 1/2" sq. male & 3/4" sq. female
2	WSH-5T 46 tools only (each set) 3/4" drive set
2	WSX-4AT 27 tools only (each set) 1" drive set
1	TB-5002 8 drawer metal chest
1	TC-502C 9 drawer roller cabinet
3	TB-9T metal tool boxes to fit 3/4" drive set
	Wrenches and Sets
2	AB-4 size 4 Superjustable wrenches, regular black finish
2	AB-6 size 6 Superjustable wrenches, regular black finish
2	AB-8 size 8 Superjustable wrenches, regular black finish
2	Ab-10 size 10 Superjustable wrenches, regular black finish

Quantity	Description
2	AB-12 Superjustable wrenches, regular black finish
2	AB-15 Superjustable wrenches, regular black finish
2	AB-18 Superjustable wrenches, regular black finish
1	APA-88B Superjustable Parts Assortment
	Box-Open End Superrench Long Series 15 degree Angle 12 Pt. Box
2	1158 - 1/4" x 1/4"
2	1159 - 5/16" x 5/16"
2	1159A-11/32" x 11/32"
2	1160-3/8" x 3/8"
2	1161-7/16" x 7/16"
2	1162-1/2" x 1/2"
2	1163-9/16" x 9/16"
2	1163A-19/32" x 19/32"
2	1164-5/8" x 5/8"
2	1165-11/16" x 11/16"
2	1166-3/4" x 3/4"
2	1166A-25/32" x 25/32"
2	1167A-13/16" x 13/16"
2	1167-7/8" x 7/8"
2	1168-15/16" x 15/16"
2	1170-1" x 1"
2	1171-1-1/16" x 1-1/16"
2	1172-1-1/8" x 1-1/8"
2	1173-1-1/4" x 1-1/4"
2	1174-1-15/16" x 1-15/16"
2	1176A-1-3/8" x 1-3/8"

Quantity	Description
2	1176-1-7/16" x 1-7/16"
2	1178-1-1/5" x 1-1/5"
2	1180-1-5/8" x 1-5/8"
2	1182-1-11/16" x 1-11/16"
2	1184-1-3/4" x 1-3/4"
2	1186-1-13/16" x 1-13/16"
2	1188-1-7/8" x 1-7/8"
2	1190-2" x 2"
2	1191-2-1/16" x 2-1/16"
2	1192-2-1/8" x 2-1/8"
2	1193-2-3/16" x 2-3/16"
2	1194-2-1/4" x 2-1/4"
2	WS-8006AR 6 Wrenches in Roll Kit (each kit)
2	WS-12R 6 Wrenches in Roll Kit (each kit)
	Miscellaneous Hand Tools
1	PL-8 Slip-joint pliers
2	PL-1520C Length 10"
2	PL-1522C Length 14" Slip-joint pliers
1	PL-46 Length 6"
1	PL-46C Length 6" Diagonal cutting pliers
1	Pl-57C Length 7" High leverage diagonal cutting pliers
1	PL-40CS Length 5" with spring diag. flush cutting pliers
1	PL-166 Length 6-1/2" end cutting nipper
2	PL-78C Length 7" extra long chain nose pliers
1	PL-12C Length 5-1/2" curved chain nose pliers

Quantity	Description
1	PL-116C Length 6" long needle nose pliers
1	PL-127C Length 5" curved long needle nose pliers
2	PL-204C Length 7" Electricians side cutting pliers
2	PL-1515 Length 8" Lock Ring Pliers with interchangeable tips
2	PL-1600C-3 Snap ring plier set
2	DSS-1 5 Schrewdrivers in cardboard box
2	DRS-4 5 Screwdrivers in cardboard box
2	DES-3A 5 Screwdrivers in cardboard box
2	DPS-5 5 Screwdrivers in cardboard box
2	DPGS-4 4 Screwdrivers in cardboard box
2	EXS-206 6 tool in plastic case, screw extractors
2	GS-4 Feeler gauge sets
1	GS-10 Feeler gauge sets
1	GS-11 Feeler gauge sets
2	PS-17R 17 punches in K-18 roll kit (each set)
2	CS-9R 9 chisels in K-16 roll kit (each set)
2	HSF-155 Soft face hammers, weight 1-1/4 lb, dia. 1-1/2", length 2-3/8, handle 13"
4	HSF-15-t dia. 1-1/2" tough tips
1	HBP-7-0, 2 oz., Ball Pein Hammers, wood handles
1	HBP-5-0, 4 oz., Ball Pein Hammers, wood handles
1	HBP-3-0, 8 oz., Ball Pein Hammers, wood handles
1	HBP-2-0, 12 oz., Ball Pein Hammers,

Quantity	Description
	wood handles
1	HBP-0, 1 lb., Ball Pein Hammers, wood handles
1	HBP-2, 1-1/2 lbs., Ball Pein Hammers, wood handles
1	HBP-4, 2 lbs., Ball Pein Hammers, wood handles
1	HBP-6, 2-1/2 lbs., Ball Pein Hammers, wood handles
2	TDS-29, 29 drills 1/16 to 1/2 by 64ths
1	CMD-2102, 6 masonry drills in plastic kit
2	CC-412-W, Welders "C" clamps, max. 12, min 4
2	CC-112, max. 12, min. 8, Welders "C" clamps
1	GP-242 2 Jaw Puller
1	GP-243 2 Jaw Puller
1	GP-249 2 Jaw Puller
1	GP-250 2 Jaw Puller
1	GP-503 Bearing Splitter
1	GP-189A Haromic Balancer Puller
1	GP-246 3 Jaw Puller
1	CT-57 Cain Pipe Tongs

PROTO CATALOG #800

Quantity	Description
1	Set No. 5200 G-M Metric 53 pc. set with box 3/8" drive
1	Set No. 5400 E-M Metric 45 pc. set with box 1/2" drive
1	Set No. 5500 E-M Metric 29 pc. set with box 3/4" drive
1	Set No. 1200 R-M Metric 18 pc. combination wrench set with case
1	Set No. 1100 P-M Metric 10 pc. box wrench set with case
1	Set No. 3000 A Metric 10 pc. open end wrench set with case

ROCKWELL PROFESSIONAL POWER TOOLS

Quantity	Description
1	2 speed tiger saw assortment of 5 blades & steel carrying case
1	Heavy duty disc. sander
2	Reversing 3/8" variable speed drill
1	Reversing 1/2" impact wrench, 90-100 psig air inlet size 1/4", 6,000 RPM torque 20-150

ROCKWELL INDUSTRIAL MACHINERY
POWER TOOLS CATALOG

Quantity	Description
1	Pedestal 10" grinder motor

Quantity	Description
1	Hexacon hornet model #H10 with cat #91, package of 12 tip
2	Set #113, Holo-Krome key set on Allen set
2	Alemite Bucket Pumps, Model 6712
6	Alemite Lever Guns, Model 4044-C
	Carpenter Tools
1 EA	Stanley Wrecking Bars #124 & 1-130
4	Stanley Nail Hammer #N 1-1/2
1	Stanley Bit Brace #923 Sweep 12"
1	Stanley Ripping Chisel #H818
1	Stanely Straight #1460
1 EA	Stanley Keyhole Saw H1275, extra blades 1275B, 1275MB
1	Stanley Cross-Cut Saw #1528
1	Stanley Rip Saw #1527
2	Stanley Hack Saw #15-160
1	Stanley Wood Chisels #66, 6 chisels in plastic roll
1	Stanley Bench Plane #4, smooth 9"' length
1	Stanley Chalk Line #1050, 50' length
1	Stanley Level #264, Aluminum Torpedo
1	Stanley Level #42-325 24"
1	Stanley Wing Dividers #47-017
2	Stanley Utility Knivers #28-499
1	Model 33 - Wisconsin 6HP Portable Pump
1	Expansive Auger Bit #22
2	Starrett Combination Square #11H 12"
1	Stanley Steel Square #14S

SANEL INDUSTRIAL CATALOG #74

Quantity	Description
1	Tool Chest Kennedy Carpenters #K-32
2	Walker Hydraulic Jack J-945 - 12-ton
1	Desmond Hex Dresser #0
1	Wilton Bench Vise #500S
2	Fairbanks Platform Trucks #MQ-2748
2	Fairbanks Type 9301-2 Barrel Hand Truck
4	Fairbanks #51-H Barrel Stands
	Piston Hand Pumps
2	Blackmer #AT 725C(3) for Solvents
4	Blackmer #AT625(2) General Purpose
6	Syraco Style "E" Part #70 Lock Fast Gates
	Floor Cleaning Equipment
1	Floor Buffer P-18D
1	Vacuum Cleaner with wet pick-up kit JB-102
1	Mop master double mopping outfits Lenior outfits
24	Rag Mops
4	Janitor Mop Sticks #93
6	Janitor Dust Pans No. 7
12	Assorted Floor Squeegees with handles
12	18" garage brooms with handles
6	14" floor brooms with handles

Quantity	Description
1	#1809, 2,000 lb. Mobile Floor Crane
	Miscellaneous Tools and Equipment
1	1-1/2 ton lever hoist as a Beebe Roustabout Level Hoists
1	1-ton #4624 Cyclone Model S-Hand Hoists
1	4,000 lb. Power Hoists #4233 Lodestar single speed 110-1-60 20 ft lift
1	Jenny Steam Cleaner #200 plus pump output 72 gph, pump speed 245 RPM type duplex piston, check valves non-corrosive disc-type solution tank, 6-gal. Fuel tank, 6-gal. burner 2-1/4 gph. Vapor Hose 3/8 x 10 x 25' weight 172 lb. net
1	Graymills turbo clean-o-matic, parts washer
1	30-gal. Drum #M-2600 regular Abitene Part Cleaning Fluid
1	Set Fuze Pullers
1	Meger tester
2	Amprobe Volt Tester
1	Motor Rotation Indicators
2	Explosion-proof drop light - Applaton type EVH with 50 ft., 3 wire ground UL rating Class 1, Group D, Hazardous location EC 432 Y
1	Vapo-proof drop light- Russel & Stall 200 Watt with 40 ft. 3 wire ground type cord
1	Propane torch kit
2	1 liter galvanized oil measure
2	4 liter galvanized oil measure
2	1 liter oil funnels

O.T.C. CATALOG #G-71
MAINTENANCE TOOLS

Quantity	Description
2	2 liter oil funnels
4	Wire hand brushes for steel
1	A45-2 HP elec. portable blower 25' 6" flexible hose ACE Sycamore Inc.
1	Craftsman 2 HP, electric 220-240 Volts, Sprayer-Compressor, 8.8 scfm at 40 psi, 7.4 scfm at 90 psi, 125 max. psi portable 20 gal. air tank 1 yr. warranted
1	#A-61 Aluminum gasket cutting set, Federick Seal, Inc.
1	Model 14D Safegard Flange spreader tool kit 150# 0 to 24" Flange Frederick Seal Inc.
1	Battery powered Weston digital test meter

YARD EQUIPMENT

Quantity	Description
3	6' Bars
4	Long handle pointed shovels
4	Short handle pointed shovels
2	Iron rakes
4	Grass rakes
4	Short handle flat shovels
1	10-HP 350 GPM centrifugal pump with 3" hose connection. Portable with trailer hook-up and wheels
2	20' 3" suction hose
3	20' 3" discharge hose
1	Electric sump pump, 1-1/4 discharge hose 30 ft. length
1	Diaphragm Pump 3" hose end 4HP Briggs & Stratton Engine
2	20' 3" Suction Hose
3	20' 3" Discharge Hose
12	Rubber Fireman Boots
36	Rubber Rain Gear
2	Dozen Rubber Gloves
4	Acid Proof Aprons
2	25-ton Walker Hydrolock Jacks

SAFETY AND FIRST AID EQUIPMENT

Quantity	Descritption
3	Industrial type first aid kit (to be mounted on wall) (1) Halco unitized model 10001 (2) Halco non-unitized model 1000
6	General first aid kits, Halco 10 unit model 1014
2	Safety harness equipped with shoulder and leg straps with 50 feet 3/4" nylon line. Atlas No. 244R with No. 510 safety line.
3	Homelite or equal 1,500 cfm blower portable gas driver
3	20' lengths of non-collapsible air duct
2	MSA Model 2-A combustible gas indicator with 5 feet and 10 feet sample lines
2	MSA #DF-77600 portable oxygen indicator with 5 feet and 10 feet sample lines
2	MSA #FD-12487 wool blankets 62" x 76" flame proofed
2	Impact goggles
6	Life preservers with throwlines
1	H_2S Tester
3	Emergency oxygen and resuscitator kit 60-653
3	Scott air pack kit with spare air tank
4	Dozen hard hats
12	Multi-purpose, dry chemical, U/L rated A:B:C, approximately 10 pound capacity in a wall cabinet

MISCELLANEOUS EQUIPMENT

Quantity	Description
12	Steel storage cabinets, 36" w x 24" d x 78" h, McMaster Model 4587 18 or equal
2	Engine driven, self-priming centrifugal pump. Pump shall be rated 500 GPM at 50 feet TDH and have 15 feet suction lift. Pump shall be equipped with discharge elbow, suction strainer, double mechanical seals, non-clog impeller, removable suction cover. Pump and drive shall be mounted, on steel base with pneumatic tires, and trailer hitch for towing. Engine to be gasoline driven air cooled, pump and drive combination to be non-overloading over entire pump curve, rope start.

END OF SECTION

SECTION 12160

OFFICE FURNITURE

PART 1 GENERAL

1.01 DESCRIPTION

A. Office furniture of the type and quantity specified shall be delivered and placed in the MCC Building, Pump Building, and the Septage Holding Tank Building, as directed by Owner.

B. In order to establish the type and quality of office furniture to be provided, model numbers of single manufacturers have been listed. Furniture of other manufacturers, equal in all respects, will be acceptable.

C. Colors of office furniture shall be as selected by Owner.

1.02 SUBMITTALS

A. Submit manufacturer's catalogs to Owner for approval of type and colors of furniture.

PART 2 PRODUCTS

2.01 OFFICE DESK

A. Office desk shall be steel body, double pedestal, plastic laminate, 1.524 m by .762 m top, two file drawers, two storage drawers, one center drawer with lock, Fisher Scientific Co. Contempra Furniture Division, Model 91-203, or equal.

2.02 CHAIR

A. Chair shall be steel frame, .419 m x .356 m seat, .381 m x .229 m back, adjustable seat height and angle of back, casters, or equal.

2.03 FILE CABINET

A. File cabinet shall be steel construction, two drawer, aluminum handles, thumb-latch locking, label holders, .375 m x .686 m x .740 m, Fisher Scientific Co. Contempra Furniture Division, Model 91-241, or equal.

2.04 WASTE BASKET

A. Waste basket shall be rectangular, steel construction, .381 m x .229 m opening, .330 m high, Witt Co. model 50, or equal. Color as selected by Owner.

END OF SECTION

SECTION 13440

INSTRUMENTATION - GENERAL

PART 1 GENERAL

1.01 RELATED WORK

A. Section 11234: Chemical Dispensing System (Chlorine)

B. Section 13441: Instrumentation Functional Descriptions.

C. Section 13442: Instrumentation Equipment.

D. Section 13443: Instrumentation & Control Panel.

E. Section 13444: Instrumentation Installation.

F. Section 13445: Instrumentation & Control for Package Systems.

G. Section 16010: Electrical General.

H. Section 16111: Conduit.

I. Section 16120: Wire & Cable.

J. Section 16131: Pull, Junction, Termination Boxes & Wiring Trough.

1.02 SYSTEM DESCRIPTION

A. The system to be furnished is described functionally in Section 13441 and shown schematically on the Drawings.

B. Provide a complete integrated, operable, Instrument and Control system including instruments, main control panel, associated equipment, documentation, start up assistance, operator training, and specified submittals and drawings.

1.03 DEFINITIONS

A. Systems Supplier: The designated party regularly engaged in supplying systems and assuming overall responsibility for the detail engineering, coordination and compatability, and furnishing of the instrumentation segment of this Project as described below.

B. Equipment Supplier: A party regularly engaged in the sales and application of instrumentation products.

C. Manufacturer: A party regularly engaged in the manufacture, testing, application and sales of instrumentation components specifically applicable to this Project.

1.04 QUALIFICATIONS

A. The systems supplier shall be capable of assuming systems responsibility as described below. This shall not relieve the Contractor of his responsibility under this Contract.

B. Systems responsibility shall be by a single systems supplier. The system supplier shall be a Manufacturer and market under his label or trademark the equipment appearing on 50% of the data sheets in Section 13442. When 50% or more are not of his manufacture, the supplier shall itemize by item number the manufacturer and basic model number of the item being supplied using a single principle manufacturer and his equipment, where possible.

C. The systems supplier shall have in his direct employ a staff of capable personnel for detail engineering, coordination, drafting, procurement, expediting, scheduling, construction inspection, installation start-up service for calibration and commissioning and service for guarantee compliance for the period specified.

D. The equipment and/or systems supplier shall on request of the Owner or Engineer submit in writing a detailed description of his capabilities and qualifications. The description shall include but not be limited to a listing of specific staff members and their responsibility, a listing of recently completed projects of this project's size and type, and a statement of his financial qualifications.

1.05 REFERENCE CODES AND STANDARDS

A. All instrumentation equipment and installation shall conform to the following United States Codes and Standards:
1. American National Standards Institute (ANSI)
2. Instrument Society of America (ISA)
3. National Electric Code (NEC)
4. National Fire Protection Association (NFPA)
5. National Electrical Manufacturers Association (NEMA)
6. Occupational Safety and Health Act (OSHA)

B. Measurement methods shall conform to the latest published standards and practices of the appropriate regulating body.

1.06 OPERATOR TRAINING

A. The systems supplier shall conduct a group training program on the operation and routine maintenance of the system for Owner's employees in accord with Section 01738. Conduct training at the Project site, consisting of 5 classroom and field training sections, five hours per day during normal working hours. The test shall be the loop diagrams, operation and maintenance manual and shall concentrate on the operation of the equipment as applied to this installation.

1.07 SUBMITTALS

A. Identify all equipment by "tag" number. Where tag numbers have not been specifically assigned, use UU-00-(A-Z) for common accessories; i.e., power supplies in a U as a second letter designation in tagged loops; i.e., LU-05A as an accessory to Level Loop 05.

B. Submit Shop Drawings in accord with Section 01340.

C. Submit Operation and Maintenance Manual in accord with Section 01730.

D. Incomplete or partial (with Owner approval) submittals are not permitted unless accompanied by loop diagrams and other support data to establish submittal's relationship to the entire system. Support data shall accompany its respective submittal. Reference to previous submittals is not permitted. The maximum allowable subdivision of submittals with prior Owner approval shall be: inline devices, miscellaneous field devices, panel devices, panel(s) (with graphics) layouts, and panel wiring.

E. Submit the following items in the quantity and format required.
   1. For approval before release for manufacturing or purchase:
      a. Preliminary loop diagrams and logic diagrams in the ISA Standard S-5.4 format and/or NEMA ICSI-102 format. Loop diagram shall include all details except terminal numbers, model numbers, controller settings and wire/cable number. Show all components, terminals, tag numbers, initial calibrations and setpoints. Drawings shall be 11 x 17 format with one loop per sheet except for alarm only and status lights which may be combined with multi-circuits on a single sheet.
      b. A complete job index and individual catalogue cuts and specifications or data sheets for each piece of equipment identifying all options being furnished and tag numbers.
      c. Instrument and control panel layout internal and face) and graphis to scale or dimensioned, with overall size, mounting, and field entries dimensioned, and items listed in Section 13443, Instrumentation and Control Panel. The graphic shall be a 1/2 size (min.) color submittal.
   2. For specification compliance review and record when order is placed in factory or with suppliers:
      a. Manufacturer's data, order sheet or equivalent for each individual instrument or device being supplied. The information shall include but not be limited to model number, scale or calibration range, type of enclosure and mounting, input/output and power data, and the instrument tag number (or loop number for auxiliary equipment).

b. Manufacturer's outline and mounting dimensions and installation arrangement for all field mounted devices. Note deviations in mounting and arrangements from the Drawings.
c. Operation and Maintenance Manuals containing spare parts list, calibration and service information and factory order sheets. Indicate and provide for later addition of loop diagrams.

3. Prior to final acceptance:
a. Final loop diagrams containing start-up data. (ISA Standard S-5.4, Illustration 7.3 and/or 7.4). The drawing shall contain all specific termination data to equipment supplied by other terminal numbers, model numbers, control settings and wire numbers. The Contractor shall be responsible for supplying the required data for coordination of the instrument system with equipment supplied by others.
b. Operations and maintenance manual supplement as specified in Section 13444 containing Loop diagrams with start up settings and calibrations, copies of certified calibration sheets and corrected information previously supplied.

1.08 DELIVERY, STORAGE AND HANDLING

A. Deliver material to Project site in its entirety or as sub-assemblies if agreed to by the Contractor. Partial shipments of sub-assemblies are not permitted.

B. The Contractor shall receive materials on site and store all material required for the instrumentation and control system. Store materials to prevent physical damage. Protect materials from moisture, corrosion, and similar environmental damage.

1.09 JOB CONDITIONS

A. The system supplier and Contractor shall be responsible for inspection of the job site to ensure compatibility of the system with existing conditions.

B. All work and materials shall be compatible with the environment of the Project.

C. The Contractor shall be responsible for the restoration of all damage to the instrument system and components sustained as a result of the Work.

D. The system supplier shall coordinate detail design to comply with requirement of Section 13444.

1.10 COORDINATION

A. Material and labor required to coordinate with the process and equipment (in addition to standard quoted fixtures required to conform to the instrumentation to the process) shall be the responsibility of the Contractor.

B. The systems supplier shall provide detailed information on the fixtures being supplied and the extent of the field installation required.

C. The systems supplier shall advise the Contractor of deficiency in equipment not supplied by systems supplier that would effect the completion and function of the system.

1.11 ALTERNATES

A. The Contractor may submit, for consideration and approval, alternate methods and/or material if accompanied by documentation on technical and complete financial benefits including impact on all other Work not a part of the instrumentation system.

B. The documentation of technical and financial benefits or equivalency shall be substantiated by certified test data and agreement of others affected.

1.12 GUARANTEE

A. The systems supplier shall guarantee in writing that the materials and workmanship of all equipment furnished by him, regardless of manufacturer, be new and free from defects for a period of one year from the date of plant acceptance.

B. The system shall be certified, calibrated, and commissioned as described in Section 13444.

PART 2 PRODUCTS

2.01 INSTRUMENTATION

A. The system instrumentation shall be the product of one manufacturer to the maximum practicable extent. Where the principal manufacturer cannot supply a device, alternates shall be supplied, except that all equipment of any one type shall be of one manufacturer and the number of alternate manufacturers minimized. When a principal manufacturer's device does not meet all specification requirements, the exception shall be noted and an alternate offered that is recommended by the manufacturer. The Owner will express his preference.

B. Equipment necessary to complete the functional requirements but not specifically listed in this specification shall be provided and be of a quality equal to or better than the equipment specifically described. Equipment shown and/or listed but not specifically mentioned in the functional description shall be a part of the Work.

C. All equipment shall be of the latest proven design. First generation equipment with less than three years general

use shall have documentation on construction, operations, field tests, and users list submitted for approval. The submittal shall be properly identified as First Generation and not included with general submittals.

D. The preferred basic equipment is listed in Section 13442.

E. Provide UL, FM or similar approval for all equipment operating in hazardous areas.

2.02 CONTROL PANELS

A. The systems supplier shall furnish the main control panels and satellite panels for influent, clarifier/trickling filter, sludge recycle, sludge transfer, disinfection, and cable junction points, local instrument and transmitter panels, pre-assembled, and wired.

B. The systems supplier shall coordinate the instrumentation system and panels, with all packaged systems, the electrical system, and the process. Unless otherwise specified, the systems supplier shall supply all controls.

2.03 INSTALLATION MATERIALS

A. Materials shall conform to the applicable specifications described elsewhere. Material not defined shall be of equal quality.

B. Interface fixtures shall be compatible with the equipment to which they are attached and the process application.

C. Details specified in Section 13444 shall be a part of the specification.

2.04 SPARE PARTS AND ACCESSORIES

A. Spare parts and accessories such as special fuses, electrodes, membranes, fluids, charts, and ink required to start-up the system and operate it for a period of 60 days shall be supplied. Package materials in a consolidated but separate container and ship to the job site with the instruments. Tag container INSTRUMENT START-UP EQUIPMENT.

B. A one year supply of charts, ink, and consumable parts (i.e. electrodes and membranes) shall be supplied. Package materials in a consolidated but separate container, with an inventory list and mark INSTRUMENT MAINTENANCE EQUIPMENT. The container shall contain the specified maintenance test equipment and spare parts.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 13441

INSTRUMENTATION FUNCTIONAL DESCRIPTIONS

PART 1 GENERAL

1.01 SCOPE

A. This Section contains the basic functional description of each instrument loop. The individual components in a loop shall, when appearing in other Specifications or on Drawings, be identified with the function letter designation and the loop number identification in accordance with ISA Standard S-5.1 and the Drawings.

B. Provide all instrumentation equipment, unless specifically noted, to satisfy the functional requirements of this Section.

C. The operating characteristics of major components are described in Section 13442. Calibrations are shown on the Drawings.

D. The instrument system is shown schematically on the Drawings.

E. The following sequential numbering system shall be maintained. Expansion and control of the numbering shall be the responsibility of the system supplier.

F. Loop numbering:
1. 0-49 - Primary by Division 13
2. 50-99 - Primary by other Division
3. Unit Series - Common System
4. 100 Series - Train 1
5. 200 Series - Train 2
6. 300 Series - Train 3 (Future)

1.02 LOOPS 01, 50, 51, 52, 53 BAR SCREENS T-01A and T-01C

A. Level is sensed up stream of the screens. A switch opens on high level to activate an alarm.

B. Integral controls are provided by the manufacturer consisting of a timer to periodical run the mechanism, a differential level system to override the timer, and dry contact closures to indicate run and malfunction (failure to run when commanded and overload). Run indication and malfunction alarm shall be provided on the graphic of CP-1.

1.03 LOOP 04 INFLUENT FLOW

A. Flow is sensed with a sonic element. The element produces an output proportional to level. The output is converted to a 4-20 mAdc signal proportional to level flow. The transmitter is equipped with an integral mounted 0-100%

output indicator. The primary measuring device is a Parshall flume. The signal is transmitted to the Instrument and Control Panel CP-1

B. The transmitted signal is recorded in engineering units integrated and totalized on CP-1.

1.04 LOOP 09 AND 10 PLANT DRAIN AND RETURN

A. Flow is sensed with a sonic element. The element produces an output proportional to level. The output is converted to a 4-20 mAdc signal proportional to level flow. The transmitter is equipped with an integral mounted 0-100% output indicator. The primary measuring device is a Palmer-Bowles flume. The signal is transmitted to the Instrument and Control Panel CP-1. The transmitted signal is recorded indicated in engineering units integrated and totalized on CP-1.

B. In the plant drain holding tank:
1. A level switch senses level and closes at a set elevation. The switch closure starts the lead pump. If the level does not decrease (switch open) in a set time the lag pump starts and the lead pump stops.
2. On low level a switch opens to stop all pumps.
3. A level switch senses level and closes at a set elevation. The switch closure starts the back up pump immediately. On low level a switch opens to stop the pump.
4. The operation of the lag and back up pumps is manually alternated.

C. Level is sensed and a switch activated at high level. The switch opening closes a valve to stop flow from the drying bed area. The valve re-opens below normal high level. If the level continues to rise, a second independent switch opens to activate an alarm on the Instrument & Control Panel CP-1.

D. Pump run indications shall be provided on the graphic of CP-1.

1.05 LOOP 05 TO 08 SEPTAGE

A. Level in the holding tanks is indicated locally.

B. Level is sensed in each holding tank and a switch activated at low level. The switch opens to activate an alarm on the Instrument & Control Panel CP-1.

C. Flow is sensed with a sonic element. The element produces an output proportional to level. The output is converted to a 4-20 mAdc signal proportional to flow. The transmitter is equipped with an integral mounted 0-100% output indicator. The primary measuring device is a Palmer-Bowlus flume. The signal is transmitted to the Instrument and Control Panel CP-1

D. The transmitted signal is recorded in engineering units integrated and totalized.

E. Locally the transmitted signal is integrated. The integrator provides a signal pulse to an electronic counter. The count is compared against a set value. When the count signal goes above the set value, a contact opens. The contact limits the number of gallons pumped. The counter is reset by a timer at periodic intervals (10 minutes to 2 hours adjustable).

F. Pump run indication shall be provided on the graphic of CP-1.

G. Mixer run indication shall be provided on the graphic of CP-1.

H. A timer with adjustable on and off time shall in the "on" cycle run exhaust blower A and the "off" cycle run blower B.

I. Blower run indication shall be provided on the graphic.

1.06 GRIT BLOWER

A. Grit blower run indication shall be provided on the graphic of CP-1.

1.07 LOOP 150 TO 153 PRIMARY CLARIFIER

A. A malfunction (i.e. overload) of the system will be sensed. A malfunction will open a single contact. The contact shall activate an alarm on the Instrument & Control Panel CP-1.

B. Run indication shall be provided on the graphic of CP-1.

1.08 LOOP 122 A, B, C PRIMARY CLARIFIER SLUDGE WASTING

A. Each pump control is activated by a repeat cycle timer. The timer has independently adjustable on and off timer.

B. The accumulated running time of each motor is displayed on CP-1.

C. Run indication to be provided on the graphic of CP-1.

1.09 LOOP 123 SCUM PIT LEVEL

A. Level is sensed by a float. If the level increases above a set level a local alarm light and an alarm is activated on the Instrument and Control panel CP-1.

B. Level is sensed by a float. When the level decreased below a set level a local alarm is activated. The local indication is equipped with an audible device that sounds for a set time (i.e. 15 seconds) and shuts off.

1.10 LOOP 111 A AND B FORWARD FLOW TO TRICKLING FILTER

A. Level is sensed by float switches, on increase or decrease in level the pumps are programmed as follows:
1. When the level increases above a set value the lead pump starts on slow speed. If the level does not decrease within a set time the lag pump starts on slow. if the level does not decrease the lead pump goes to fast and the lag pump stops. if the level does not decrease the lag pump is started in fast speed. If the level exceeds a second high level the sequence is advanced at a shorter time interval. $/:a1c On a decrease in level below a set value the sequence is reversed except that when going from one pump fast to 2 pumps slow the second pump slow speed starting is delayed to stagger the starting.

B. Lead/Lag pump selection is manual at CP-101.

C. Level is sensed by float switches. On increase or decrease of level above and below limits an alarm is activated on the Instrument & Control Panel CP-1.

D. Run indication of each pump is indicated on the Instrument and Control Panel CP-1.

1.11 LOOP 112 A AND B TRICKLING FILTER WETTING RECYCLE

A. Level is sensed by a float switch. If level decreased below a set minimum, the pumps are stopped and an alarm activated. Restart shall be manual (operator initiated).

B. Run indication of each pump is indicated on the Instrument & Control Panel CP-1.

1.12 AERATOR RUN

A. Aerator run (separate fast and slow) indications shall be provided on the graphic of CP-1.

1.13 LOOP 113, 114, 115 SECONDARY RECYCLE FLOW

A. Flow is sensed with a sonic element. The element produces an output proportional to level. The output is converted to a 4-20 mAdc signal proportional to flow. The transmitter is equipped with an integral mounted 0-100% output indicator. The primary measuring device is a Palmer-Bowles flume. The signal is transmitted to the Instrument and Control Panel CP-1

B. The transmitted signal provides the feedback for an analog output controller. The signal is compared against an operator set set point. The output is modulated to maintain the set value. The controller has a process indicator and set point indicator displayed in engineering units. The output has a bumpless-positionless manual-auto transfer switch and a 0-100% output indicator. In manual, the output is positioned with a control on the instrument

face unaffected by the process-setpoint relation. The output of the controller modulates a control valve to maintain control.

C. The set point signal provides a signal to an electronic switch. The signal is compared against set values. When the set point signal goes above the set values, a contact closes. The switch has a fixed differential. The contacts activate a light system indicating the number of pumps required to maintain the set (desired) flow.

D. A level switch opens to stop all pumps and activate an alarm on low low wet well level. The pumps shall be manually restarted.

E. Pump run indication shall be provided on the graphic of CP-1.

F. A level switch opens on low level to activate an alarm on Instrument & Control Panel CP-1 Graphic.

1.14 LOOP 116 - SECONDARY SLUDGE WASTING

A. Each pump control is activated by a repeat cycle timer. The timer has independently adjustable on and off timer.

B. Pump run indication shall be provided on the graphic of CP-1.

C. The accumulated running time of each motor is displayed.

D. Level in the wet well is monitored and if it goes below a predetermined elevation, the pumps are shut down. The pumps are automatically restarted when the level is restored.

1.15 LOOP 154, 155 - SECONDARY CLARIFIER/FLOCULATOR

A. Torque is sensed on the mechanism and if the torque reaches 100% a contact, furnished by the equipment supplier, opens to activate an alarm. If the torque reaches 125%, the unit shuts down. A shear pin failure causes a switch contact to open to activate an alarm. on the Instrument & Control Panel CP-1 graphic.

B. Run indication shall be provided for the motors on the Instrument & Control Panel CP-1 graphic.

1.16 LOOP 117 - SECONDARY CLARIFIER SCUM

A. Level is sensed by a float switch. On an increase in level a pump starts. On decrease in level, the pump stops.

1.17 LOOP 118, 119 - POLYMER SYSTEM

A. Level is sensed by a switch. On a decrease in level, any alarm is activated on the Instrument & Control Panel CP-1.

B. The water fill/wetting system supplied with the equipment is manually activated. Level is sensed by a switch. On high level the switch opens to close the water fill valve.

C. Run indication is provided for the mixer and feed pumps on the graphic of Instrument & Control Panel CP-1.

1.18 LOOP 124 - DIGESTER FEED

A. Each pump control is activated by a repeat cycle timer. The timer has independently adjustable on and off timer.

B. Pump run is provided on the graphic of CP-1.

C. The accumulated running time of each motor is displayed of CP-1.

1.19 LOOP 156 - THICKENER FEED MIXER

A. Operation of the equipment shall be monitored. If the mixer stops an alarm activates.

B. Run indication is provided on the graphic of CP-1.

1.20 LOOP 157 - DIGESTER THICKENER

A. Torque is sensed on the mechanism and if the torque reaches 100% a contact, furnished by the equipment supplier, opens to activate an alarm. If the torque reaches 125%, the unit shuts down. A shear pin failure causes a switch contact to open to activate an alarm on the Instrument & Control Panel CP-1 graphic.

B. Run indication is provided for the motors on the Instrument & Control graphic of CP-1.

1.21 LOOP 159-69 - DIGESTER GAS AND BOILER SYSTEM

A. The control of the gas system will be supplied by the manufacturer. The following interface shall be required. Operation alarms for the following malfunctions shall be furnished on Instrument and Control Panel CP-1.
1. Boiler firing system
2. Oil storage low level
3. Digester pressure high
4. Flare failure

B. The following run or operation indication shall be furnished of the Instrument and Control Panel CP-1.
1. Sludge mixing pumps
2. Water circulating pumps
3. Boiler operation
4. Flare operation

1.22 LOOP 127 DIGESTOR GAS DETECTOR

A. The presence of gas (methane and H_2S) is sensed in the gas equipment room. If the concentration level exceeds 75%

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L.E.L. or hazardous limit an alarm shall activate on the graphic of Instrument and Control Panel CP-1.

B. A red rotary beacon shall operate outside the door to the equipment room.

1.23 LOOP 54 - 58 CHLORINE SYSTEM

A. The chlorine feed and storage system is described in Section 11234.

B. A common malfunction alarm shall be indicated on the graphic of the Instrument and Control Panel CP-1.

C. Run indication and totalizing for the transfer pumps is provided on the Instrument and Control Panel CP-1.

1.24 LOOP 11 - EFFLUENT FLOW AND CHLORINE PACING

A. Flow is sensed with a sonic element. The element produces an output proportional to level. The output is converted to a 4-20 mAdc signal proportional to flow. The transmitter is equipped with an integral mounted 0-100% output indicator. The primary measuring device is a Parshall flume The signal is transmitted to the Instrument and Control Panel CP-1 and the Chlorine Control Panel.

B. The transmitted signal is recorded, integrated, and totalized on CP-1.

C. The transmitted signal provides the input for a controller. The signal is compared against an operator set ratio. The output is modulated to maintain the set value. The controller has a process indicator and ratio indicator displayed in engineering units. The output has a bumpless-positionless manual-auto transfer switch and a 0-100% output indicator. In manual, the output is positioned with a control on the instrument face uneffected by the process ratio relation. A face mounted local-remote switch allows the operator to select the desired mode. The output of the controller modulates the chlorine system to maintain control.

1.25 LOOP 59 - CHLORINE ALARM

A. Chlorine gas presence will be detected in the cylinder room and the chlorinator room. If the level of gas exceeds a set value an alarm will sound on the local chlorinator system panel. Red rotary beacons shall activate at each entrance to the respective rooms. The alarm shall be retransmitted to the Instrument and Control panel CP-1 to activate an alarm.

1.26 MISCELLANEOUS INDICATIONS AND ALARMS

A. Run indication shall be provided on the graphic of Instrument and Control Panel CP-1 for the following:
1. Chlorine Mixers (Stop)

2. Generator Run (2 locations)
3. Generator Malfunction (Alarm)(2 locations)
4. Remove Pump Stations (Alarm)
5. Seal water low (alarms) (1 main system, 2 each train).

END OF SECTION

SECTION 13442

INSTRUMENTATION EQUIPMENT

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Instrumentation - General: Section 13440.

B. Instrumentation Functional Description: Section 13441.

C. Instrumentation Field Installation: Section 13444.

1.02 SUBMITTALS

A. Shop Drawings shall be submitted in accordance with Section 13440.

1.03 QUALITY CONTROL

A. All instrumentation shall meet or exceed I.S.A. Standards and Recommended Practices, ANSI, National Electric Code, OSHA and any other applicable code or local regulation.

B. Instrumentation shall comply with Section 13440, Paragraph 2.1.

C. All panel instruments shall be of the same manufacturer and model type to provide ease of maintenance, uniform appearance and to minimize spare parts requirements.

PART 2 PRODUCTS

2.01 EQUIPMENT REQUIREMENTS

A. The primary power shall be 220 volts, 50 Hertz. Panel devices may be powered from a low volt system (i.e. 24 or 48 volt d.c.) provided each device or loop has an individual fused disconnect and that a minimum of 2 power supplies each capable of handling the entire system, are provided with 50% minimum spare capacity each.

B. Transmission to and from electronic analog field devices shall be at 4-20 madc. Distribution within a panel may use variable voltage, but must be consistent (current or voltage) throughout the system. Voltage resistors shall be separate mounted from devices using resistor.

C. Transmission to the main panel of alarms and status lights shall be 48VDC maximum.

D. All component external connection points shall be made at terminal blocks with No 6-32 or larger screws.

E. All equipment shall be suitable for operation in ambient temperatures of 0 deg. C to 55 deg. C for panel and indoor devices and -25 to 50 deg. C for field devices. Field devices may be equipped with protection to meet the requirements.

F. Electronic receiving equipment shall be capable of receiving accurate data over specified instrumentation wiring as described in the Specifications, and shown on the Drawings. Any filters, amplifiers, surge protectors, isolators, or similar devices required to transmit, and receive accurately, or protect the device shall be provided.

G. Electronic receiving equipment shall have ungrounded isolated inputs.

H. Indicators, recorders, controllers, integrators, relays and other receiving devices when operating in a loop shall be of a design such that a failure of an individual device shall not affect the operation and integrity of the remaining loop functions.

I. Enclosures for instruments installed in a control panel may be general purpose if the enclosure is dust tight or better in construction. If not, devices shall be dust tight or better as dictated by the installation area classification.

J. Rack mounted devices may be used if the rack contains 24% spare slots for expansion and active slots are labeled with tag number of device in slot.

2.02 INSTRUMENT DATA SHEETS

A. Attached are Data Sheets listing the basic instrumentation equipment. Only the principal equipment is listed. Supplemental equipment shall be of equal or better quality to that listed. Heavy duty industrial type (not commercial, residential, computer or laboratory) equipment shall be considered standard.

B. The listing of a manufacture and model number represents the equipment used as the basis of design to indicate the size, capacity mounting arrangement, mounting dimensions, function and technical capabilities of the instrumentation.

PART 3 EXECUTION

Not Used.

INSTRUMENT DATA SHEET NO. F-1
CONTROL VALVE

SERVICE

Line Size:	150 mm
Maximum Flow (L/M):	6500
Maximum Pressure kPa:	180
Differential Pressure kPa:	120
Operation Temperature:	2 - 40 deg C
% Solids:	2
Material:	Waste water

BODY

Type:	Butterfly
Size:	150 mm
Material:	D. I.
Connect:	150 # Bolted
Packing:	TFE
Bonnet:	Mfg. Std.

TRIM

Form:	Full Port
Material:	Mfg. Std.
Plug/Seat/Disc:	S. S.
Shaft:	S. S.
Tightness:	Std.
CV Maximum:	

ACTUATOR

Type::	Electric Pre assembled on valve

MANUFACTURER:
MODEL:
TAG: LCV-09, FCV-113, 114

NOTES

(1) See F-2 for electric
(2) Valve to meet AWWA Specifications

INSTRUMENT DATA SHEET NO. F-2
ELECTRIC OPERATOR

The operator system shall be complete with all controls and accessories. The system shall be modulating per functional description . Separate mounted controls shall be supplied with 10' interconnecting cable (actuator to control) preconnected to the control unit. All remote connections (power, remote control and transmission) shall all be made at master terminal block in either the control or activator.

Drive Enclosure:	NEMA 12
Power:	220 Volt 1 Phase
Duty:	Intermittant Duty
Actuator Power Switching:	Manufacturer's Standard
Control Input:	See below
Integral Controls:	Remote-local selector Open-Off-Close
Position Indicator:	Mechanical Local Lights
Overtravel Limits:	Manufacturer's Standard
Travel Indication:	(2) S.P.D.T. 5 AMP Dry Contact (wired to T.B.)
Control Type:	See functional description 15 sec. min. operation time full stroke on LCV-09

MANUFACTURER:
MODEL:
TAG:

INSTRUMENT DATA SHEET NO. L-2
ELECTRONIC SWITCH

Input:	As required
Output:	S.P.D.T. 5 AMP (each point)
Power:	220 Volt, 50 pHertz
Set Point:	Calibrated Dial# 0-100% of span-each point
Dead Band:	As required (adjustable to calibrated dial)
Accuracy of Set Point:	±5%
Operating Temperature:	40-120 deg F. (See General Requirements)
Enclosure:	Dust tight (See General Requirements)
Miscellaneous:	ID Nameplate
Mounting:	Surface (or rack option)
Size:	Manufacturer's Standard
Spare Parts:	1 spare unit of each type

If primary manufacturer does not market a unit with a calibrated dial a waiving of this requirement shall be requested.

MANUFACTURER:
MODEL:
TAG: FAS-113, 114

INSTRUMENT DATA SHEET NO. L-4
COMPUTATION MODULE

Integrator

Input:	4-20 mA linear
Output:	24 Volt dc, Pulse 3.5 Watt
Power:	220 Volt, 50 Hertz (See General Requirements)
Accuracy:	0.5% F.S.-1-100%
Pulse Rate:	60 PPM Maximum
Pulse Duration:	To match counter or relay
Zero Drop Out:	Adjustable
Operation Temperature:	40-120 deg F.
Enclosure:	(See General Requirements)
Miscellaneous:	ID nameplate
Mounting:	Surface (or rack)
Spare Parts:	1 spare unit calibrated 10 ppm at 100% input

Counter

Scale:	Counts
Range:	8 Digit
Reset:	None
Input:	Compatible with integrator
Nominal Size:	1-1/2" x 2"

MANUFACTURER:
MODEL:
TAG: FQI-04, 08, 10, 11

INSTRUMENT DATA SHEET NO. M-1
PRESSURE GAGES

Type:	Direct Reading
Mounting:	Local
Dial:	4.5 White
Case:	Phenol
Ring:	Manufacturer's Standard
Lens:	Plastic
Pressure Element:	Bourdon
Process Connection:	1/2 inch N.Pt
Connection Position:	Bottom
Element Material:	Bronze
Socket Material:	Bronze
Movement:	Bronze
Options:	a. Diaphragm seal with 316SS wetted parts b. Diaphragm seal with wetted parts c. Snubber d. Syphon e. A and B to be factory assembled, filled and calibrated to gage

MANUFACTURER:
TYPE:

Quantity	Range (kPa)	Tag	Options
2	0-200	P-01	a,e
3	0-400	P-02	a,e
1	0-200	P-03	a,e
3	0-400	P-04	
2	0-100	ME-02	c
5	0-400	P-100	a,e
3	0-400	P-101	a,e
5	0-400	P-102	a,e
2	0-100	P-103	a,e
1	0-600	ME-400	
1	0-600	ME-401	
1	0-600	ME-402	

INSTRUMENT DATA SHEET NO. M-2
ANNUNCIATOR

Annunciator to conform with ISA Standard S18.1

Standard:	ISA S18.1 Dated 1979
MountingLogic:	Rack
Cabinet Style:	Remote Indication
Cabinet Rating:	NEMA 1
Lamp Type:	Per Graphic Spec
Lamp Color:	Red Graphic
Alarm Points/Light Box:	1
Lamps/Alarm Point:	1 Remote
Logic Type:	Solid State Electronic
Logic Location:	Separate Mounted
Field Contact Voltage:	48 dc or Manufacturer's Standard
Activating Logic:	Field Selectable N.O. or N.C.
Lock-In for Alarms:	Field Selectable
Flasher for Alarms:	Integral to Logic
Audible for Alarms:	a. Horn with adjustable on and off time 1-10 sec/0-10 min b. Horn Relay - D.P.D.T. 3 Amp continuous signal until acknowledged
Sequence:	ISA Standard A
Power Supply:	220 Volt 50 Hz Primary
Power Supply Location:	Separate Mounting
Tagging:	tag each alarm and status card location with the Tag No. shown in the Contract Documents.
Arrangement:	See Drawings. Mount in CP-1
Miscellaneous:	a. Provide 1 each type cards and relays used. If more than 10 of one type are used, furnish 10% spares +2. b. Submit legend and arrangement c. Provide nameplate with Tag No. above or below each card slot

MANUFACTURER:
MODEL:
TAG: AN-1

INSTRUMENT DATA SHEET NO. M-4A
FLOAT SWITCH

Type Self-Contained

Body Material:	Polyurethane Coated Metal
Cord:	Poly Coated
Mounting:	Hung from Cord
Bouyancy Weight:	Internal
Cord Length:	7 meters field verify.
Switch Type:	Mercury
Form:	S.P.D.T.
Rating:	3 AMP, 220 Volt
Spare Parts:	2 complete units
MANUFACTURER:	Flyte
MODEL:	ENH-10
TAG:	LAS-01, 05, 06, 09, 111A1-2 111B1-2, 112A-B, 115 LCS-09A1-3, 111A1-4, 111B1-4, 112A-B, 115, 117A-B, 123

INSTRUMENT DATA SHEET NO. M-5
LEVEL INDICATOR

Element Type:	Diaphragm
Material:	Bronze
Range:	Dual (Volume and Depth)
Overrange:	150%
Connection:	Manufacturer's Standard 1/4" 1/2"
Scale Diameter:	5 cm
Scale Length:	270 deg
Mounting:	Surface
Enclosed:	NEMA 3 or 3R
Tagging:	Metal I.D. with Tag #
Options:	Air Pump (Integral)
MANUFACTURER:	Hershey or equal

INSTRUMENT DATA SHEET NO. M-8
CHLORINE ALARM

Type:	Forced Circulation with Self Contained Blower
Electrolyte:	Non-Water Based, 1 year normal life
Detection Level:	1 ppm chlorine by volume Non-adjustable set point
Sampling Rate:	2 scfm
Response Time:	Instantaneous
Power:	220V, 50 Hz. (Est. 25 Watts)
Output:	D.P.D.T. relay with 10 Amp contacts
Mounting:	Wall
Sample Inlet:	1" NPT
Indication:	Flashing alarm light. Sample flow rate power on light.
Controls:	Alarm reset and test
Approvals:	FM
Miscellaneous:	a. 5 year supply of electrolyte. b. 3 - 220 Volt, 50 Hz red rotary beacon with weatherproof housing for remote mounting.
MANUFACTURER:	Chlorine System Mfg. Std.
MODEL:	
TAG:	AIS-59A-B

INSTRUMENT DATA SHEET NO. R-1
RECORDER

Type:	Miniature 6x6 nominal
Mounting:	Panel
Chart Type:	strip
Chart Speed:	2 cm/hr
Chart Drive:	Electric 220 Volt 50 Hz
PenPrint Drive:	Direct Positive No cord type
Indication:	Individual direct reading
Chart:	0-100%
Writing System:	Capillary and Fiber Tip Pen with 100 feet writing/filling or Inkless
Power:	220 Volt 50 Hz
Input:	4-20 mAdc
Accuracy:	± 0.5%
Dead Band:	± 0.1%
Miscellaneous:	a. Service Tool kit 1 set for each 5 recorders. b. 60 days 0-100 Charts, 1 year supply of charts with scales as determined at start up from samples and graduation listings. c. 1 year supply of disposable items i.e., ink, pens, etc.
MANUFACTURER:	
MODEL:	
TAG:	FR-04, 08, 10, 11

INSTRUMENT DATA SHEET NO. R-2
CONTROLLER

Size:	3x6 Nominal
Mounting:	Rack or Shelf
Class:	NEMA 1
Input:	4-20 mAdc
Man-Auto Switch:	Bumpless-Positionless
Set Point:	External Local with output
Control Action:	Proportional 2-500% + Reset 0.01-60 Repeats/Min. and Anti-Reset Wind-up
Indication:	Process, set point, output (0-100%) process and set point to be direct reading with changeable scales.
Output:	4-20 mAdc with adjustable limits
MANUFACTURER:	
MODEL:	
TAG:	FIC-113, 114

INSTRUMENT DATA SHEET NO. R-3
INDICATORS

ANALOG INDICATOR FIELD

Type:	Inch Square Taut Band
Enclosure:	NEMA 4 Window
Scale Length:	3.25 inches nominal
Display:	0-100%
Input:	4-20 ma each pointer or as required
Accuracy:	± 0.5% F.S.
Repeatability:	± 0.2% F.S.
Power:	loop powered
Miscellaneous:	I.D. Nameplate
MANUFACTURER:	
MODEL:	
TAG:	Reference

ANALOG INDICATOR MAIN PANEL

Type:	Vertical Scale Inch Square Taut Band
Enclosure:	General Purpose
Scale Length:	3.25 inches nominal
Display:	Engineering Units and Factor
Input:	4-20 ma each pointer
Accuracy:	± 0.5% F.S.
Repeatability:	± 0.2% F.S.
Power:	220 Volt 50 Hz or loop powered
Miscellaneous:	I.D. Nameplate
MANUFACTURER:	
MODEL:	
TAG:	FI-113, 114

INSTRUMENT DATA SHEET NO. T-1
SONIC LEVEL (FLOW)

The transmitting system shall be complete with all fixtures and accessories including interconnection cable between the sensing element and the transmitter.

The systems shall all have the same basic electronics P.C. board. Level range, flow characterizing, alarm relaying and output functions shall be accomplished by plug-in modules or integral selectors.

Loss and restoration of power or line transients shall not effect calibration or Micro Processor Programming.

The transmitter shall be equipped with terminals and circuits to synchronize operation when more than one unit is mounted and operated adjacent to each other.

Element - LE or FE

Housing:	NEMA 4 Corrosion Resistant
Temperature Comp.:	Integral
Heating:	As required
Cable Length:	As required by installing contractor

Transmitter - LIT or FIT

Enclosure:	NEMA 4 or 3R
Power:	220 Volt, 50 Hz.
Zero-Span:	Independently adjustable by digital switch
Output:	4-20 mAdc at 0-800 OHMS
Output Indication:	Manufacturer's Standard visible through door
Flow Characteristics:	Switch selectable pre-programed
Mounting:	Wall or pipe
Accuracy:	±1% range
Accessories:	Thermostatically controlled heater for outdoor installations if required by manufacturer to meet ambient conditions.

Miscellaneous

1-Sensor Head Each Type.

1-Spare P.C. board of each type.

MANUFACTURER:
MODEL:
TAG: FIT-04, 08, 10, 11, 113, 114

INSTRUMENT DATA SHEET NO. T-7
FLUME LINER

The flume shall be constructed of fiberglass reinforced polyester resin. The minimum wall thickness shall be 3/16 inches. The walls shall be supported in a manner to prevent distortion. The interior surfaces shall be smooth gel coat. The flume shall be mounted in a channel liner.

Fixtures shall be supplied to prevent distortion during installation.

Calibration curves and calculations shall be supplied.

MANUFACTURER: Hind of California
SIZE: Refer to Drawings
TAG: FE-04, 08, 10, 11, 113, 114
TYPE: Refer to Drawings

INSTRUMENT DATA SHEET NO. T-9
GAS DETECTOR

Gas detector system: complete with all fixtures including interconnecting cable when 2/C #18 twisted shielded cable cannot be used. Use catalytic bead type sensors.

System element: direct contact, not requiring a sampling system.

AE

Gas Sensed:	Methane
Ambient Temperature:	-10 to +120 deg F
Response Time (Maximum):	1 second
Life (Average):	3 years
Control Cable Length:	50 feet

AIS

Accuracy:	±5% F.S.
Repeatability:	±2% F.S.
Span:	0-100% LEL
Mounting:	Wall
Type:	NEMA 1
Power:	220 Volt, 50 Hz
Indicator:	0-100%
Output Relays (3): (Malfunction, 1st Set and 2nd Set)	SPDT 3 Amp
Set Point Adjustment:	Internal
Lock-In:	Selectable

Miscellaneous

Calibration Gas if required.

MANUFACTURER:
MODEL:
TAG: AIS-165

END OF SECTION

SECTION 13443

INSTRUMENT AND CONTROL PANEL

PART 1 GENERAL

1.01 RELATED WORK

A. Section 13440: Instrumentation General.

B. Section 13441: Instrumentation Functional Description.

C. Section 13444: Instrumentation Installation.

1.02 DESCRIPTION OF WORK

A. Provide complete panel including graphic.

B. Annunciator, record, provided under Section 13442.

C. Test Panel.

1.03 SUBMITTALS

A. Submit Shop Drawings and product data in accordance with Section 01340.

B. The panel fabricator shall submit the following for approval prior to fabrication:
   1. Provide bill of material of all items installed. List tag number, quantity, manufacturer, model number, and supplier. Indicate if supplied under other sections for installation only by fabrication.
   2. Provide schematics or ladder type diagrams for all circuits not covered by specific diagrams elsewhere. Typical or tabulated type circuit presentations are not permitted.
   3. Catalogue cuts or data sheets, properly identified, for all accessory components such as terminal blocks, auxiliary relays, sockets, lamps, pushbuttons, and switches.
   4. Panel Drawings showing overall size, face layout with typical dimensions, panel interior layout showing rear of panel components, terminal blocks, bulk heads, wire and tube troughs. The submittal shall have sufficient detail to present:
      a. The component content.
      b. The face arrangement for logistics and operator efficiency.
      c. Accessibility of components and terminals.
      d. Separation of signal routing and terminals.
      e. The specific requirements and features described below shall be circled, underlined or otherwise highlighted on the submittal.
   5. Provide internal wiring diagram.
   6. Graphic layout with one color rendering. Minimum 1/4 full size.

C. Submit copies of an internal wiring and piping diagram with the terminal points of all wires and tubes identified with the wire or tube number and the terminal point identification.

D. The panel fabricator shall submit operation and maintenance manual in accordance with Section 01730. Include only items and systems furnished under this section.

1.04 SPARE PARTS

A. The panel fabricator shall furnish the following spare parts not furnished under Section 13442:
   1. Ten each size fuses.
   2. 10% (or 2 each minimum) of plug-in relays, alarm cards, pilot lights, assemblies, push buttons, and indicator bulbs (10 minimum).
   3. 5% Graphic tiles to match basic background.

1.05 FACTORY INSPECTION AND TESTING

A. Permit Engineer to inspect the panel(s) during construction with 24 hour notice to the fabrication shop.

B. The panel fabricator shall submit for approval a final test demonstration plan to the Engineer for review 5 weeks prior to the start of the final test. The plan shall consist of the operational features that will be demonstrated to verify that the panel has been properly wired and piped. A test stand with switches, lights, meters, and signal generators shall be available to simulate field conditions.

C. The panel fabricator shall advise the Engineer two weeks prior to the date of the scheduled final test and the expected duration of the test.

D. The Engineer will witness the final testing of the panel and will authorize release for shipment.

PART 2 PRODUCTS

2.01 ENCLOSURE

A. The size and type of enclosures are shown on the Drawings. The final enclosure size shall be governed by the component selection. If different than shown on the Drawings, approval of the Engineer is required prior to shop drawing submittal.

B. Manufacture enclosures from cold rolled steel free of dents or other defects with a straight flat face.

C. Fabricated enclosures: angle frame, with welded frame and shell construction.
   1. Enclosure face: 4.5 mm thick minimum.

2. All other surfaces of the shell: 10 gage minimum.

D. Pre-fabricated standard catalogue enclosures: heavy duty Hoffman Custom Controls, type or equal.

E. Provide print storage pockets on the inside of each enclosure, sized to hold all prints required to service the equipment.

2.02 COMPONENTS

A. Basic components are described on the Drawings and below.

B. All miscellaneous components: heavy duty industrial type equal or better in quality than the basic instrumentation.

C. Mounting hardware: stainless steel or cadmium plated.

D. Relays:
1. Relays: 3 pole, D.T., octal plug-in type with a transparent dust cover, equipped with an indicating light to indicate when its coil is energized. Provide 5 amp 220 volt ac contacts. The mechanical life of the relay shall be 10,000,000 operations minimum.
2. Industrial machine tool track mounted relays. The relays shall have power reed type encapsulated contacts. Provide a visual indication to show that the relay is energized.
3. Provide 24 VDC interface relays, coil currents, and operating characteristics compatible with the transmission system.

E. Timers:
1. Timers: plug-in, multi-range analog with selectable ranges between 1 second and 10 hours full scale or digital type with a dust and moisture resistant case. Provide output contacts rated at 5 amp 115 volt ac minimum and a timing in progress indication. The mechanical life shall be 10,000,000 operations minimum.
2. Track mounted solid timers of the same style and configuration as the track mounted relays may be used in conjunction with the relays where operator adjustability and critical timing are not required.

F. Pushbuttons & Non-Graphic Pilot Lights:
1. Pushbuttons and non-graphic pilot lights: heavy duty, oil tight of standard size.
2. Pilot lights: press-to-test type unless a master lamp test system is provided.
3. A.C. pilot lights: transformer type with 5000 hour minimum lamp life.
4. Pushbuttons: full guard type with screw terminal type contact blocks. Pushbutton colors:
   a. Start: green.
   b. Stop: red.
   c. Acknowledge or reset: yellow.
   d. All others: black.

G. Equipment identification nameplates: laminated plastic engraved on the upper 1/2 of the surface to permit recording of changing process and operational data or future identification on the remaining lower half.
   1. Use white surface with a black core (letters) on the panel exterior.
   2. Use black with white core (letters) inside panels with white or light interiors.

H. Interior lighting: full length fluorescent type.

I. Provide a grounded 220V service receptacle.

2.03 GRAPHIC

A. Base Type: Mosaic Style

B. Base:
   1. Zinc alloy grid 24 mm segments
   2. Steel support frame (Part of Panel)
   3. Grid support pillars (length to suit)
   4. Master terminal block
   5. Size per drawings.

C. Graphic Material
   1. Polycarbonate tiles
   2. Non-glare
   3. Self-extinguishing
   4. Non-reflective
   5. Rotatable 360 deg.

D. Art work
   1. Colors bonded to tiles
   2. Layout basic as shown on drawings. Add details and legends.
   3. Basic colors per drawings.
   4. Legends integral part of tiles.

E. Indication
   1. LED or incandescent with 5000 hours life at rated voltage. Operate at 94% rated voltage.
   2. Lamp color shown on drawings.
   3. Operation compatible with field wiring with respect to wire size, length and cabling.
   4. Compatible with annunciator for alarm.

F. Wiring
   1. Terminal for No. 16 to No. 12 wire
   2. No. 20 AWG minimum internal.
   3. Quick disconnects to each lamp.

2.04 WIRE AND WIRING COMPONENTS

A. Power wire: No. 16 AWG type MTW stranded unless specified otherwise. Wire color as follows:
   1. Line power: black
   2. Neutral or common: white
   3. A.C. control: red

4. D.C. control: blue
5. Low voltage status and alarm: orange
6. Equipment or chassis ground: green
7. Externally powered circuits: yellow

B. Instrument signal wiring: 2 or 3 conductor, twisted, shielded cable, No. 20 gage minimum with external vinyl jacket.

C. Graphic light wiring at the lamp socket may be 22 AWG, minimum, if properly fuse protected and terminating in a terminal block capable of accepting No. 14 AWG field wiring.

D. Terminal blocks: barrier type with the appropriate voltage rating (300V min.), raised channel mounted type, angled when mounted on side panels.

E. Wiring trough for supporting internal wiring: plastic type with snap on covers and open top sidewalls to permit wire changing without disconnecting.

F. Wire connectors: hook fork type with non-insulated barrel for crimp type compression connection to the wire.

G. Wire and tube markers: sleeve type with heat impressed letters and numbers (one sleeve per wire). Multiple wrap around markers are not permitted unless covered by a transparent protective overall shield and samples submitted and approved.

H. Provide a 6 x 25 mm (minimum) copper ground bus for the total width of the panel.

I. Supply and assemble instrument air headers as shown on the Drawings. Provide 1/2" dual filter regulators for field mounting (supply air).

2.05 SPACE DESIGNATIONS

A. Equip future space with all wiring terminals, panel racks, sockets, and fixtures required by the type of device indicated. Do not include the plug-in final elements. Provide blank nameplates comparable to active equipment.

B. Spare space is space only for surface mountings and be limited to mounting cut outs and drillings for specified items as shown on the Drawings. Provide removable cover plates over cut outs, finished to match the surrounding surface.

C. Blank space requires no mountings or cut outs.

2.06 ENCLOSURE ASSEMBLY

A. Make cut-outs true and square with no ragged cuts and de-burr leaving no sharp edges.

B. Grind welds smooth. Keep welding on the panel face to a minimum.

C. Provide stiffeners and supports to insure a rigid stable structure.

D. Degrease the finished enclosure and paint with two coats prime paint and two coats finish paint in accordance with the paint manufacturer's instructions. Paint prior to the installation of equipment.
   1. Provide final finish smooth, free of runs, and uniform in tone and thickness.
   2. Supply two 0.5 liter containers of each color used with the panel for field touch up.
   3. Colors to be selected by the Engineer from color chips supplied by the panel manufacturer.
   4. The interior shall be white.

E. Do not paint brushed anodized aluminum, stainless steel and FRP panels.

2.07 COMPONENTS SHOP INSTALLATION

A. Mount all components to permit servicing, adjustment, testing and removal without disconnecting, moving, or removing any other component. Arrange terminal block to be accessible and serviceable with a standard 8 inch blade screw driver with terminal marking easily visible from outside the enclosure.

B. Mount components with cadmium plated or stainless steel machine screws utilizing tapped holes or captive nuts. Nuts are not permitted for securing mounting screws.

C. Attach components mounted on the inside of panels to removable plates and not directly to the enclosure.

D. Do not mount alarm chasses, function generators, auxiliary relays, power supplies, and similar devices within 18 inches of the bottom of the panel base on free standing panel.

E. Mounting shall be rigid and stable unless shock mounting is required by the manufacturer to protect equipment from vibration.

F. Identify all internal components plastic or metal engraved tags attached with epoxy cement and/or drive pins adjacent to (not on) each component identifying the component in accordance with the drawing, specifications, and supplier's data.

G. Attach panel face nameplates with screws to permit future changes.

H. Orient components mounting in accordance with the component manufacturer's and industries' standard practices.

I. The interior lighting shall be operated by an external switch, wired to the same circuit as the service receptacle. This power shall be separate from the instrument power.

2.08 GRAPHIC ASSEMBLY

A. Assemble, wire and functionally test.

B. Mount in main panel.

C. Lines, Symbols and legend to be integral to tiles (not attached to surface). For multi-equipment with same basic Tag No., tag letter to be on or immediately below light, with group legend above group.

D. Provide suitable framing to mask panel cut out.

E. Provide lamp test system.

F. Wire all devices to terminals.

2.09 SHOP WIRING

A. Route power and low voltage DC signal wiring in separate wire ways. Crossing of the two system wires shall be at right angles. Separate parallel troughs of different systems by a minimum of 3 inches for low voltage D.C. and 12" between A.C. and D.C. systems. Connect shields and shield drain wires to the ground bus direct or via a #18 AWG (minimum) green wire.

B. Do not obstruct usable space on subpanels with open wiring.

C. Tag all wire at both ends with the same unique number corresponding to the wire number on the schematic or loop diagrams.

D. Terminate all wiring on terminal blocks or equipment screw terminals. A maximum of 2 wires per terminal is permitted (terminal block jump straps are not considered wires). Splices are not permitted. Where 4-20 ma signals are distributed within a panel as voltage, terminal block mount the load resistor external to all devices and wire devices individually to the load terminals.

E. Provide draw out type devices with enough slack to permit withdrawal without disconnecting wiring.

F. Identify all terminals with wire number (not consecutive numbers) shown on the electrical schematics, instrument loop diagrams, and panel internal wiring diagrams.

G. Arrange terminal blocks in vertical rows and separate into groups, power, ac control, dc signal, alarm, and graphic.

H. Use only one side of a terminal block row for internal wiring.

I. Do not place the field wiring side of the terminal within 6 inches of the side of a panel or adjacent terminal. Maintain unobstructed access between the panel entrance and the field terminals.

J. Provide ten percent spare terminals grouped with a minimum of 6 terminals adjacent to each other in a row or group.

K. Do not fill wiring troughs to more than 60% visible full.

L. Match mark wiring trough covers to identify placement. If component identification is shown on covers for visibility, place the same identification on the mounting sub panel.

M. Provide 220 volt power to recorders, power supplies, and systems obtaining power from the panel with individual disconnect means for each system.

N. Connect the panel frame, all subpanels, instrument ground connection, conduits, cable tray and shield to the ground bus.

Tag	Item	Provided By
CP-1	Main Panel w/graphic	Inst. System Supplier
CP-2	Influent Control	Inst. System Supplier
CP-101	Clarifier/Filter	Inst. System Supplier
CP-102	Thickener/Digestor	Inst. System Supplier
CP-3	Sludge Holding/Transfer	Inst. System Supplier
CP-50	Chlorination	Chlorine Sys. Sypplier
CP-51A-B	Bar Screen	Bar Screen Mfg.
CP-150	Boiler System	Boiler/Digester Mfg.
CP-155	Polymer System	Polymer System Mfg.

END OF SECTION

SECTION 13444

INSTRUMENTATION INSTALLATION

PART 1 GENERAL

1.01 RELATED WORK

A. Section 13440: Instrumentation General.

B. Section 13441: Instrumentation - Functional Descriptions.

C. Section 13442: Instrumentation Equipment.

D. Section 13443: Instrument and Control Panel.

E. Section 13445: Instrument and Control for Package Systems.

F. Section 16010: Electrical General.

G. Section 16111: Conduit.

H. Section 16120: Wire and Cable.

I. Section 16131: Pull, Junction, Termination Boxes and Wiring Troughs.

1.02 WORK INSTALLED BUT FURNISHED UNDER OTHER SECTION

A. Instrumentation and control panels specified in Section 13443.

B. Field instrumentation equipment specified in Section 13442.

C. Connection to the instrument system of Package Systems referenced in Section 13445 and shown on the Drawings.

1.03 WORK FURNISHED BUT NOT INSTALLED

A. In line devices such as control valve and flow elements furnished under Section 13442 shall be delivered for installation.

B. Special equipment interconnection wire, root valves and manifolds furnished with equipment shall be installed by the appropriate division.

C. Pressure, float, position, and similar switches used in conjunction with systems specified in Division 16.

1.04 DESCRIPTION OF SYSTEM

A. The entire system is described in Sections 13440 thru 13445 and shown schematically on the Drawings.

B. This section includes installation, certified calibration, start-up and documentation to provide a functional system.

C. Conduit, duct banks, and wiring shall be furnished and installed by the Electrical contractor as specified in Division 16.

1.05 QUALITY ASSURANCE

A. All workmen shall be skilled in the work to which they are assigned, and all work shall be performed under the direct supervision of an experienced and competent instrument foreman.

B. All craftsmen shall be properly licensed and/or certified.

C. All work shall be done in accordance with standards set by National Electric Code, NFPA, UL, FM, applicable local, state, federal and owner agencies and departments.

1.06 SUBMITTALS

A. Submit shop drawings in accord with Section 01340.

B. Submit Operations and Maintenance Manuals in accord with Section 01730. Furnish a supplement to the manual within two weeks of final acceptance containing all of the loop diagrams, containing all required data and a copy of each instrument's certified calibration and commissioning sheets. The original certified calibration and commissioning sheets shall be retained by the Contractor for a period of 5 years or delivered to the Owner.

C. Submit the following for approval prior to installation or use:
   1. Catalogue cuts of terminal blocks, junction boxes, conduit hubs, and mounting fixtures not supplied elsewhere.
   2. Samples of the wire and cable markers and connectors.
   3. Specification sheets for wire, wire bundles, tube, tube bundles, and tube fittings.
   4. Sample calibration and commissioning data sheets (8-1/2 x 11 for storage in a 3-ring binder) obtained from system supplier or engineer responsible for calibration.
   5. Field sketches or drawings of terminal box layouts, sensor mounting fixtures (field fabricated) and equipment racks.

D. Four weeks prior to start-up, submit two complete sets of loop diagrams, vendor equipment calibration procedures, field connection diagrams, and vendor equipment specification sheets.

1.07 DELIVERY, STORAGE AND HANDLING

A. This specification section includes the receipt, handling and storage of all instrumentation equipment and panels

until accepted by the Engineer. Restore all damage caused by mishandling and environmental conditions to its original condition by replacement or repair.

1.08 JOB CONDITIONS

A. Coordinate the instrumentation installation and insure its compatability with limitations or restrictions imposed by other divisions with respect to such things as Electrical Classification, Operations activity (i.e. washdown), and environmental protection (i.e. freezing). Where conflicts occur the most stringent requirement will govern unless defined otherwise by the Engineer.

B. Maintain sequence and work schedule charts showing the coordination of instrumentation with other crafts and start-up schedule.

1.09 ALTERNATES

A. Alternate material and methods may be submitted as indicated in Section 13440.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide materials suited to the environment and compatable with the process at points of contact.

B. All material shall be heavy duty industrial type unless commercial, laboratory, or computer and communication type are noted specifically.

2.02 CONDUIT AND FITTINGS

A. Conduit shall conform to the requirements of Section 16111.

B. Junction boxes, terminal boxes, and wiring troughs not specifically mentioned below shall conform to the requirements of Section 16131.

C. Field terminal boxes: RFI type with a grounding lug for areas not requiring Nema 7-9 construction.
   1. Provide terminals mounted to the front of the box to permit access without interference of incoming cable.
   2. Provide sufficient space at the bottom (or top and sides) for access to the entering wiring without removal of terminal mounting.

2.03 WIRE AND CABLE

A. Wire not specifically mentioned below shall conform to the requirements of Section 16120. Pair cable means twisted paired cable.

B. Shielded single pair or triples (Triad)(Instrument Cable):
   1. Acceptable manufacturers: Okonite, Dekoron or Thermo Electric.
   2. For general shielded service, (signal 4-20 ma) single pair or triad cables shall consist of two or three conductors, with drain wire, twisted together, served with a continuous grounding shield and protected with an insulating jacket.
   3. Individual conductors: tinned, soft, annealed copper conductor, No. 16 AWG, stranded, insulated with 90 degrees C flame retardent insulation rated 600 volts.
   4. The twisted pair or triad shall have a maximum lay of 2 inches (6 twists per foot).
   5. Drain wire: tinned, stranded copper No. 18 AWG.
   6. The twisted assembly shall be shielded with a spirally applied aluminum mylar or polyester shield with 35% overlap and covered with a 45 mil heavy duty thermosetting jacket meeting the requirements of paragraph 7.4.7 of IPCEA S-66-524 for thermosetting jackets.
   7. The cable shall pass the UL flame test for tray cable.

C. Shielded multi-pair or multiple triad cable (Instrument Cable):
   1. Acceptable manufacturers: Okonite, Dekoron, or Thermo Electric.
   2. Shielded multi-pair or multi-triad cable (signal cable) construction shall be an assembly of twisted pairs or triads of AWG No. 20 tinned copper and as described in paragraph B above except less jacket.
   3. Color code or number the pairs or triads and cable together as an assembly having a circular cross section served with an overall spirally wrapped aluminum or polyester mylar shield with a stranded tinned copper drain wire and polyester tape for complete shield isolation.
   4. Cover the assembled cable with a heavy duty thermosetting jacket meeting the requirements of paragraph 7.4.7 of IPCEA S-66-524 for thermosetting jackets.
   5. The cable shall pass the UL flame test for tray cable.

D. Single pair or triples (Triad)(Instrument Cable):
   1. Acceptable manufacturers: Okonite, Dekoron, or Thermo Electric.
   2. For general alarm and indication service, single pair or triad cables shall consist of two or three conductors, twisted together, and protected with an insulating jacket.
   3. Individual conductors: tinned, soft, annealed copper conductor, No. 16 AWG, stranded, insulated with 90 degrees C flame retardent insulation rated 600 volts.
   4. The twisted pair or triad shall have a maximun lay of 2 inches (6 twists per foot).
   5. Cover the twisted assembly with a 45 mil heavy duty thermosetting jacket meeting the requirements of paragraph 7.4.7 of IPCEA S-66-524 for thermosetting jackets.

6. The cable shall pass the UL flame test for tray cable.

E. Multi-pair or multiple triad cable (Instrument Cable):
1. Acceptable manufacturers: Okonite, Dekoron, or Thermo Electric.
2. Multi-pair or multi-triad cable (alarm and indication) construction shall be an assembly of twisted pairs or triads of AWG No. 20 tinned copper and as described in paragraph D above except less jacket.
3. Color code or number the pairs or triads and cable together as an assembly having a circular cross section served with an overall spirally wrapped aluminum or polyester mylar shield with a stranded tinned copper drain wire and polyester tape for complete shield isolation.
4. Cover the assembled cable with a heavy duty thermosetting jacket meeting the requirements of paragraph 7.4.7 of IPCEA S-66-524 for thermosetting jacket.
5. The cable shall pass the UL flame test for tray cable.

F. 300 volt wire may be substituted for 600 volt when used with 480 volt Y power systems with grounded center tap. UL listed tray rated cable is not required when all wiring is installed in metal conduit.

G. General wiring shall conform with Section 16120.

H. Direct burial shielded multi-pair or multiple traid cable (Instrument Cable):
1. Acceptable manufacturers: Okonite, Dekoron, or Thermo Electric.
2. Shielded multi-pair or multi-triad cable (signal cable) construction shall be an assembly of twisted pairs or triads of AWG No. 20 tinned copper.
3. Individual conductors: tinned, soft, annealed copper conductor, No. 20 AWG, stranded, insulated with 90 degrees C flame retardent insulation rated 600 volts.
4. The twiested pair or triad shall have a maximum lay of 2 inches (6 twists per foot).
5. Drain wire: tinned, stranded copper No. 22 AWG.
6. The twisted assembly shall be shielded with a spirally applied aluminum mylar or polyester shield with 35% overlap.
7. Color code or number the pairs or triads and cable together as an assembly having a circular cross section served with an overall spirally wrapped aluminum or polyester mylar shield with a stranded tinned copper drain wire and polyester tape for complete shield isolation.
8. Cover the assembled cable with a heavy duty thermosetting inner jacket with an aluminum co-polymer bonded to it to form a waterproof cover.
9. Apply an outer jacket of low density polyethylene or PVC over the entire assembly.

I. Wire markers: vinyl sleeve type with heat impressed letters and numerals. Individual numeral (or letter) wrap

around markers, unless provided with an overall protection, are not permitted.

J. Wire termination connectors: hook fork type.

K. Terminal blocks: white nylon track mounted barrier type with a marking strip, rated 300V minimum, medium duty, and manufactured by Buchanan, Allen Bradley or Square D.

2.04 NAMEPLATES

A. Provide engraved nameplates for identifying each field transmitter or final control element minimum of 2 x 4 inches in size with one inch high characters. The background shall be white, the letters black.

PART 3 EXECUTION

3.01 INSPECTION OF WORK DONE BY OTHERS

A. Inspect installation of instrumentation equipment installed by others.

B. Report conditions that will restrict the performance of the instrumentation system, together with a recommended solution to the Contractor, Owner, and Engineer in writing.

3.02 PREPARATION

A. Verify all utility connections and grounding required by the instrumentation system.

3.03 INSTALLATION GENERAL

A. All wiring and piping shall be constructed perfectly plumb, square, level, and true to lines and surfaces indicated, in a neat, substantial and workmanlike manner, and in such a way as to properly serve for the purpose intended.
   1. All members and parts, upon installation, shall be properly framed, secured together, and anchored in place.
   2. All cuts shall be deburred and immediately cleaned from opposite end before connecting.

B. All instruments shall be mounted, piped and connected in strict accordance with manufacturer's instructions.

C. Field mounted instruments shall be located where shown on the Drawings.
   1. Control panels and controls shall have unobstructed access from an aisle or walkway. They shall be securely supported on pipes, stands or brackets or satisfactory heavy material to prevent excess vibration or movement.

2. All instruments shall be located to allow convenient access for readability, calibration and routine maintenance.

D. Identify each instrument with an engraved nameplate, applied adjacent thereto.

3.04 ELECTRICAL INSTALLATION

A. Maintain maximum practical separation between signal (analog, alarm and status) conduits and power feeders and ac systems. The following is a guide to separation:

	Separation in Inches				
Levels	1-2	1-3	1-4	2-3	2-4
Conduit/conduit	3	6	12	3	9
Tray/conduit	4	6	18	6	12
Tray/tray	6	12	24	6	12
Unshielded conductors					

Level 1 - Low voltage d.c. analog signal, thermocouple & RTD wiring.
Level 2 - Low voltage switched signals; lights, alarms, digital.
Level 3 - a.c. voltage below 300 volts or 20 amps.
Level 4 - a.c. voltage above 300 volts or 20 amps.

B. Do not place Level 1 and 2 signal wires in the same conduits or pull boxes as Level 3 and 4 wires.

C. All conductors running from the field to the control panel shall be a single, continuous length, without splices, except at approved junction boxes. The junction boxes shall have terminal blocks with 20% of the total installed terminals spare. All wires used or unused shall be terminated on terminal. These and designated future terminals shall not be considered spare.

D. Multi-conductor cable may be used between junction boxes and control panels.
1. Identify cables or wire bundles at both ends with a permanent tag identifying the cable or bundle number, function, and the location of the other end of the cable or bundle.

E. Ground all shielded cable at the control panel end only. Shields shall be carried through junction boxes with the least possible resistance, be insulated and kept isolated from ground at these points. Insulate the field end of the shield to prevent grounding.

F. Terminate all field conductors at the control panel terminal board. Routing within the panel(s) shall not occupy the same wireway or location as the internal panel wiring. Millivolt signal wires (i.e.: thermocouple) may be connected direct to the input terminals of the receiving instrument if so specified.

G. Terminate all wire ends with hook fork type non-split compression lugs.

H. Identify all wires at both ends with wire marker.

I. Enter field equipment enclosures through the back, side or bottom (not top) with weatherproof hubs. Wiring shall enter near the terminal point and not obstruct access to, or removal of, components. Top entry is permitted if a vapor seal is provided directly above the weatherproof hub.

J. Enter pull or terminal boxes at any location with protection against moisture accumulation and dripping on exposed terminals.

K. All internal wiring of the instrument panel will be done at the panel fabrication shop.

L. Provide vapor seals in conduits where they enter an area of a different environment or temperature.

M. Provide seals as required by the NEC for hazardous areas.

3.05 FIELD QUALITY CONTROL (CHECKOUT)

A. General
1. Prior to final connection, thoroughly clean all work completed, including the interior of all panelboards. Remove all dirt, trash, and foreign material.
2. Clean the outside of all instrument panelboards.
3. Touch up damaged painted surfaces as required to leave the equipment in an acceptable condition.
4. Make final connections to the Instrument Panels in accordance with Shop Drawings and Drawings.

B. Electronic and Electrical Check
1. Prior to electrical check out, place all breakers, switches and similar disconnect devices in the off position.
2. Verify the panel and other equipment grounding.
3. Make visual inspection and test continuity to verify that no damaging wiring errors occur between power and signal wiring.
4. Check the systems for improper or accidental grounding.
5. Obtain the permission of the Owner prior to energizing controls.
6. Energize each system and component and simulate their inputs. Check the output to verify the proper calibration and interaction with associated hardware.
7. Hypotting is not permitted on instrument systems unless specific instructions are given to safeguard electronic equipment from damage.

C. Final Control Element
1. Prior to actuating a final control element (valve, level actuator, or variable speed drive) obtain the

permission of the Owner and any other involved contractors to prevent damage to associated equipment.

2. Verify the calibration and direction of the final control element in accordance with the manufacturer's instructions.

3.06 ADJUSTMENT AND CLEANING

A. Calibration and Commissioning:

1. Provide the services of a qualified engineer to supervise the calibration and commissioning of the entire system. Use qualified technicians with proper tools and equipment for calibration.
2. Calibrate each instrument at 10%, 50% and 90% using test instruments that are rated to an accuracy of at least 5 times greater than the instrument being checked. The test instrument shall have its accuracy traceable to the National Bureau of Standards, as applicable.
3. Commission each system by simulating inputs at the first element in the loop for 10%, 50% and 90% of span (or on/off) and verify the output for accuracy. Make provisional settings on controllers and switches during commissioning. The final calibrations and settings shall be included on the loop diagrams and on separate sheets for inclusion with the instruction books.
4. During the start-up, provide sufficient personnel to aid with the start-up of the instrument and control equipment to correct any faults and to make the necessary adjustments for the proper operation of the equipment and installation.

END OF SECTION

SECTION 13445

INSTRUMENTATION AND CONTROL FOR PACKAGED SYSTEMS

PART 1 GENERAL

1.01 RELATED WORK

A. Section 13440: Instrumentation General.

B. Section 11331: Bar Screen

C. Section: 11315: Digester (specifically Boiler)

D. Section 11218: Utility Water System

1.02 SYSTEM DESCRIPTION

A. The requirements of this Section shall not restrict the package design or the responsibility of the manufacturer of the various equipment packages required by this contract, but shall provide uniformity between the various instrumentation and controls provided by different equipment package manufacturers.

B. The systems shown on the Drawings are subject to design requirements of specific vendors and their methods. The contractor shall at no additional cost to the Owner deliver a functioning installed control system with the approved variation required by the selected system supplier.

1.03 SUBMITTALS

A. Submit Shop Drawings and product data in accordance with Section 01340.

B. Use NEMA and ISA Standard symbols and identification designations on Shop Drawings. Conform to the following format:
   1. Single Line or One Line Diagrams (See Figure 1):
      a. Show the basic power distribution of the equipment package system
      b. Include, but do not limit information to, circuit disconnect frame size and setting (trip or fuse), horsepower or KW, starter or contactor size and type, transformer sizing, load and short circuit data, motor or equipment identification, wire sizes and circuit identification.
   2. Schematic or Elementary Diagrams (See Figure 2):
      a. Draw diagrams between vertical lines which represent the source of power. Connect one side of all coils to the right line (exception - motor starter overload contacts may be between the starter coil and the right line). Make diagram complete with all control devices of the system

indicated. Indicate devices remote from the control panel by appropriate symbols.

b. Use a cross-referencing system for each relay or timer coil to locate all contacts on the diagram. Identify each line with a line number. Identify all wires with a wire number.

c. Where color coded cable is used, include color code in the diagram.

d. Indicate limit, pressure, floats and similar devices in the turned-off, disconnected or shelf position.

e. Show selector and other multi-contact switches with contact closure sequence on the diagram or a separate chart.

f. Describe the functions of valves, starters and indicating lights on the diagram and completely describe the sequence of operation, both automatic and manual.

g. If no one line is required, equipment ratings including horsepower, starter size, transformer data, fuses, and breaker size shall be shown on the schematic.

3. Connection or Wiring Diagrams (See Figure 3):

a. Diagrams may be of the wireless type, indicating the wire numbers adjacent to the contact, coil or light to which they are connected. Indicate the components and spare space for future equipment in their respective positions in panels and cabinets. Indicate all terminal blocks with numbering.

4. Interconnection Diagrams:

a. Make diagrams similar to connection or wiring diagrams. Indicate all field mounted devices external to panels and cabinets. These devices need not be shown in their relative locations. Interconnection diagrams may be incorporated on connection or wiring diagrams.

5. Instrument Loop Diagrams:

a. Draw loop for systems containing process Instrumentation in the format of ISA Standard S5.4 Illustration 7.3 and/or 7.4 on nominal 11" x 17" sheets.

b. Where switch functions or status indications are the only functions required of instrumentation, they may be incorporated into electrical and/or pneumatic drawings in lieu of separate Loop Diagrams.

6. Plot Plan or Assembly Drawings:

a. Show the location of panels and field devices in plan view.

b. Show the wiring and control tubing requirements.

c. Elevation from a base elevation, unless a specific detail or elevation is required to clarify a location.

7. Panel Drawings:

a. Provide enclosure face and interior arrangement. Make drawings to scale and indicate all outline, mounting and clearance dimensions.

b. Indicate relative location and size of panel mounted components. Components need not be dimensioned if drawn to scale.
c. Show nameplate legends with exact engraving.
d. Indicate, identify and dimension useable spare panel space.
e. Submit the panel face layout drawn to scale together with a complete nameplate schedule including wording to Engineer for approval prior to fabrication.

8. Miscellaneous Items:
a. Provide a bill of materials listing the make, model, type and rating of all components, except for mounting hardware, wire, wire lugs and similar installation items.
b. Identify all instrument and control devices by tag number on layout drawings and this drawing submitted as part of the instrumentation and control package.

1.04 PROTECTION OF EQUIPMENT

A. Protect equipment from all damage in the factory or during shipment, including chafing and scratching from inadequate packing, until Owner's acceptance.

B. Repair all damage to the equipment at no cost to Owner.

1.05 SHIPPING PROTECTION

A. Crate the exterior of the panel.

B. Provide heavy felt or other packing where the crate touches the surface of the panel in order to avoid marring the surfaces.

C. Plastic protective covering over the panel finish may be used without crating with prior approval of the Contractor and Owner.

D. Support all mounted components during shipment to prevent damage.

E. Mount the panel on skids for shipping in order to facilitate unloading and handling of the equipment at the Project site. Design skids so the equipment can be rolled, jacked up, or hoisted with high lift without damage.

1.06 INSPECTION AND TESTING

A. The Engineer reserves the right to inspect the equipment during manufacture and prior to shipment.

B. Notify the Engineer three weeks before final tests are made.

C. Conduct final tests only in Engineer's presence unless Engineer has given written authorization to conduct tests without witness. Waiver of witness does not release the manufacturer of systems responsibility.

D. Connect the panel to a temporary power source with identical ratings as supplied to check the functional operation of all instrumentation, control switches and alarm points prior to crating and shipment. Include simulated transmitter signals and dummy loads in functional test.

PART 2 PRODUCTS

2.01 OPERATORS PANEL

A. Enclosures smaller than 92 cm by 122 cm: wall mounted with provisions for pedestal mounting at Engineer's option.

B. All other enclosures: floor mounted, free standing, totally enclosed, straight front with provisions for top or bottom entry of cable and tubing.

C. Panel maximum dimensions: seven feet high by three feet deep with the length of the panel sufficient to contain all the required equipment, plus designated spare space for 20 percent future equipment. Refer to the Drawings for available space.

D. Fabricated panels: angle iron frame of welded construction covered by the shell material. Provide stiffners to prevent warping and distortion.

E. Panel shell material: cold rolled steel, flat and free of dents or other defects. Provide continuous welded seams and joints watertight and ground smooth.
   1. Front face: 4.5 mm thick.
   2. All other surfaces: 12 gage.

F. For panels larger than 36 inches by 48 inches provide the following:
   1. An interior lighting system: fluorescent, rapid start fixtures making a continuous lighting strip from side to side. Provide exterior wall switch mounted beside the door. Reflectors are not required.
   2. Maintenance receptacle: grounded, separately powered 220 volt, 50 Hz.

G. Panel access doors: hinged, full length doors, maximum 76 cm wide, formed with stiffening to provide rigidity in any position. Concealed hinges: continuous piano-type stainless steel. Latches: three point with chrome plates, recessed handles, complete with lock. Provide continuous 0.3 cm thick cellular neoprene gasketing full perimeter of door.

H. Provide a print pocket in each panel.

I. Operator panel and enclosure construction: NEMA 12.

2.02 PANEL WIRING

A. Power Wiring: No. 12 AWG, minimum, type MTW, stranded. Control wiring (non-signal): No. 16 AWG, minimum, type MTW stranded. Color code wire as follows:
1. Primary voltage source or hot power: black
2. Grounded common or neutral: white
3. Equipment ground: green
4. A.C. control: red
5. D.C. control: blue
6. Alarm system: orange
7. Circuits containing voltage from foreign source (i.e. motor starters): yellow

B. Low voltage internal panel graphic light wiring: No. 22 AWG, minimum, between the light and an appropriate terminal block that shall accept No. 14 AWG field wiring.

C. Electronic signal wiring: two conductor No. 16 shielded cable with a vinyl cover.

D. Terminals: barrier type of the appropriate voltage rating manufactured by Buchanan, Allen Bradley, Square D, or equal.

2.03 PANEL GRAPHIC

A. Apply the graphic presentation to a sheet of 4.5 mm thick aluminum with background color and superimposed components, lines, and details suitably mounted. Background, symbol, and line colors will be selected by the Owner from samples supplied from the panel manufacturer.

B. For the basic method use back lighted translucent type. laminated platic material, approximately 0.15 cm thick with beveled edges. manufacturer's standard method.

C. Indicating lights (motor run etc.): 24 volt incandescent, approximately 1 cm diameter, replaceable lamps with 5000 hour life.

D. Lamp power supply: 24 volts D.C. with a capacity of 150% of the connected load.

2.04 GENERAL COMPONENTS

A. Coordinate hardware between packaged units and peripheral equipment.

B. Provide hardware of the latest design and proven successful operation.

C. Operator devices: heavy duty oil tight construction.
   1. All indicating lights: transformer type. Individual lights shall be press to test unless a master lamp test system is provided.
   2. Bulbs: interchangeable and all of the same type having a minimum 5000 hour rated life.
   3. Screw terminal connections.

D. Control relays:
   1. Relays: 3 pole, double throw, octal plug-in type with a transparent dust cover and a visual means of indication when the relay is energized (i.e. lamp). Screw terminals on socket.

E. Timers:
   1. Timers: plug type with multiple range analog or 5 digit digital of the same make and model for all applications. Screw terminals on socket.

F. Nameplates (non-graphic): 0.15 cm laminated plastic with 0.3 cm high characters arranged in two or three rows. Overall size: 2.5 x 6.25 cm unless mounting space or legend content dictate otherwise.
   1. Exterior nameplate: white with a black core (letters).
   2. Interior nameplates: black with a white core (letters).

G. All field mounted device housings: NEMA 4 construction, minimum.

H. All field mounted operator devices shall be heavy duty oil tight.
   1. Intrinsically safe and NEMA 7-9 equipment: UL, FM, or equal approved for the area classification.

2.05 ALARMS

A. Conform to ISA Standard S18.1.

B. Solid state systems are standard.

C. If relay type systems are proposed (as an option) provide enclosed, plug-in relays.

D. Field power to dry contacts: 24 volt dc unless otherwise approved to reduce need of separation between alarm and instrument signal lines.

E. Alarm application:
   1. Furnish the Engineer a tabulated list of the nameplate designations for all functions to be alarmed.
   2. A central alarm panel is furnished under other Sections in addition to any local alarm panels required for packaged systems.
   3. Provide the local annunciator with an alarm test and acknowledge pushbuttons.

4. Where multiple functions associated with a master stop are alarmed, provide a First Out feature to ascertain which function tripped first.
5. Where two alarm points or less are required for packaged equipment, provide flashing lights for each point and an auxiliary normally closed dry contact that opens on abnormal conditions for retransmitting alarm condition to a central panel.
6. For more than two alarm points provide an annunciator in the package panel complying with I.S.A. S18.1 standard (Type A-1-6-7-14). Audible alarm or relay shall not inhibit subsequent alarms after acknowledging initial alarm. Replace the horn with a relay containing one normally open and one normally closed dry isolated contact for retransmitting alarm condition to a central panel. In addition to the relay install a flashing light or beacon on the top of the control panel replacing the normal audible device. Wire this light to terminals to facilitate moving to an alternate location at the option of the Engineer.

2.06 PANEL SHOP FINISH

A. Finish paint: air dry lacquer for steel panels.

B. Anodized aluminum, stainless steel and FRP panels: a natural brushed finish.

C. After all cutting, drilling and welding is complete, degrease, sand or sand blast all surfaces to be painted to insure good bonding.

D. Apply two coats of prime paint in accordance with the paint manufacturer's instructions.

E. Apply one coat of paint smooth, free of runs and uniform in applied tone and thickness. Paint the panel interior white and the exterior color as selected by the Owner from samples supplied by the paint manufacturer.

F. Provide two one quart cans of the finish paint with the panel for field touch-up.

2.07 PANEL EQUIPMENT INSTALLATION

A. Provide all switches, terminal blocks, indication lights, relays, flashers, or other control equipment as specified and wire complete to terminal blocks for connection to the field wiring. Align and mount equipment and nameplates.

B. Mount all equipment with cadmium plated or stainless steel hardware and tapped holes. Bolts with nuts are permitted only if they can be affixed by one man.

C. Identify all components, such as control instrument, relays, terminal blocks, and miscellaneous equipment in the panels visible from the open door of the panel. Use designations corresponding to the identification on the

Drawings and Shop Drawings. Use engraved nameplates. Locate identification on panel(s) not on component.

D. Mount components to permit complete removal without disturbing the mounting or wiring of adjacent components.
   1. Do not mount equipment on access doors or swing panels without Engineer's prior approval.

E. Operator and Control Devices:
   1. Mount devices in a logical arrangement for ease of operation.
   2. Space devices in accordance with the manufacturer's recommendation.
   3. Do not spread devices apart for appearance. Group devices logically to make extra space available for future use.
   4. Mount internal equipment above 18 inches from floor.
   5. Mount face devices above 36 inches from floor.

F. Nameplates:
   1. Identify all control groups and instruments on the front of the panel with laminated plastic nameplates stating the Service and Tag Number. Fasten nameplates to the panel with pan head stainless steel sheet metal screws (no glue).

2.08 PANEL WIRING

A. Provide a multi-row master terminal block at the bottom of each panel for field wiring. Arrange the blocks in vertical rows.
   1. If single row master terminal blocks are provided, install blocks at the side of the panel.
   2. Use only one side of the row of each terminal block for connections from inside the panel.
   3. Terminals to be raised equal in height to top of wiring trough.
   4. Provide unobstructed access between field side of terminals and field entry location.

B. Make connections for all power and signal wires for field connections to terminal blocks. Power, control and signal wiring terminals shall not be intermixed but clearly separate. Provide 20 percent spares in each group.

C. Permanently mark all terminal blocks with the proper wire numbers.

D. Mark both ends of all wires with vinyl permanent marking tape with wire numbers in agreement with the manufacturer's wiring drawings.

E. Maintain continuity on shields throughout each loop with grounding only at the panel master terminal block. Reinsulate all other exposed shields.

F. Install the internal panel wiring in supported covered wiring troughs or channels.

G. Intrinsically safe devices: conform to NFPA Section 493.

H. NEMA 7-9 relay and control panels:
   1. Provide multi-pole local disconnect or intrinsically safe relays in separate enclosures for dry contact power isolation entering relay panels.
   2. Provide warning nameplate to "disconnect power before opening" on relay and control panels.
   3. Provide Underwriters (UL, FM, or equal) certification on assembled enclosure.

.09 PANEL GRAPHIC

A. Arrange the display to depict the process schematically including major equipment items, piping, pumps and valves as shown on the Flow Diagrams or equipment layout.

B. Mount display in an aluminum frame, with a natural brushed finish, enclosing all sides. Provide gasketing within the frame for sealing, cushioning and expansion of the graphic sheet.

C. Provide a 24 volt power supply with the graphic.

D. Dry type field contacts will activate the graphic indication. Provide terminal blocks for field contacts. Provide a lamp test with a single pushbutton on the front of the panel.

..10 EQUIPMENT WIRING AND TUBING

A. Conform to the general wiring and piping specification sections.

B. Prewire or prepipe wiring and tubing from groups of locally mounted devices and sub-assemblies to locally mounted NEMA 4 junction boxes with terminal blocks and/or bulkhead fittings. Use junction boxes to minimize the number of conduit or tubing bundle runs to the Operator's Panel or between sub-assemblies. Elevate terminals from back of box to approximately 1" from cover.

C. Mount all equipment and/or field devices.

D. Design device control system to use a maximum of 4 wires total between remote device and the master control panel. On powered devices use two wires to supply power to the unit and two wires for switch sensing. Accomplish additional functional switch sensing and/or additional functional requirements such as remote auxiliary indication or interlocks with an auxiliary control relay.

E. Limit flexible conduit to a maximum of 18" in length.

F. Arrange entry to panels and junction boxes by threaded hubs.

2.11 MOTOR CONTROLLER INTERFACE

A. When controllers are provided separately in motor control centers, the control circuits will be 120 V, 60 Hz from individual control circuit transformers in each motor controller.

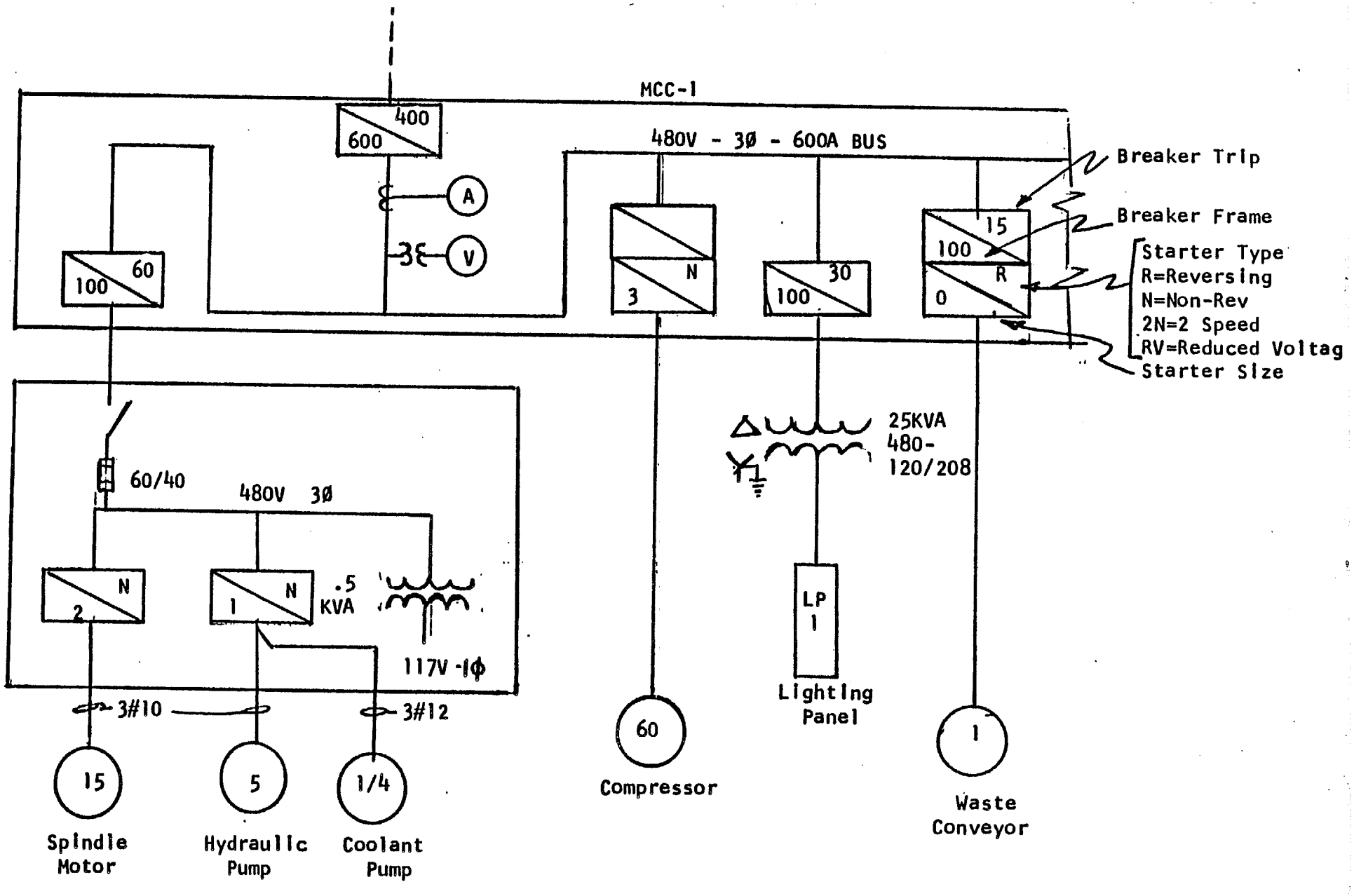
B. For operator control panels provided with the packaged equipment system, provide all operator actuated devices and automatically controlled devices arranged to operate the motor controller through an individual dry contact, one for each motor, separately wired to terminals in the Operator's Panel. Arrange each dry contact to close when its associated motor is required to run and open when the motor is required to stop.

C. External wiring between the individual motor controllers and the operators panel is furnished under other Sections.

D. The motor controller will be equipped with a single dry contact wired to terminals in the Operator's Panel. The dry contact shall be closed when the controller is energized and opened when the controller is de-energized. Use contact in the control system to furnish logic information for run indicating lights and interlocks with relays provided with the packaged equipment system for multiple functions in the system.

E. Arrange motor control logic of the packaged equipment system having start-stop pushbutton stations located at the motor or remote from the Operator's Panel either in addition to or in lieu of the Operator Panel controls, to control the motor via the dry contact in the Operator's Panel.

F. Power wiring from the motor control center to the motors provided with the system is provided under other Sections.



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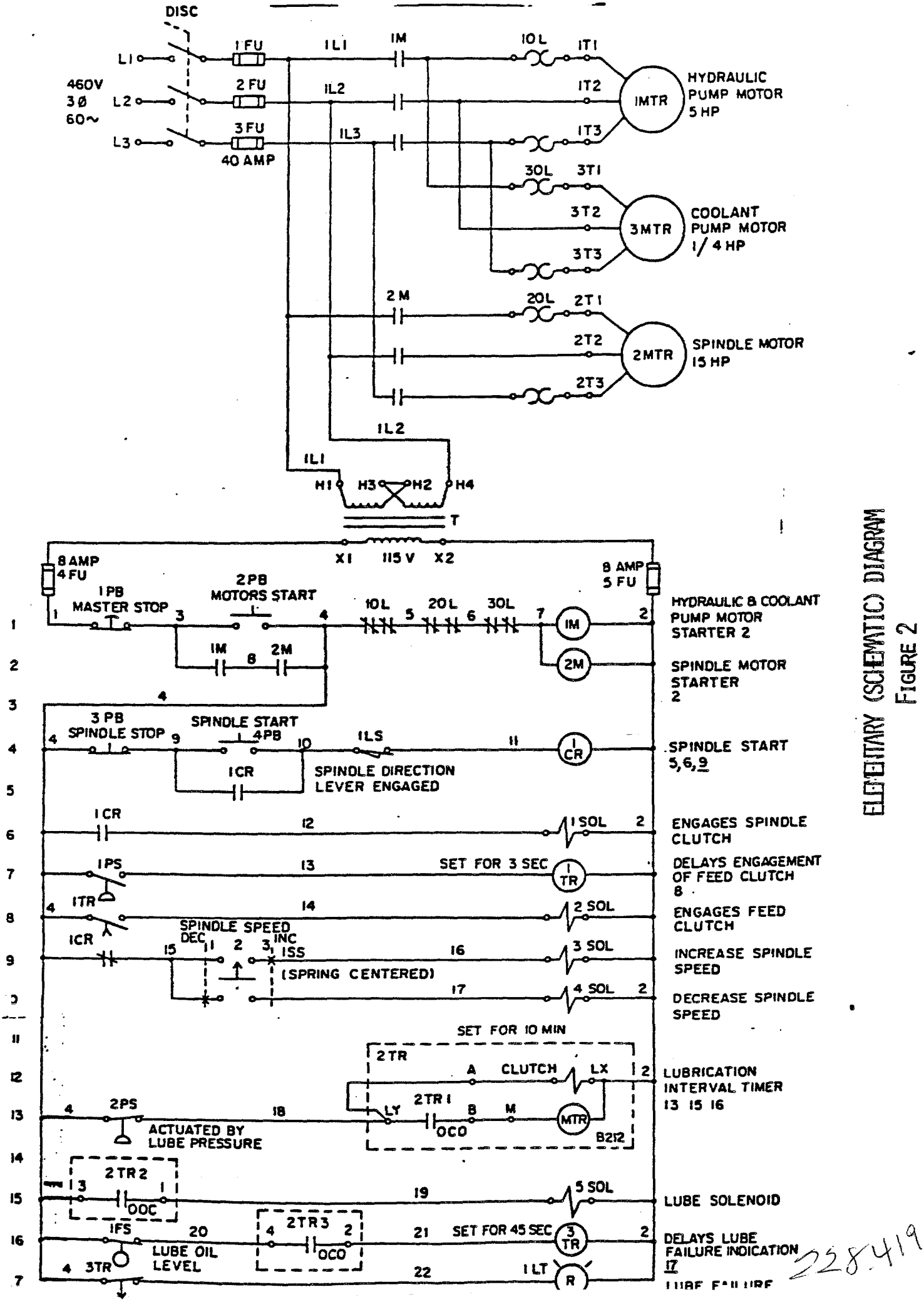
SINGLE LINE DIAGRAM

FIGURE 1



ELEMENTARY (SCHEMTIC) DIAGRAM

FIGURE 2

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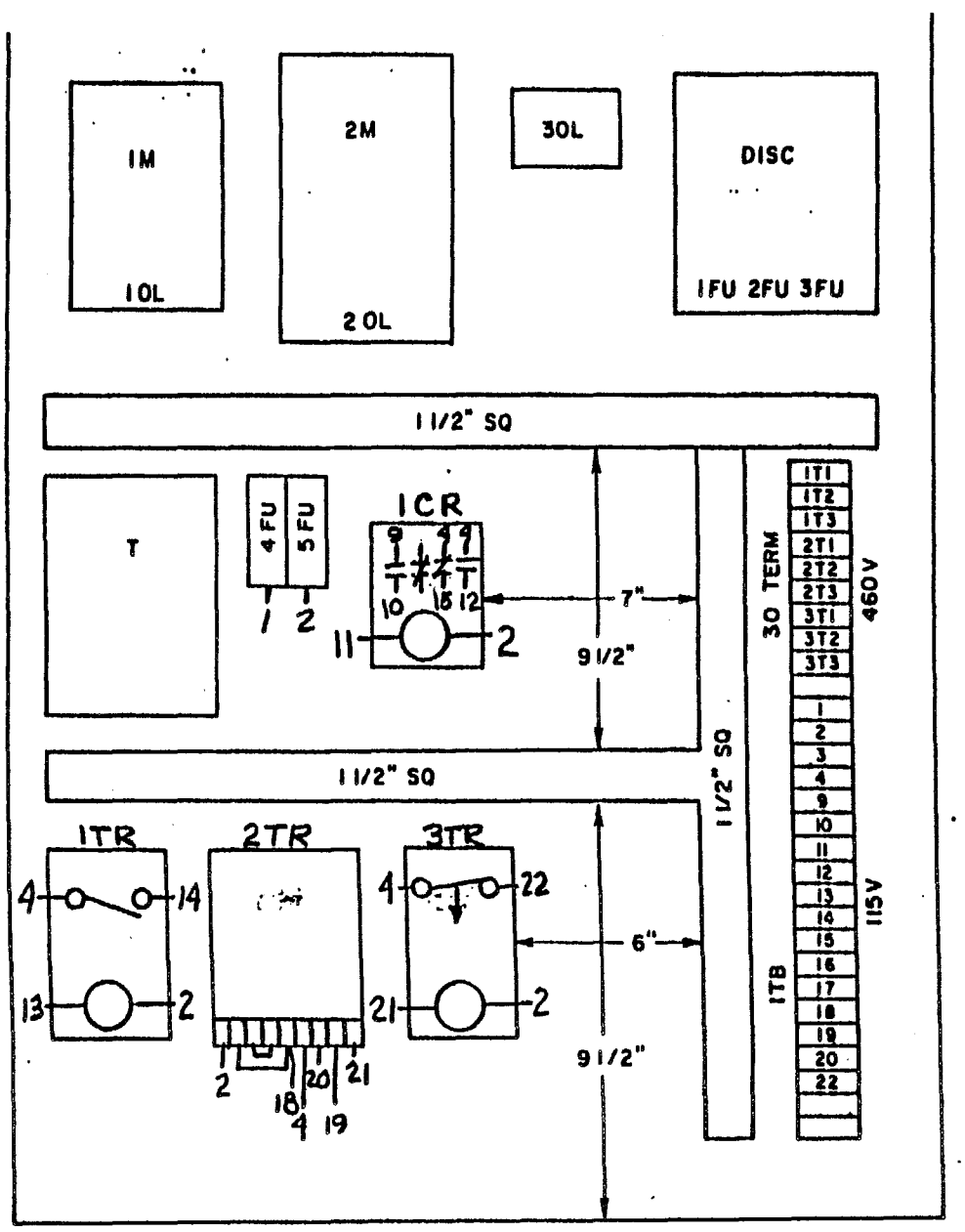
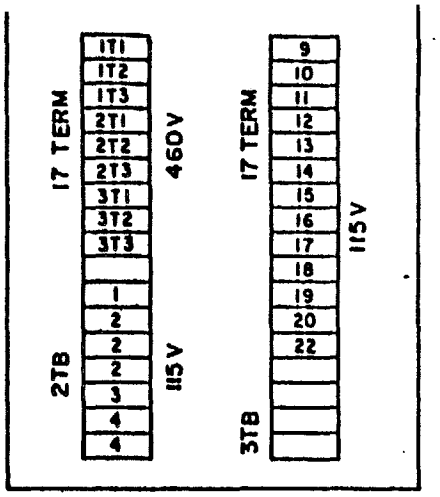
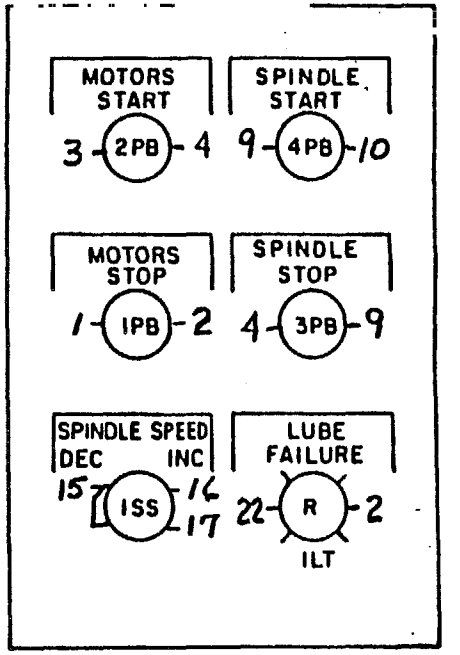


MAIN CONTROL PANEL



MASTER TERMINAL BOX PANEL



CONTROL STATION

CONNECTION DIAGRAM
FIGURE 3

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SECTION 14300

MONORAIL AND HOIST EQUIPMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. The Contractor shall provide all labor, material and equipment required to furnish and install, complete and ready to operate, the overhead monorail systems with accessories as herein described and as noted in the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Structural Steel: Section 05120.

B. Painting: Section 09900.

C. Mechanical General: Section 11000.

D. Non Process Motors: Section 16152.

1.03 SUBMITTALS

A. Shop Drawings shall be submitted in accordance with Section 01340.

B. Operation and maintenance manuals shall be submitted in accordance with Section 01730.

1.04 ELECTRICAL REQUIREMENTS

A. Power shall be supplied to the electric hoists and trolleys by means of recoiling cord system, enclosed bus bars, or festooned conductors. The system shall include all swiveling hardware, junction boxes, and catenary cables.

B. Electric hoists and trolleys shall be furnished complete with motors, motor starters, control voltage transformer and pendant mounted controls. Power supply to systems shall be 380 volts, 3 phase 50 hertz.

PART 2 PRODUCTS

2.01 DESIGN CRITERIA

A. Systems shall include all overhead track, curve sections, switches, suspension fittings and other accessories, conductor material, hoists and trolleys to operate on the track.

B. All structural supports which may be necessary where building members are not suitably located or are of such

character as to be unsuitable for providing direct connection shall be furnished and installed by the Contractor with the approval of the Engineer.

C. All equipment, such as castings, forgings and stampings shall be designed with a safety factor of not less than 5, based upon the ultimate strength of the material.

2.02 TRACK

A. Overhead track may be either a rolled or fabricated section, designed with a minimum safety factor of 5 based on the ultimate strength of the material. Deflection of the track under full load shall not exceed 1/450 of the span. Track section shall be installed with suitable couplings at rail joints to provide flush and level connections.

B. Suitable safety stops shall be provided. Safety stops shall be capable of withstanding the impact of the full loaded carrier at 20 percent of normal full load speed.

C. Radii of curves shall be designed to permit ease of passage without binding.

D. All necessary clamps, hanger rods and other fittings from which the track is suspended shall be provided as part of the complete system. The track shall be flexibly suspended using ball and scoket fittings to provide for field adjustment.

2.03 HOISTS

A. All hoists shall have an impact factor included in the design calculations based upon the full live load capacity of the hoist.

B. Chain hoist shall be spur geared type of lightweight design.

C. Electric hoists shall be wire rope type with reduced voltage push-button control.

D. All hoists shall conform to the minimum standards established by Hoist Manufacturing Association, Washington, D.C.

2.04 EQUIPMENT

A. Electric hoists and trolleys shall be as manufactured by Shepard-Niles, Wright, Harnischfeger, or equal designed to operate on monorail beam or monorail system as specified herein and as shown on the Drawings.

B. Monorail system shall include the steel monorail track, switches and appurtenances including mounting brackets and beams as required. Monorail system may be as manufactured by Louden Division of American Chain and Cable Co., inc.

"Supertrack" having 3.33 inch flange. Alternate system may be a rolled steel monorail beam, design for the loads, having bends, switches and all necessary appurtenances to produce a complete system as shown on the Drawings. The monorail system shall be supported as shown on the drawings with all suspension systems and accessories required for the complete installation of the system.

2.05 GRIT TRANSFER HOIST

A. The transfer hoist shall be used to transfer grit from each of the grit chambers to a grit truck for removal to a disposal site. The grit transfer hoist shall consist of a 2 ton electric hoist with motor-driven trolley designed for pendent pushbutton operation, power cable, spring-operated reel, and a clamshell bucket. The operation of the hoist and bucket shall be such that the bucket at all times shall be parallel to the monorail. Operation of the transfer hoist will be approximately four hours per day. The grit transfer hoist shall have a capacity of 2 tons and shall be a self-contained unit consisting of a 2 ton single-wire rope winch and a 2 ton twin-wire rope winch and appurtenances, all mounted on a motor-driven trolley, the speed of which shall be at least 45 fpm. The lifting speed of both winches shall be approximately 20 fpm (3 hp). The lift shall be a minimum of 36 feet. The twin-wire winch shall operate the bucket holding line, and the single-wire winch shall operate the closing line. The bucket holding line shall consist of two wire cables leading to an equalizer bar on the bucket. Sufficient hoisting cable shall be supplied with the hoist to accommodate not only the maximum lift for each winch but the additional length of closing line necessary for reeving the clamshell bucket plus two extra wraps on the drums.

The drums for both winches shall have machine-cut grooves and guarded flanges and shall have the capacity to take the entire run of cable in one layer with no overlapping. The grooves shall be cut right hand on one drum and left hand on the other so that as the cable winds on the drums the axial cable travel will be in the same direction for all cables to reduce the tendency of the bucket to twist.

The cable shall be flexible high-strength plow steel cable having a load factor of safety of at least 5 to 1.

The hoists shall be spur-gear driven and shall have antifriction bearings throughout, a mechanical load brake, and a separate electrically operated motor brake. Either brake shall be capable of supporting the full load and shall be easily accessible for external adjustment by removing coverplates. Shafts of the motor, drum, and drum pinion shall run in grease-lubricated ball or roller bearings. The mechanical-load brake and the gear train and bearings shall be oil-bath lubricated.

The hoist shall be provided with an upper and lower geared limit switch of the automatic reset control circuit type to prevent overtravel.

The trolley shall be a 4-wheel, or more, severe duty motor-driven trolley suitable for operation on the monorail indicated on the drawings. The trolley shall consist of a drive trolley, and a trailer trolley with a load frame suspended on swivel mountings between the two. Both winches shall be parallel mounted on the underside of the load frame. The drive trolley may be either of the type using a fully enclosed, single-speed electric motor equipped with a magnetic brake, a spur-geared transmission completely enclosed in an oiltight housing and suspended on the flanged driving wheels with power to two wheels, or a tractor unit having a motor-driven rubber-tired wheel driving on the underside of the monorail with wheel pressure maintained by springs or adjustable devices built into a supporting frame or platform suspended from flanged trolleys running on the monrail flange. Ball or roller bearings shall be used throughout both types of drive. All control equipment shall be mounted in an enclosed compartment which forms an integral part of the hoist and shall include a transformer for a 120-volt control circuit. The pendent pushbutton station shall be suspended from the control compartment by means of an overhung brace so that the pushbutton station will be accessible from the walkway when the hoist is at any point along the monorail.

2.06 CLAMSHELL BUCKET

A. The clamshell bucket shall be a two-line level-arm bucket having a capacity of 1/3 cu. yd. suitable for handling sewage grit and shall weigh not over 1,200 lb. It shall be not wider than 2 ft. 4 in. and shall be equipped with counterweights, reinforcing plates, and an equalizer bar mounted at right angles to the bucket lips to take the two holding lines.

All sheaves shall be grooved to suit the hoist cables and shall have grease-lubricated bushings.

The lips of the bucket should have renewable beveled alloy-steel cutting edges of sufficient thickness to prevent distortion. Wearing pads of hardened alloy steel shall be fitted at the 4-corner brackets of the scoops.

All rivets on the scoops shall be countersunk to provide smooth interior surface for the scoops. The sides and bottom plates of the scoops shall be drilled with 9/16-inch holes 3 inches on centers to facilitate draining water from the grit.

The opening and closing of the bucket shall be by means of the single wire rope on the winch.

2.07 PROJECT REQUIREMENTS

A. Influent Structure
   1. Bar Screen Area - Three (3) ton electric hoist and severe duty motorized trolley shall be furnished and be installed complete with steel monorail and appurtenances as shown on the Drawings. The electric hoist shall be rated for 3 ton capacity having a lift not less than 20 feet at 20 FPM equipped with an electric motorized trolley designed to operate at 45 FPM single speed on the monorail track.
   2. Grit Removal Area - Two (2) ton electric grit transfer hoist and severe duty motorized trolley shall be furnished and be installed complete with steel monorail, clamshell bucket and appurtenances as shown on the Drawings. The hoist shall have a lift not less than 36 feet at 20 FPM and the trolley shall be designed to operate at 45 FPM.

B. Chlorine Building and Storage Area - A three (3) ton electric hoist and motorized trolley shall be furnished and be installed complete with steel monorail, switches and appurtenances as shown on the Drawings. The electric hoist shall be rated for 3 ton capacity having a lift not less than 16 feet at 15 FPM with an electric motorized trolley designed to operate at 45 FPM single speed on the monorail track. The monorail track, with hand operated sliding switches and bends shall be as shown on the Drawings. Radius of curves shall be as shown and shall be compatible with the trolley to be installed.

C. Digester Building
   1. A one (1) ton electric hoist and motorized trolley shall be furnished and be installed complete with steel monorail and appurtenances as shown on the Drawings. The electric hoist shall be rated for 1 ton capacity having a lift not less than 32 feet at 20 FPM with an electric motorized trolley designed to operate at 45 FPM single speed on the monorail track.
   2. At the basement level as indicated on the Drawings, are five locations for hand propelled overhead trolleys and monorail beams with a one (1) ton capacity each. One hook suspended hand operated chain hoist with one (1) ton capacity and a lifting height of 20 feet shall be provided.

PART 3 EXECUTION

3.01 INSTALLATION

A. Equipment shall be installed in accordance with the manufacturer's recommendations.

B. The Contractor shall obtain authorization from the Engineer prior to burning or drilling holes in beams or other parts of the building structure. Details of track suspension shall be as shown on the Contract Drawings; and

deviation shall be brought to the attention of the Engineer.

3.02 SYSTEMS TEST

A. After the hoists have been erected and the tracks have been vertically and horizontally aligned, the hoists shall be given running tests to determine their ability to perform as specified and that all controls function properly. Test loads, if used, may be as high as rated capacity plus 25 percent overload and shall be provided by the Contractor.

END OF SECTION

SECTION 14510

SLUDGE DRYING BED FRONT END LOADER

PART 1 GENERAL

1.01 RELATED WORK

A. Section 11000: Mechanical Equipment General

B. Section 14512: Sludge Drying Bed Dump Truck

1.02 DESCRIPTION OF EQUIPMENT

A. Provide two gasoline power front end loaders for removal of sludge from drying beds and transport and deposit into dump truck.

1.03 SUBMITTALS

A. Submit Shop Drawings in accord with Section 01340.

PART 2 PRODUCTS

2.01 EQUIPMENT

A. Loader shall have lifting capacity of 1700 pounds.

B. Bucket size shall be minimum of 16.5 cubic feet.

C. Loader engine shall be gasoline power (to be a minimum of 45 horsepower).

D. Engine shall be four cylinders water cooled.

E. Power train shall consist of hydrostatic transmission with chain drive to all wheels.

F. Units shall have a maximum speed of 6.2 mph

G. Provide keyswitch with pushbutton type starting and battery ignition and 12 volt battery.

H. Brakes to be mechanical parking type.

I. Provide water temperature gage, oil pressure gage, low fuel light.

J. Unit to be supplied with dry type air cleaner, muffler, fuel filter and hand throttle and choke, and adjustable seat.

K. Each unit to be equipped with pallet forks.

L. Provide for each unit one complete set of Loegering tire crawlers track.

M. The front end loader supplied for this project shall be of a manufacturer that has a Jordanian agent in Jordan with established spare parts and service facility, to ensure prompt service.

2.02 SPARE PARTS

A. Provide the following spare parts for each unit:
1. 6 fuel filters
2. 6 air cleaners
3. 4 spare tires
4. 6 air cleaners.

PART 3 EXECUTION

3.01 DELIVERY

A. Deliver front end loaders to sludge drying bed site.

END OF SECTION

SECTION 14511

LANDFILL DUMP TRUCK

PART 1 GENERAL

1.01 RELATED WORK

A. Section 01570: Landfill Operation Guidelines

1.02 DESCRIPTION

A. Provide one complete dump truck.

1.03 REFERENCE STANDARDS

A. Performance ratings shall conform to SAE standards.

1.04 SUBMITTALS

A. Submit catalog cuts and detailed performance data in accord with Section 01340.

B. Submit operation and maintenance manual.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. The dump truck supplied for this project shall be of a manufacturer that has a Jordanian agent in Jordan with established spare parts and service facility to ensure prompt service.

2.02 DESIGN CRITERIA

A. Wheelbase: 187".

B. Frame: Section modulus including 1/4" inside frame reinforcement not less than 25.0 and R.B.M. 2m 750,000 in-lbs. per rail.

C. Engine: EM6-250 Maxidyne Diesel Mack Engine. 4 cycle inline 6 cylinder diesel not less than 250 horsepower and 907 ft.-lbs. torque. Water filter, fuel filters and oil filters for maximum filtration as recommended by engine manufacturer for optimum engine life.

D. Engine Alarm System: Buzzer and light to warn of low oil pressure, high water temperature.

E. Engine block heater: Electric 220 volts, 50 Hz.

F. Air Cleaner: Dry Type.

G. Transmission: 6-speed direct with low-hold range with the following rations:

	Direct	Range	Reverse
1st Gear	8.59	23.08	36.33
2nd Gear	4.99	-	21.32
3rd Gear	2.84	-	12.11
4th Gear	1.66	-	7.07
5th Gear	1.00	-	4.27

H. Steering: Integral full hydraulic

I. Exhaust: Vertical

J. Fuel Tanks: Minimum 50 gallon steel fuel tank.

K. Rear Axle: 44,000 lb. capacity with 6 spoke cast spoke wheels, rear carriers to be dual reduction drive.

L. Front Axle: 18,000 lb. capacity with 6 spoke cast spoke wheels.

M. Tires: 11:00 x 22 14 ply tube type with rear tires traction type tread.

N. Brake System: Full air brakes with 12.0 cu. ft. air compressor gear driven (belt driven not acceptable), front brakes 16.5" x 5" total lining area 2026 sq. cm. Rear brakes 16.5' x 7" total lining area 920 sq. in. Auxiliary spring brakes with spring loaded chambers, double diaphragm type mechanical spring realse.

O. Hand Control Valve: Rear service brakes.

P. Drain Valve: B/W heated drain valve.

Q. Alcohol Evaporator: Brake System

R. Electrical System: 4-12 Volt maintenance free batteries, 12 volt 90 amp alternator. Automatic reset circuit breakers all exposed electric connections sprayed Glyptol, full copper ground circuit.

S. Mirrors: West Coast type.

T. Hood and fendors: One piece fiberglass construction with wheel splash aprons, forward tilt 75 deg.

U. Cab: Unitized all steel welded construction, heel plate for throttle pedal, separate driver seal air suspension type. Full instrumentation (no lights instead of gages).

V. Air Horn; Single grover.

W. Seat belts: Retractable

X. Radiator Guard Plate type.

Y. Body: 10 yd. capacity, 12 yd. ends, full cab shield, inside controls, ladder, sand plates, slanted full seal tail gate, roller cover, heated body, mounted and painted, with back-up alarm.

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 14512

SLUDGE DRYING BED DUMP TRUCK

PART 1 GENERAL

1.01 RELATED WORK

A. Section 14510: Sludge Drying Bed Front End Loader.

1.02 DESCRIPTION

A. Provide one complete dump truck for removal of sludge from drying beds.

1.03 REFERENCE STANDARDS

A. Performance ratings shall conform to SAE standards.

1.04 SUBMITTALS

A. Submit catalog cuts and detailed performance data in accord with Section 01340

B. Submit operation and maintenance manual in accord with Section 01730.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. The dump truck supplied for this project shall be of a manufacturer that has a Jordanian agent in Jordan with established spare parts and service facility to ensure prompt service.

2.02 DESIGN CRITERIA

A. Wheelbase: 137 inches.

B. Frame: Minimum of 9-1/8" x 3" x 1/4" standard frame construction.

C. Engine: 5.7L V8 (350 Cu. In.) Gasoline GMC engine, not less than 160 SAE net horsepower and 275 net lbs/ft. torque. Water filter, fuel filters and oil filters for maximum filtration as recommended by engine manufacturer for optimum engine life.

D. Engine Alarm System: Buzzer and light to warn of low oil pressure, high water temperature.

E. Air Cleaner: Dry Type.

F. Transmission: Manual 4-speed, direct GM SM-465.

G. Steering: Hydraulic Power.

H. Fuel Tanks: Single 50 gallon steel fuel tank.

I. Rear Axle: Minimum 15,000 pound capacity with drop center, 20 x 6.0 x L disc wheels.

J. Front Axle: Minimum 5,000 pound capacity with drop center, 20 x 6.0 x L disc wheels.

K. Tires: 8.25/20E (10-ply) tube type with rear tires traction type tread.

L. Brakes: Dual Power, Vacuum/Hydrualic Brake, also include an orscheln-type parking brake.

M. Mirrors: West coast type.

N. Hood and fenders: Alligator hood model with double wall construction for front fenders.

O. Cab: Unitized all steel welded construction, heal plate for throttle pedal, separate driver seal air suspension type. Full gage instrumentation.

P. Electric Horn.

Q. Seat Belts: Retractable.

R. Body: 5-6 cubic yard capacity, full cab shield, sand plates, slanted full seal tail gate, top of gate not to exceed 80 inches from ground surface, mounted and painted, with back-up alarm, 12 ton hoist capacity and 20 inch cylinder stroke.

END OF SECTION

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SECTION 14515

LANDFILL FRONT END LOADER

PART 1 GENERAL

1.01 RELATED WORK

A. Section 01570: Landfill Operation Guidelines

1.02 DESCRIPTION OF SYSTEM

A. Provide one diesel powered four wheel drive, pneumatic tired, front end loader, and accessories as described herein.

1.03 DESIGN CRITERIA

A. The bucket shall be hydraulic discharge type with capacity of 4 cubic yards SAE heaped and a cutting width not less than the overall width of machine over tires.

B. The minimum tire size shall be 23.5 x 25 L2 tubeless with traction tread.

C. The overall height to top of ROPS shall be not more than 10 ft. 10 inches.

D. The overall length of the loader with bucket on ground shall be not less than 23 ft. 3 inches.

E. The dump clearance at full height with bucket dumped at 45 deg. shall be not less than 9 ft.

F. The bucket reach at full height with bucket dumped at 45 deg. shall be not less than 2 ft. 7 inches.

G. The bucket reach at 7 ft. 2 inches with bucket dumped at 45 deg. shall be not less than 4 ft. 8 inches.

H. The loader clearance circle with bucket in carry position shall not exceed 44 ft. 7 inches.

I. The tipping loads in pounds shall be not less than 27,900 when straight; 25,670 when turned 35 deg.

J. The loader operating weight fully serviced with ROPS cab shall be not less than 36,740 pounds.

K. The minimum bucket breakout force shall be 25,900 pounds.

L. The high travel speed shall be not less than 38 kilometers per hour and the low range shall not exceed 7.7 km/h forward and 9.2 km/h reverse.

M. The total raise, lower, and dump time shall not exceed 15.2 seconds.

N. The diesel engine shall be rated not less than 170 SAE net flywheel horsepower at a rated RPM of not more than 2200.

O. At full throttle, the torque rise capability of the engine, under standard SAE conditions, shall not be less than 503 ft-lb. at 1600 RPM.

P. The minimum fuel tank capacity shall be 65 gallons.

Q. The minimum hydraulic system capacity shall be 52 gallons.

.04 REFERENCE STANDARDS

A. Performance ratings shall conform to SAE Standards including SAE J 732 C.

.05 SUBMITTALS

A. Submit catalog cuts and detailed performance data in accord with Section 01340.

B. Submit operation and maintenance manual in accord with SEction 01730.

1.06 GUARANTEE

A. Provide Manufacturer's guarantee for a minimum period of one year from Engineer's acceptance.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. The front end loader supplied for this project shall be of a manufacturer that has a Jordanian agent in Jordan with established spare parts and service facility to ensure prompt service.

2.02 BUCKET CONTROL

A. The general purpose bucket control functions shall include raise, lower, dump, hold, float, and rollback with a bucket position indicator; self leveling system; automatic return to dig; and, automatic bucket height control.

B. For discharge bucket, additional functions of discharge, retract and hold shall be provided.

.03 STEERING

A. The articulated steering system shall be designed to permit the front and rear wheels to track at any steering angle.

B. The loader shall be hydraulically steered with power supplied by a hydraulic pump independent of the loader system pump.

2.04 BRAKES

A. The service brakes on all wheels shall be air over hydraulic of the disc type.

B. The parking brake shall automatically set if air pressure is lost.

2.05 LOADER LINKAGE

A. The loader linkage shall be designed to provide good work visibility.

B. The rods of the actuating cylinders shall be surface hardened and chrome plated, and all hydraulic lines shall be routed in protect against normal work environments.

2.06 HYDRAULIC SYSTEM

A. The hydraulic system reservoir shall be sealed and pressurized.

B. The rated pump discharge pressure shall be not greater than 2500 psi.

C. The system shall include a level indicator, fill, drain, reservoir clean-out, and be protected with a full flow micronic filter.

2.07 AXLES

A. The loader axles shall be heavy duty of the full floating type, driven by a torque proportioning differential to provide optimum power to all wheels.

B. Each rear wheel shall be capable of dropping 14 inches with all other wheels remaining on the ground for full traction.

C. The axles shall be removable for servicing without disturbing the wheels or drive mechanism.

2.08 TRANSMISSION

A. The loader transmission shall be of the full power shift type having a minimum of 3 forward and 2 reverse speeds with the necessary features to provide for fast, smooth on-the-go directional changes.

B. A safety interlock to prevent engine start-up with the transmission engaged shall be provided.

C. A clutch cutout shall also be provided to disengage the transmission with brakes applied for maximum hydraulic power for lift or bucket breakout operations.

.09 ENGINE

A. The loader shall be powered by a liquid cooled heavy duty diesel engine, having replaceable cylinder liners surrounded by coolant. Rotating exhaust valves and replaceable exhaust valve inserts shall be provided.

B. A speed governor shall be furnished to control the engine at all throttle settings.

C. The fuel and lubrication system shall be protected by readily replaceable full flow filters and the aircleaner shall be of the two stage dry type with restriction indicator.

.10 ELECTRIC SYSTEM

A. A 24-volt electric system shall include batteries, starter adequate for operation to minus 20 deg. C, 40 amp alternator with voltage regulator, 2 headlights, rear floodlight, taillight with stop light, and air horn.

2.11 INSTRUMENTS

A. Instruments shall include hourmeter; tachometer; air system pressure indicator; engine water and torque converter oil temperature gages; engine oil pressure and alternator gages; and transmission clutch pressure and parking brake warning lights.

2.12 CAB

A. The loader shall be equipped with a ROPS cab conforming to OSHA. CAb shall be or walk through design with full length keylock doors and access ladders, with 67 way adjustable air suspension seat and seat belt, safety glass with tinted windshield, sound suppression, front windshield wiper, dome light, ash tray, filtered air pressurization with 3 speed control, and a rear view mirror.

2.13 OTHER ACCESSORIES

A. Provide all of the following features on the loader:
1. Fenders for all wheels
2. Engine compartment side panels
3. Drive line guard
4. Engine block heater: electric 220 volts, 50 Hz.
5. Cab heater
6. Windshield defroster
7. Rear windshield wipers
8. Sparle arresting muffler
9. Security system, lock-up kit
10. Two additional driving lights mounted at top of cab
11. Turn signals with emergency flashers
12. Dead engine emergency steering system
13. Reverse back-up alarm

2.14 FACTORY FINISH

A. Finish paint loader in accord with Manufacturer's standards.

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 15050

PIPING INSTALLATION

PART 1 GENERAL

.01 RELATED WORK

A. Section 02221: Trenching, Backfilling and Compacting

B. Section 03001: Cast-In-Place Concrete

C. Section 09900: Painting

D. Section 15060: Piping Materials

.02 DEFINITIONS

1. Piping: all exposed and buried pipes, fittings, valves, flanges, gasketing, hangers and supports or bedding comprising any given system, plastic piping and instrument tubing included.
2. Exfiltration: the quantity of water which must be added to the upstream manhole at the conclusion of a hydrostatic test to restore the water level to the elevation recorded at the start of the test.

.03 QUALITY ASSURANCE

A. Certify welders and machine operators as qualified in accord with the standard by which the piping is installed.

B. The engineer reserves the right to request and witness the making of test specimens by welders, and to observe the physical testing of specimens. The Contractor shall pay for one set of test materials and tests for each welder and machine operator.

1.04 SHOP INSPECTION AND TESTING

A. The quality of all materials, the process of manufacture and finished piping shall be subject to inspection and approval of the Engineer.•

B. Pipe may be inspected at the place of manufacture, and on the Work site, and shall be subject to rejection, if defective, at any time even though submitted samples may have been approved.

C. Engineer may have pipe or fittings inspected or tested, or both, by an independent inspection service at either the manufacturer's plant or elsewhere. Such inspections and/or tests will be at the Owner's expense.

.05 REFERENCE STANDARDS

A. American National Standards Institute:
1. ANSI A21.50: Thickness Design of Ductile Iron Pipe.

2. ANSI B31.1: Power Piping.

B. American Society for Testing and Materials:
1. ASTM D 2321: Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe.

C. American Water Works Association:
1. AWWA C206: Standard for Field Welding of Steel Water Piping Joints.
2. AWWA C600: Standard for Installation of Gray and Ductile Cast Iron Water Mains.

1.06 SUBMITTALS

A. Submit Shop Drawings of piping layouts and Certificates of shop tests for piping in accord with Section 01340.

PART 2 PRODUCTS

2.01 MATERIALS

A. Conform to Section 15060.

PART 3 EXECUTION

3.01 GENERAL

A. Inspect piping before installation

B. Clearly tag defective piping without damaging or defacing piping.

C. Remove defective piping from Project site at no cost to Owner.

D. Notify Engineer of conflicts arising during the erection of piping. Do not improvise or field change piping without the approval of the Engineer.

E. Erect piping to allow flexibility and to prevent stresses in materials and bending moments at joints or connections to equipment.

F. Use full lengths of pipe wherever possible. Do not use short lengths of pipe with couplings, except as may be approved by the Engineer.

G. Install pipe without forcing or springing.

H. Avoid tool marks and unnecessary pipe threads. Remove burrs formed when cutting pipe by reaming.

I. Before installing pipe, clean the inside free of cuttings and foreign matter.

J. Where piping is pitched for drainage, maintain an accurate grade. Support piping to prohibit deflection due to gravity that would be sufficient to pocket the lines when full of liquid.

K. Make changes in direction using pipe fittings unless otherwise shown on the Drawings.

L. Install unions in piping connections to equipment, regulating valves, and wherever necessary to facilitate the dismantling of piping and removal of valves and other items requiring maintenance. Flanges on equipment may be considered as unions. At least one union shall be provided in every straight run of pipe.

M. Contractor to provide and install adaptors between metric piping and equipment having English connection (flanges or threaded).

N. Take Service piping off the top of headers, unless otherwise indicated. Slope service piping for drainage where possible.

O. Install pipe anchors, thrust blocks, expansion joints, loops and bends required to protect the piping against vibration, misalignment and overstressing.

P. Install exposed piping straight, run parallel to or at right angles to walls and graded so the entire system can be drained. Install drain valves at low points of piping and vent valves at high points of the piping.

Q. Install piping so that it will not interfere with the operations or accessibility of doors or windows or encroach on aisles, passageways or equipment, or interfere with the servicing or maintenance of equipment. Group adjacent piping in the same horizontal or vertical plane.

R. Paint buried bolts, nuts, lugs, rods, and brackets, except stainless steel with one coat of bituminous paint prior to backfilling.

S. When connecting a pipe to a pump nozzle, leave bolts and nuts loose until after the entire pipeline has been installed, aligned and checked.

T. Install piping to allow expansion and contraction without damage to piping, structures or anchors. On all encased pressure piping, install self-equalizing type expansion joints with control rods in straight runs of 90 feet or more, unless otherwise noted on the Drawings.

U. Install piping passing through walls and floors in sleeves, wall pipes or wall castings accurately located before concrete is poured or place in position during construction of masonry walls. Extend pipe sleeves through floors one inch above the finished floor and one inch below the underside of the floor. Use cast iron wall

pipes, with integral water stops, for wall penetrations where liquid is contained on one side and a dry area is required on the other side. The use of over-sized wall sleeve with packing or seals shall not be permitted.

V. Taper field cuts back approximately 1/8-inch, at an angle of 30 degrees with the centerline of the pipe, to remove rough edges which might damage a gasket.

3.02 BURIED PIPING INSTALLATION

A. Excavate trench, install buried piping and backfill trench in accord with AWWA C600.

B. Provide adapters where it is necessary to join pipes of different types. Adapters shall conform to manufacturer's recommendation for the type of joint.

C. Install the piping at the lines and grades indicated on the Drawings.

D. Install concrete thrust blocks or restrained joints at bends, tees, and other fittings in pipe lines. Place concrete against undisturbed earth. If the soil is unsuitable for bearing, provide bridle rods, clamps, and accessories to brace the fitting properly. Paint bridle rod assembly thoroughly and heavily with one coat of bituminous paint after assembly or, if necessary, before assembly.

E. Bed cast iron and ductile iron pipe in accord with ANSI A21.50 Type IV or Type V with materials as designated in Section 02222 and 02224.

3.03 FLANGED PIPING

A. Center and level piping to the indicated position and the correct elevation with flanges plumb and level. Clean flanged faces, bolt holes, and gaskets before assembly. Align bolt holes to straddle vertical center line of flange.

B. Tighten bolts uniformly and progressively on opposite sides of the flange so there will be no strain on the flange or piping. When making difficult connections, rubber cement or light string may be used to hold the gasket in place.

C. Do not use raised face flanges to connect to cast iron flat-faced flanges.

3.04 SCREWED PIPING

A. All screwed joints shall have long taper threads and be made tight with TFE tape.

B. For pipe up to and including 1-1/2 inches, ream to remove burrs and stand on end and pound to remove scale and dirt.

C. Use two wrenches when making up screwed joints to avoid loosening or over-stressing adjacent piping and valves.

3.05 WELDED PIPING

A. For carbon steel piping, conform to AWWA C206.

B. For other metallic piping, conform to ANSI B31.1.

3.06 PUSH-ON TYPE JOINTS

A. Inspect gasket, socket, and spigot for cleanliness. Remove foreign matter and excessive coating.

B. When cast iron or ductile iron pipe is cut in the field, taper the outside of the cut end back 1/4-inch, at an angle of about 30 degrees with the center line of the pipe. Remove sharp or rough edges which may injure the gasket.

C. Insert the gasket in the socket, in accordance with the manufacturer's instructions.

D. Lubricate the exposed face of the gasket and the spigot using Push-On Joint lubricant. Do not use lubricant other than that furnished with pipe and fittings.

E. Align fittings and pipe. Insert the spigot into the socket until it just makes contact with the gasket. Complete joint by forcing the spigot past the gasket until spigot makes contact with the bottom of the socket.

F. If assembly is not accomplished with the application of reasonable force, remove the spigot end of the pipe to check for the proper positioning of the gasket. Keep joint in straight alignment during assembly.

3.07 CAULKED JOINTS

A. Seat spigot end of pipe in the bell of the adjacent pipe. Adjust spigot to give a uniform space for the joint.

B. Pack joint with braided hemp or jute fiber long enough to completely encircle the pipe. Drive packing into the bell to leave a space of at least 2-1/2 inches in depth to be filled with lead.

C. Keep the melting pot near the joint to be poured. Do not allow dross to accumulate in the melting pot. Caulk joints to provide secure tight joints without overstraining the iron of the bells. Use one pound of lead at each joint for each one inch diameter of the pipe. Make each joint in one pour.

.08 MECHANICAL JOINT PIPING

A. Wash spigot and bells of pipe and the rubber gaskets with soapy water to remove all foreign matter.

B. Assemble the joint in accordance with manufacturer's recommendations.

3.09 PVC PIPING

A. Install in accordance with the manufacturer's instructions.

B. Install buried PVC piping in accordance with ASTM D2321.

C. Buried PVC Piping: Place a 12" wide colored plastic tape embedded in the backfill 1'-0" above the crown of the pipe for the full length of the PVC pipe. Tape should say "Buried PVC Pipe."

3.10 COPPER PIPING

A. Soldered joints: Clean ends of tubing and inner surfaces of fittings with steel wool until copper is bright. Apply thin coating of soldering flux. Insert tubing end into the fitting as far as possible. Heat and finish joint in accordance with fitting manufacturer's instructions. Use solid string or wire solder composed of 50 percent tin and 50 percent lead. Do not use cored solder. Allow joints to self cool to prevent chilling of solder.

B. Flared joints: Cut and de-burr ends of copper tubing. Slip sleeve nut onto tubing and flare end with a flaring tool. Do not crack or split the flared portion. If inspection reveals cracks or splits, cut off and remake flare. Seat flared end squarely on the fitting and tighten the nut.

3.11 PIPE SUPPORTS

A. Furnish all materials including clamps, rods, angles, channels, and plates, for supporting the piping.

B. Pipe lines close to the floor may be supported from the floor by structural shapes or by poured concrete blocks or piers. Do not block floor drainage with supports.

C. Determine supports for piping in accordance with this specification unless detailed on drawings.

D. space supports and hangers for steel and cast iron piping in accordance with the following table, except where otherwise indicated on the Drawings. These support spacings do not apply where concentrated weights such as valves or heavy fittings, or where changes in direction of the piping system, occur between hangers.

Nominal Pipe Size (inches)	Maximum Hanger Spacing in Feet	Rod Size
1	7	3/8"
1-1/2	9	3/8"
2	10	3/8"
3	12	1/2"
4	14	5/8"
6	17	3/4"
8	19	7/8"
10	22	7/8"
12	23	7/8"
14	25	1"
16	27	1"
18	28	1-1/8"
20	30	1-1/4"
24	32	1-1/2"

E. Continuously support hose and flexible tubing in steel angle, channel or cable trays.

3.12 APPURTENANCES

A. Provide valves and piping not mentioned in piping specifications, but shown and specified on the Drawings.

3.13 FINAL INSPECTION

A. Each section of buried piping will be inspected by the engineer prior to backfilling.

B. Correct, repair or replace any pipe which is not true to both line and grade and free of projections and debris.

3.14 FIELD TESTING PRESSURE PIPE

A. Before pressure testing, remove or isolate all equipment that could be damaged by the test pressure or test medium from the pipe being tested.

B. Backfill buried pressure piping to a minimum depth of two feet above the top of the pipe before final testing. The Contractor may perform preliminary tests at his own expense prior to backfilling if desired.

C. Temporarily brace piping to prevent damage or movement during testing.

D. Test pressure piping hydrostatically in accord with AWWA C600 at 1.5 times the maximum operating pressure or the pump shut-off pressure, whichever is greater, but in no case exceeding the allowable working pressure of the piping materials. The operating pressures shall be defined by the Engineer. No air testing shall be permitted.

E. Pipe installation will not be accepted until the leakage for the section of line tested is less than the rate of leakage specified below:
   1. Flanged, welded, screwed and soldered: No measurable leakage.
   2. Push-on, mechanical joints or caulked bell and spigot piping: In accordance with AWWA C600.

F. Locate and repair the defective joints and/or pipe until the leakage is within the specified allowance, at no cost to Owner.

G. Test compressed air systems to which instruments are connected with clean dry air as specified in Section 13444.

3.15 FIELD TESTING GRAVITY PIPING

A. Backfill buried gravity piping to a depth of not less than two feet above the top of the pipe before final testing. The Contractor may perform preliminary tests at his own expense prior to backfilling if desired.

B. Test gravity piping hydrostatically.

3.16 GRAVITY PIPE HYDROSTATIC TEST

A. Perform hydrostatic testing by plugging the downstream end of the pipe to be tested and the inlets to the upstream manhole.

B. Fill the upstream manhole with water to a height four feet above the top of the pipe at the upstream manhole, or four feet above the groundwater level, whichever is higher.

C. After all test water has been placed in sewer section, let stand for minimum of one hour and refill to specified test height.

D. Test piping by allowing water to stand for a minimum of two hours. Record actual test duration.

E. At conclusion of test, measure the height of water surface in upstream manhole and calculate the change in elevation from the test height.

F. Calculate the exfiltration rate in gallons per inch of inside diameter of piping system tested per mile per 24 hours.
   1. Include manholes in calculation as sections of pipe four feet long with diameter equal to manhole size.

G. Maximum allowable exfiltration rate: 100 gallons per inch of inside diameter per mile per 24 hours.

3.17 DISINFECTING

A. Prior to placing in service, disinfect potable water piping in accordance with AWWA Standard for Disinfecting Water Mains, AWWA C601.

3.18 NON-POTABLE WATER PIPING

A. Attach 3 inch high by 6 inch wide brass sign lettered in Arabic and English with the words "UNFIT TO DRINK" to hose bibs and yard hydrants connected to utility water system.

END OF SECTION

SECTION 15060

PIPING MATERIALS

PART 1 GENERAL

1.01 RELATED WORK

A. Section 15050: Piping Installation.

1.02 REFERENCE STANDARDS

A. American Water Works Association:
1. AWWA C203: Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied.

PART 2 PRODUCTS

2.01 PIPE SIZES

A. Piping Specifications show pipe diameters in English sizes. The following is a list of equivalent metric sizes.

ENGLISH, IN.	METRIC DIAMETER, MM	ENGLISH, IN.	METRIC DIAMETER, MM
1/2	13	12	300
3/4	20	14	350
1	25	16	400
1-1/2	40	18	450
2	50	20	500
3	80	24	600
4	100	30	800
6	150	36	900
8	200	48	1000
10	250		

2.02 PIPE COATINGS

A. Buried steel pipe: coat on outside in accord with AWWA C203, with one coat Type A primer, one coat coal tar emulsion and one coat aluminum paint.

2.03 VALVE OPERATORS

A. Provide chain wheel or lever operator and chain for all valves located six feet or more above operating level.

PART 3 EXECUTION

3.01 PIPING SPECIFICATION INDEX

Piping Specification Index

Service	Symbol	Location	Spec No.
Air, low pressure	LPA	Exposed Buried	CS-2 CS-2
Chlorine Solution	CL	Exposed Buried Buried	PL-4
Chlorine Gas	CG	Exposed	CS-2
Digester Gas	DG	Exposed Buried Buried	CS-2 CS-2
Drains, Sanitary	SD	Exposed Buried	CI-2 CI-2
Drains, Non-Sanitary	DN	Exposed Buried	CI-2 CI-2
Drains, Storm	SD	Buried	CO-9
Drying Bed Underdrain	DD	Buried	PL-5
Fuel Oil	FO	Exposed Exposed	CS-9 CS-9
Plant Drain	PD	Exposed Buried	CI-4 CI-1
Polymer	PR	Exposed Buried	SS-2 SS-2
Process (forward) Flow	PF	Exposed Buried	CI-4 CI-1
Scum	SC	Exposed Buried	CI-4 CI-1
Septage	SE	Exposed	CI-4

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Piping Specification Index

Service	Symbol	Location	Spec No.
		Buried	CI-1
Sludge	SL	Exposed	CI-4
		Buried	CI-1
Sludge Recycle	SR	Exposed	CI-4
		Buried	CI-1
Sludge Transfer	ST	Exposed	CS-2
		Buried	CS-2
Supernate	DN	Exposed	CI-4
		Buried	CI-1
Water, Utility (non-potable)	UW	Exposed	CI-4
		Buried	CI-1
Water, Potable	PW	Exposed	CI-4
		Buried	CI-1
Water Supply, Hot	HWS	Exposed	CS-8
		Buried	CS-8
Water Return, Hot	HWR	Exposed	CS-8
		Buried	CS-8

PIPING SPECIFICATION CI-1

Rating: 125 psig, @ 100 deg. F/38 deg. C

Item	Size	Description
Pipe	2" and under	Steel Sch. 80, Galvanized, ASTM A120
	3"	Steel Sch. 40, Galvanized, ASTM A120
	4"-48"	Ductile iron, cement lined, Class 51. ANSI A21.50 and A21.51; cement lining ANSI A21.4.
Line Joints	3" and under	Screwed
	4" and over Non-Pumped Service	Push-on, Mechanical joints at fittings
	4" and over Pumped Service	Push-on, Restrained joints at fittings. When restrained joints are used, provide restrained joints for 3 full pipe length upstream and downstream from fittings.
Restrained Joints		Push-on rubber gasket joints ANSI 21.11 with spigot retainer ring and bar, bell retainer ring and tee head bolts.
Fittings	2" and under	300 psi, M.I., galvanized, ANSI B16.3
	3"	150 psi, M.I., galvanized, ANSI B16.3
	4"-12"	250 psi, C.I., cement lined mech. jt., ANSI A21.10, 21.11, or restrained type as specified under joints.
	14"-48"	150 psi, C.I., cement lined mech. jt., ANSI A21.10, 21.11, or restrained type as specified under joints.

PIPING SPECIFICATION CI-1

Rating: 125 psig, @ 100 deg. F/38 deg. C

Item	Size	Description
Unions	2" and under	300 psi, M.I., galvanized, ground joint, all-iron, ANSI B16.3
	3"	150 psi, M.I., galvanized, ground joint, all-iron, ANSI B16.3
Couplings	all sizes	Dresser Style 38, Smith-Blair, or equal, galvanized steel, asbestos gaskets, galvanized bolts with restraints
Bolts & Nuts	all sizes	Flanged joint: Stainless Steel square head bolts, hex nuts. Mechanical joint: Low alloy steel, ANSI A21.11
Gaskets	all sizes	Push-on: rubber, ANSI A21.11, Mech. jt: rubber, ASTM C425 ANSI A21.11, Flanged joint: rubber, 1/8" thick
Coatings	all sizes	All underground piping and valves shall have exterior shop coat of bituminous coating, ANSI A21.6
Linings	4" and C.I. over	All D.I. pipe and fittings to be cement lined per ANSI A21.4
Gate Valves	3" and over	V-16
Plug Valves	3" and over	V-17

PIPING SPECIFICATION CI-2

Rating: Gravity flow at 140deg.F

Item	Size	Description
Pipe	2" and under	Sch. 40 galvanized steel, ASTM A 120
	3"-8"	Cast iron soil pipe, service weight (if approved by local codes) ANSI A112.5.1, coal tar coated inside and outside
	10" and over	Ductile iron, ANSI A21.51. Thickness class per ANSI A21.50. Bituminous shop coated per ANSI A21.6
Line Joints	2" and under	Screwed couplings
	3" and over	Push-on o-ring type
Fittings	2" and under	125 lb. galvanized cast iron threaded drainage fittings ANSI B16.12
	3"-8"	Cast iron soil pipe, push-on type, extra heavy, ANSI A112.5.1, coal tar coated inside and outside
	10" and over	Cast iron push-on type, ANSI A21.10 and ANSI A21.11. Bituminous shop coated per ANSI A21.6
Gaskets	3"-8"	Neoprene, ASTM C 564
	10" and over	Rubber, ANSI A21.11

PIPING SPECIFICATION CI-3

Rating: 125 psig, @ 100 deg. F/38 deg. C

Item	Size	Description
Pipe	2" and under	Steel Sch. 80, Galvanized, ASTM A120
	3"	Steel Sch. 40, Galvanized, ASTM A120
	4"-54"	Ductile iron, Flanged, Class 53. ANSI A21.15
Line Joints	2" and under	Screwed
	3"	Flanged or Screwed.
	4" and over	Flanged.
Fittings	2" and under	300 lb. galvanized M.I., screwed. ANSI B16.23
	3"	150 lb. galvanized M.I., screwed. ANSI B16.3 or 125 lb. flanged cast iron. ANSI A21.10.
	4" and over	125 lb. flanged cast iron. ANSI A21.10
Unions	2" and under	300 lb. galvanized M.I. screwed. All iron.
	3" and over	Flanged.
Flanges	3"	125 lb. C.I. screwed. ANSI B21.10.
	4" and over	Cast iron screwed ANSI A21.15. Factory installed on pipe.
Couplings	4" and over	Lock type, Dresser style 67 or equal with Buna-s or neoprene gaskets.

PIPING SPECIFICATION CI-3

Rating: 125 psig, @ 100 deg. F/38 deg. C

Item	Size	Description
Gaskets	4" and over	(Neoprene) (Natural rubber) 1/8" thick, full face.
Bolting	All sizes	ASTM A 307 Grade B, square head bolts, heavy hex nuts ANSI B1.1 and B18.2.
Gate Valves	2" and under	V-34
	3" and over	V-21
Check Valves	2" and under	V-20
	3" and over	V-23

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PIPING SPECIFICATION CI-4

Rating: 125 psig, @ 100 deg. F/38 deg. C

Item	Size	Description
Pipe	2" and under	Steel Sch. 80, Galvanized, ASTM A120
	3"	Steel Sch. 40, Galvanized, ASTM A120
	4"-54"	Ductile iron, cement lined, Flanged, Class 53. ANSI A21.15
Line Joints	2" and under	Screwed
	3"	Flanged or Screwed.
	4" and over	Flanged.
Fittings	2" and under	300 lb. galvanized M.I., screwed. ANSI B16.23
	3"	150 lb. galvanized M.I., screwed. ANSI B16.3 or 125 lb. flanged cast iron. ANSI A21.10.
	4" and over	125 lb. flanged cast iron, cement lined. ANSI A21.10
Unions	2" and under	300 lb. galvanized M.I. screwed. All iron.
	3" and over	Flanged.
Flanges	3"	125 lb. C.I. screwed. ANSI B21.10.
	4" and over	Cast iron screwed ANSI A21.15. Factory installed on pipe.
Couplings	4" and over	Lock type, Dresser style 67 or equal with Buna-s or neoprene gaskets.

PIPING SPECIFICATION CI-4

Rating: 125 psig, @ 100 deg. F/38 deg. C

Item	Size	Description
Gaskets	4" and over	(Neoprene) (Natural rubber) 1/8" thick, full face.
Bolting	All sizes	ASTM A 307 Grade B, square head bolts, heavy hex nuts ANSI B1.1 and B18.2.
Lining	4" and over	D.I. pipe and fittings to be cement lined, ANSI A21.4
Expansion Joints		Body to be flanged rubber with steel reinforced rings, double or single arch. Provide split steel retaining rings on flanges. Joint to be suitable for both vacuum and pressure. Joints on discharge side of pumps to be supplied with control rods. Tapered (concentric and eccentric) joints can be used for reducer at pump flanges.
Gate Valves	2" and under	V-34
Gate Valves	2-1/2"	
Dwg. 331, 355	3" and over	V-21
Globe Valves	2" and under	V-35
Knife Gate Valves	2" and over	V-15
Butterfly Valves	3" and over	V-65
Plug Valves	2" and under	V-66
	3" and over	V-17

PIPING SPECIFICATION CI-4

Rating: 125 psig, @ 100 deg. F/38 deg. C

Item	Size	Description
Ball Valves	2" and under	V-36
Check Valves	2" and under	V-20
	3" and over	V-23

PIPING SPECIFICATION CO-9

Rating: Gravity Flow - Ambient Temp.

Item	Size	Description
Pipe	12" and Over	Reinforced Concrete ASTM C76, Class III Wall Thickness B
Joints		Tongue and Grooved, Machined end with cold applied bituminous pipe joint
Cold-Applied Bituminous Joint:		1. Manufactured from asphalt, liquifiers, mineral fillers and fibers, free from moisture. 2. Filler shall have positive adhesion to pipe surfaces. 3. Plastic and workable with trowel. 4. Plastic flow shall not occ below 27 deg. C. 5. Filler shall be type approved by Engineer. 6. Installation of bituminous joint: a. Place bituminous joint material on edges of upper half of tongue t laid and lower half of groove of pipe previou laid. b. Place sufficient joint material on each joint completely fill space between two sections. c. Fill all voids both inside and out; trowel inside smooth in pipes 600 mm and larger. d. The finished joint shal not be greater than on inch in width.

PIPING SPECIFICATION CS-2

Rating: 150 psig @ 500 deg. F.

Item	Size	Description
Pipe	Under 2"	Sch. 80 steel, seamless ASTM A 120
	2" and over	Std. weight steel, seamless, ASTM A 120
Fittings	Under 2"	3,000 lb. steel socket welding fittings ANSI B16.11
	2" and over	Std. wt. steel butt welding fittings, ANSI B16.9
Line Joints (Water Service)	Under 2"	Socket weld
	2" and over	Butt weld
(Air Service)	2" and over above grade	Butt weld, Flanged at valves
	2" and over buried	Butt Weld Flanted at valves
Expansion Joints:		Body to be flanged rubber with steel reinforced rings double or single arch. Provide split steel retaining rings on flanges. Joint to be suitable for both vacuum and pressure. Joints on discharge side of pumps to be supplied with control rods. Tapered (concentric and eccentric) joints can be used for reducer at pump flanges.
Flanges	Under 2"	150 lb. steel, socket welding, ANSI B16.11
	2" and over	150 lb. steel, weld neck or slip-on, ANSI B16.5
Bolting	All sizes	ASTM A 307 Grade B, square head bolts, heavy hex nuts ANSI B1.1 and B18.2

PIPING SPECIFICATION CS-2

Rating: 150 psig @ 500 deg. F.

Item	Size	Description
Gaskets	All sizes	1/16" thick Acrylic-Nitrile, Garlock Style 3000 or equal (Except Digester Gas) Flexitalic Style CG (Digester Gas)
Gate Valves	Under 2"	V-1
	2" and over	V-2
Butterfly Valves	All Sizes	V-65A
Check Valve Air Service Only		V-70
Plug Valves	2" and under	V-66
	3" and over	V-17
Check Valve	2" and under	V-20 (Except Digester Gas)
Water Service	2" and under	V-71 (Digester Gas)
	3" and over	V-23
Dresser Lock-Type Coupling		Style 67
Wafer Knife Gate Valve	2" and over	V-15

PIPING SPECIFICATION CS-8

Rating: 125 psig @ 350 deg. F/177 deg. C

Items	Size	Description
Pipe	2" and under	Schedule 80 steel, ASTM A 120
	3" and over	Std. wt. steel, ASTM A 120
Line Joints	2" and under	Screwed couplings
	3" and over	Butt-welded
Fittings	2" and under	125 lb. C.I., ANSI B16.3
	3" and over	Std. wt. steel butt-welding, ANSI B16.9
Unions	2" and under	300 lb. M.I., screwed, brass to iron seat
	3" and over	150 lb. flanged
Flanges	all sizes	150 lb. steel weld-neck, ANSI B16.5
Bolts & Nuts	all sizes	ASTM A307, Grade B square head bolts, heavy hex nuts, ANSI B1.1 & ANSI B18.2
Gaskets	all sizes	1/8" SBR Garlock Style 22 or equal
Gate Valves	2" and under	V-18
	3" and over	V-21
Globe Valves	2" and under	V-19
	3" and over	V-22
Check Valves	2" and under	V-20
	3" and over	V-23

PIPING SPECIFICATION CS-9

Rating: 150 psig @ 365 deg. F/185 deg. C

Item	Size	Description
Pipe	2" and under	Schedule 80 steel, ASTM A 120
	3" and over	Std. wt. steel, ASTM A 120
Line Joints	2" and under	Screwed couplings
	3" and over	Butt-welded
Fittings	2" and under	150 lb. M.I., galvanized, ANSI B16.3
	3" and over	Std. wt. steel butt-welding, ANSI B16.9
Unions	2" and under	300 lb. M.I., galvanized, screwed brass to iron seat
	3" and over	150 lb. flanged
Flanges	all sizes	150 lb. steel weld-neck, ANSI B16.5
Bolts & Nuts	all sizes	ASTM A307, Grade B square head bolts, heavy hex nuts, ANSI B1.1 & ANSI B18.2
Gaskets	all sizes	1/8" thick Acrylic Nitrile, Garlock Style 3000 or equal
Gate Valves	2" and under	V-18
	3" and over	V-2
Globe Valves	2" and under	V-19
	3" and over	V-4
Check Valves	2" and under	V-20
	3" and over	V-9

PIPING SPECIFICATION PL-4

Rating: 125 psig @ 70 deg. F/21 deg. C
70 psig @ 130 deg. F/60 deg. C

Item	Size	Description
Pipe	1/2"-4"	Schedule 80 PVC type 1
	6"	
Line Joints	all	Solvent welded couplings
Fittings & Flanges	all	Sch. 80 PVC type 1, socket type, solvent welded
Unions	1/2"-1-1/2"	Sch. 80 PVC type 1 screwed union, socket ends, solvent welded, Viton O-Ring
	2" & over	Sch. 80 PVC type 1 flanges
Bolting	all sizes	ASTM A307 grade B, square head bolts, heavy hex nuts, ANSI B1.1 & B18.2. Install type B plain washer, ANSI B27.2 under bolt head and nut
Gaskets	all sizes	EPDM, 1/8" thick, 50A shore durometer, full face
Ball Valves	1/2"-1-1/2"	V-33
	2"-6"	V-38
Check Valves	1/2"-1-1/2"	V-39
	2"-4"	V-40

PIPING SPECIFICATION PL-5

Rating: Gravity flow @ 100 deg. F

Item	Size	Description
Pipe	4"-15"	PVC sewer pipe, ASTM D3034. Standard dimension ratio (SDR) 35 max.
Joints	4"-15"	Push on or solvent weld
Fittings	4"-15"	PVC, push on or solvent weld, ASTM D3034, SDR 35 max.
Gaskets	4"-15"	Rubber, ASTM D3212

Notes:
1. Installation shall be in accordance with ASTM D2321.
2. Perforations, where required, shall be 1/2" diameter holes spaced on 5" centers in two rows 120 degrees apart.

PIPING SPECIFICATION - CLASS PL-7

Rating: Chlorine gas, vacuum only.

Item	Size	Description
Flexible Tubing	3/8" O.D. - 5/8" O.D.	0.062" wall polyethylene tubing with polyethylene compression type fittings.
Pipe	1/2" & over	Schedule 80 PVC Type 1 with Sch. 80 solvent welded socket fittings.
Unions	1/2"-1-1/2"	Schedule 80 PVC Type 1 screwed union, solvent welded socket ends, Viton o-ring.
Thread Seal	-	Teflon tape.
Ball Valves	1/2"-1-1/2"	V-33

PIPING SPECIFICATION SS-2

Rating: 150 psig @ 130 deg.F/54 deg.C.

Item	Size	Description
Pipe	1/4"-3/4"	Sch. 408 stainless steel type 316, ASTM A 312.
	1" & over	Sch.5S stainless steel type 316L, ASTM A 312.
Line Joints	1/4"-3/4"	Screwed couplings.
	1" & over	Welded aligning connectors. Flanged where shown.
Fittings	1/4"-3/4"	150 lb. screwed, type 316 stainless steel.
	1" & 2"	Sch. 5S type 316 stainless steel, butt-welding or tangential with aligning connectors.
Flanged Joints	1" - 6"	150 lb. carbon steel flanges with type 316 S.S. inserts, speedline or equal. -or- 150 lb. carbon steel lap-joint flanges with type 316L S.S. stub ends, type 'A'.
	8" & over	150 lb. carbon steel lap-joint flanges with type 316L S.S. stub ends, type 'A'.
Unions	1/4"-3/4"	150 lb. type 316 S.S. screwed unions.
Bolting	1" & over	ASTM A 307 Grade B, square head bolts, heavy hex nuts ANSI B1.1 and B18.2.
Gaskets	1" & over	1/16" thick Viton, ring type.
Ball Valves	1/4"-3/4"	V-37
	1" - 2"	V-28

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PIPING SPECIFICATION SS-2

Rating: 150 psig @ 130 deg.F/54 deg.C.

Item	Size	Description
Check Valves	1/4"-3/4"	V-57
	1" & over	V-67
Butterfly Valves	2" & over	V-29
Plug Valves	1/4-3/4	V-11, V-66
	1" & over	V-12, V-17

Valve Type	Gate
Rating	800 lb.
Working Press & Temp (WOG)	800 psig @ 850 deg. F
Working Press & Temp (Steam)	800 psig @ 850 deg. F
End Connections	Socket-welding
Body Material	Forged Steel
Bonnet Type	Bolted
Stem Type	Rising, OS&Y
Stem Material	410 S.S.
Trim Material	410 S.S.
Disc Type	Solid Wedge
Operator	Handwheel

Acceptable Valves	Sizes Available
Jenkins Fig. 8800 W	1/4" - 2"
Lunkenheimer Fig. 8002	1/4" - 2"
Vogt Fig. SW-12111	1/4" - 2"

VALVE SPECIFICATION V-2

Valve Type ..... Gate

Rating ..... 150 lb.

Working Press & Temp (WOG)..... 150 psig @ 500 deg. F

Working Press & Temp (Steam)..... 150 psig @ 500 deg. F

End Connections ..... Flanged

Body Material ..... Cast Steel

Bonnet Type ..... Bolted

Stem Type ..... Rising, OS&Y

Stem Material ..... 410 S.S.

Trim Material ..... 410 S.S.

Disc Type ..... Wedge

Operator ..... Handwheel

Acceptable Valves	Sizes Available
Crane No. 47	2" - 12"
Jenkins Fig. 1009	2" - 12"
Powell Fig. 1503N	2" - 12"

VALVE SPECIFICATION V-4

Valve Type ..... Globe

Rating ..... 150 lb.

Working Press & Temp (WOG)..... 150 psig @ 500 deg. F.

Working Press & Temp (Steam)..... 150 psig @ 500 deg. F.

End Connections ..... Flanged

Body Material ..... Cast Steel

Bonnet Type ..... Bolted

Stem Type ..... OS&Y

Stem Material ..... 410 S.S.

Trim Material ..... 410 S.S.

Disc Type ..... Plug

Operator ..... Handwheel

Acceptable Valves	Sizes Available
Jenkins Fig. 1040	2" - 8"
Lunkenheimer Fig. 1755-B2	2" - 6"
Walworth Fig. 5275-F	2" - 12"

Valve Type	Check
Rating	150 lb.
Working Press & Temp (WOG)	150 psig @ 500 deg. F.
Working Press & Temp (Steam)	150 psig @ 500 deg. F.
End Connections	Flanged
Body Material	Cast Steel
Bonnet Type	Bolted
Trim Material	Stainless Steel
Disc Type	Swing
Accessories	Valves 3" & over to have outside lever and adjustable weight.

Acceptable Valves	Sizes Available
Walworth Fig. 5341-F	2" - 24"
Crane Fig. 147	2" - 16"

Valve Type	Wafer Knife Gate
Rating	150 lb.
Working Press & Temp (WOG)	150 psig @ 190 deg. F.
End Connections	Tapped Flanges
Body Material	Steel
Bonnet Type	Bolted
Stem Type	Rising, OS&Y
Stem Material	Stainless Steel
Trim Material	Stainless Steel
Seat Material	Neoprene
Operator	Handwheel

Acceptable Valves	Sizes Available
DeZurik Fig. 827	2" - 72"

Valve Type	Gate
Rating	125 lb.
Working Press & Temp (WOG)	125 psig @ 100 deg. F.
Code	AWWA C500
End Connections	Flanged
Body Material	Cast Iron
Bonnet Type	Bolted
Stem Type	Non-rising
Stem Material	Bronze
Trim Material	Bronze
Disc Type	Wedge Gate
Operator	10" & under, 2" square nut 12" & over, enclosed gear
Accessories	Valve box & cover for buried valves.

Acceptable Valves	Sizes Available
Clow AWWA	2" - 48"
Crane No. 2485-0	2" - 8"

Note: Valves shall be tight closing under seating and unseating head. Packing shall be adjustable. Valves shall be repackable under full line pressure.

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Valve Type	Eccentric Plug
Rating	125 lb.
Working Press & Temp (WOG)	125 psig @ 100 deg. F.
Code	AWWA C500
End Connections	(Flanged)
Body Material	Semi-Steel
Bonnet Type	Bolted
Packing	BUNA
Plug Material	Semi-Steel
Trim Material	Nickel seat, S.S. bushings, nuts, bolts, stud spring. Oil impregnated S.S. bushings.
Plug Type	Eccentric Plug, Neoprene Faced
Operator	Buried valves 6" & under, 2" square nut. Exposed valves 4" & under, lever 8" & over, enclosed worm gear.
Accessories	Valve box & cover for buried valves.
Note:	1. Valve to be able to withstand 125# pressure in either direction. 2. Valve packing to be replaceable under full line pressure.

Acceptable Valves	Sizes Available
DeZurik Fig. 118	3" - 54"

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Valve Type	Gate
Rating	200 lb.
Working Press & Temp (WOG)	400 psig @ -20 deg. to 150 deg. F.
Working Press & Temp (Steam)	200 psig @ 550 deg. F.
End Connections	Screwed
Body Material	Bronze
Bonnet Type	2" & under, screwed 2-1/2"-3", bolted
Stem Type	Rising, inside screw
Stem Material	Bronze
Trim Material	Stainless Steel
Disc Type	Solid Wedge
Operator	Handwheel

Acceptable Valves	Sizes Available
Crane No. 424	1/4" - 3"
Jenkins No. 270V	1/4" - 3"

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Valve Type	Globe
Rating	200 lb.
Working Press & Temp (WOG)	400 psig @ -20 deg. to 150 deg. F.
Working Press & Temp (Steam)	200 psig @ 550 deg. F.
End Connections	Screwed
Body Material	Bronze
Bonnet Type	Union
Stem Type	Rising
Stem Material	Brass or Bronze
Trim Material	Nickel alloy
Disc Type	Renewable Plug
Operator	Handwheel

Acceptable Valves	Sizes Available
Jenkins Fig. 556P	1/4" - 2"
Crane Fig. 212P	1/4" - 3"

Valve Type	Check
Rating	200 lb.
Working Press & Temp (WOG)	400 psig @ -20 deg. to 150 deg. F.
Working Press & Temp (Steam)	200 psig @ 550 deg. F.
End Connections	Screwed
Body Material	Bronze
Bonnet Type	Screwed
Trim Material	Brass and Bronze
Disc Type	Swing

Acceptable Valves	Sizes Available
Jenkins Fig. 762A	1/4" - 3"
Crane Fig. 36	1/4" - 3"

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Valve Type	Gate
Rating	125 lb.
Working Press & Temp (WOG)	200 psig @ -20 deg. to 150 deg. F.
Working Press & Temp (Steam)	125 psig @ 450 deg. F.
End Connections	Flanged
Body Material	Cast Iron
Bonnet Type	Bolted
Stem Type	Rising, OS&Y
Stem Material	Bronze or Brass
Trim Material	Bronze
Disc Type	Wedge Gate
Operator	2"-12" Handwheel 14"-48" Enclosed gear.

Acceptable Valves	Sizes Available
Crane Fig. 465-1/2	2" - 48"
Jenkins Fig. 651A	2" - 24"

Valve Type ..... Globe

Rating ..... 125 lb.

Working Press & Temp (WOG)..... 200 psig @ -20 deg. to 150 deg. F.

Working Press & Temp (Steam)..... 125 psig @ 450 deg. F.

End Connections ..... Flanged

Body Material ..... Cast Iron

Bonnet Type ..... Bolted

Stem Type ..... Rising, OS&Y

Stem Material ..... Bronze or Brass

Trim Material ..... Bronze

Disc Type ..... Beveled

Operator ..... Handwheel

Acceptable Valves	Sizes Available
Crane Fig. 351	2" - 10"
Jenkins Fig. 613	2" - 8"

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Valve Type	Check
Rating	125 lb.
Working Press & Temp (WOG)	200 psig @ -20 deg. to 150 deg. F.
Working Press & Temp (Steam)	125 psig @ 450 deg. F.
End Connections	Flanged
Body Material	Cast Iron
Bonnet Type	Bolted
Trim Material	Bronze
Disc Type	Swing
Accessories	Valves 3" to 8" to have outside lever and adjustable weight. Valves 10" to 24" to have outside air chamber to provide slow adjustable closing speed.

Acceptable Valves	Sizes Available
Crane Fig. 383	2" - 8"
Walworth Fig. 928F	2" - 8"
GA Industries	8" - 24"

Valve Type	Ball
Rating	150 lb.
Working Press & Temp	150 psig @ 105 deg. F. 65 psig @ 140 deg. F.
End Connections	Socket
Body Material	PVC
Seal Material	Viton O-Rings
Trim Material	TFE seats
Operator	Lever

Acceptable Valves	Sizes Available
Chemtrol	1/2" - 4"
Hayward	1/4" - 6"

Valve Type	Gate
Rating	150 lb.
Working Press & Temp (WOG)	300 psig @ -20 to 150 deg. F.
Working Press & Temp (Steam)	150 psig @ 406 deg. F.
End Connections	Screwed
Body Material	Bronze
Bonnet Type	Union
Stem Type	Rising, inside screw
Stem Material	Bronze
Trim Material	Bronze
Disc Type	Solid Wedge
Operator	Handwheel

Acceptable Valves	Sizes Available
Crane Fig. 431UB	1/4" - 2"
Jenkins Fig. 49U	1/4" - 3"

Valve Type	Globe
Rating	200 lb.
Working Press & Temp (WOG)	400 psig @ -20 to 150 deg. F.
Working Press & Temp (Steam)	200 psig @ 550 deg. F.
End Connections	Screwed
Body Material	Bronze
Bonnet Type	Union
Stem Type	Rising, inside screw
Stem Material	Bronze
Trim Material	Bronze
Disc Type	Bevel
Operator	Handwheel

Acceptable Valves	Sizes Available
Crane Fig. 70	1/8" - 2"
Jenkins Fig. 750	1/8" - 2"

Valve Type	Ball
Rating	150 lb.
Working Press & Temp (WOG)	400 psig @ -20 to 150 deg. F.
Working Press & Temp (Steam)	150 psig @ 366 deg. F.
End Connections	Screwed
Body Material	Bronze
Stem Material	Brass or Bronze
Trim Material	Teflon
Operator	Lever

Acceptable Valves	Sizes Available
Jenkins Fig. 32A	1/4" - 2"
Walworth Fig. 575	1/4" - 2"

Valve Type	Ball
Rating	500 lb.
Working Press & Temp (WOG)	500 psig @ 150 deg. F.
Working Press & Temp (Steam)	150 psig @ 350 deg. F.
End Connections	Screwed
Body Material	Stainless Steel
Stem Type	Blowout-proof
Stem Material	Stainless Steel
Trim Material	S.S. & TFE
Operator	Lever

Acceptable Valves	Sizes Available
Crane Fig. 950 TF	1/4" - 2"
Jenkins Fig. 1336	1/4" - 2"

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Valve Type	Ball
Rating	150 lb.
Working Press & Temp (WOG)	150 psig @ 75 deg. F. 70 psig @ 130 deg. F.
End Connections	Flanged
Body Material	PVC
Seal Material	Viton O-Rings
Trim Material	TFE seats
Operator	Lever

Acceptable Valves	Sizes Available
Chemtrol	1/2" - 4"
Hayward	1/2" - 6"

Valve Type ..... Ball Check

Rating ..... 150 lb.

Working Press & Temp (WOG)..... 150 psig @ 75 deg. F.
70 psig @ 130 deg. F.

End Connections ..... Socket

Body Material ..... PVC

Seal Material ..... Viton O-Rings

Operator ..... Lever

Acceptable Valves	Sizes Available
Chemtrol	1/2" - 4"
Hayward	1/2" - 3"

Valve Type	Ball Check
Rating	150 lb.
Working Press & Temp (WOG)	150 psig @ 75 deg. F. 70 psig @ 130 deg. F.
End Connections	Flanged
Body Material	PVC
Seal Material	Viton O-Rings
Operator	Lever

Acceptable Valves	Sizes Available
Chemtrol	1/2" - 4"
Hayward	1/2" - 3"

Valve Type	Butterfly
Rating	150 lb.
Working Press & Temp (WOG)	150 psig @ 100 deg. F.
End Connections	Flanged
Body Material	Cast iron.
Stem Material	Stainless Steel
Trim Material	Elastomeric seat
Disc Material	Ni-resist or Bronze
Operator	Valves 6" and under, lever. Valves 6" and over, enclosed gear with position indicator.

Acceptable Valves	Sizes Available
Pratt	3" - 24"
DeZurik Fig. 632	2" - 36"

Valve Type	Butterfly
Rating	150 lb.
Working Press & Temp (WOG)	150 psig @ 250 deg. F.
End Connections	Flanged
Body Material	Cast iron.
Stem Material	Stainless Steel
Trim Material	EPDM seat
Disc Material	Ni-resist or Bronze
Operator	Valves 6" and under, lever. Valves 6" and over, enclosed gear with position indicator.

Valve Type	Eccentric Plug
Rating	125 lb.
Working Press & Temp (WOG)	125 psig @ 100 deg. F.
End Connections	Screwed
Body Material	Cast iron.
Bonnet Type	Bolted
Packing	Buna
Plug Material	C.I., Neoprene faced.
Trim Material	S.S. Bushings, nuts, bolts, stred spring. Oil impregnated bushing.
Plug Type	Eccentric
Operator	Lever

Acceptable Valves	Sizes Available
DeZurik fig. 118	1/2" - 4"

Valve Type	Check
Type	Duo Check with center post and spring return
Rating	125 psig
Operating Temperature	250 deg. F.
End Connection	Wafer Type
Body Material	Carbon Steel
Plate Material	Carbon Steel
Seat Material	Neoprene

Acceptable Valves

Mission

Valve Type ..... Check

Rating ..... 600 lb.

Working Press & Temp (WOG)..... 1480 psig @ 100 deg. F.

Working Press & Temp (Steam)..... 825 psig @ 800 deg. F.

End Connections ..... Screwed

Body Material ..... Steel

Bonnet Type ..... Bolted

Trim Material ..... Stainless Steel

Disc Type ..... Swing

Acceptable Valves	Sizes Available
Crane Fig. 174	1/2" - 2"
Vogt Series 4835	1/2" - 2"

END OF SECTION

SECTION 15177

UNDERGROUND FUEL STORAGE TANKS

PART 1 GENERAL

1.01 RELATED WORK

A. Section 15060: Piping Materials.

1.02 DESIGN CRITERIA

A. Conform to attached tank schedule.

B. Tanks to be constructed in accordance with ASTM D3299.

1.03 SHOP DRAWINGS

A. Submit shop drawings in accord with Section 01340.

B. Submit operation and maintenance manual in accord with Section 01730.

PART 2 PRODUCTS

2.01 TANKS

A. Tanks shall be reinforced fiberglass plastic, filament wound.

B. Tank shall be U. L. listed for fuel oil storage service.

C. Tanks shall be chemically inert to Petroleum products.

D. Tanks shall be capable of storing liquids with specific gravity up to 1.1

E. Tanks shall meet the following criteria:
1. External Hydrostatic Pressure: Buried in ground with three feet of over burden over top of tank. The hole fully flooded and safety factor of 3:1 against general buckling.
2. Surface Loads: When installed according to manufacturer's installation instructions, tanks will withstand surface H-20 axle loads.
3. Internal Load: Tank shall withstand 5 PSI air pressure test with 5 to 1 safety factor.
4. Operating Environment: Tank shall be able to withstand the corrosivity of the environment up to a specific gravity of 1.1 and a maximum operating temperature of 150 degrees F as well as internal corrosion due to condensation or product additives.
5. Tank to be manufactured on mandrel molded surface with material consisting of 20 mil veil glass and 90% resin inner surface.

F. Fill Tubes
   1. Tubes shall be fiber glass-reinforced plastic.
   2. Tubes shall be factory installed, 4" diameter, and shall include a 6" steel fitting with a double tapped reducer bushing to 4" diameter.

G. Fittings-Threaded - NPT
   1. All threaded fittings shall be of a material of construction consistent with the requirements of the U. L. label. All fittings to be supplied with cast iron plugs.
   2. All standard threaded fittings are 4" in diameter and shall be half couplings. Reducers are to be used for smaller sizes where specified and provided by contractor.
   3. Thread Standards - All threaded fittings shall have machine tolerances in accordance with the ANSI standard for each fitting size.
   4. Strength - NPT fittings will withstand a minimum of 150 foot-pounds of torque and 1,000 foot-pounds of bending, both with 2:1 factor of safety.
   5. Suction Line - Shall be installed on site by the contractor. Diameter of pipe and grade and schedule as called out in other sections. Pipes shall be terminated a minimum of 3" from the bottom of the tank.
   6. Return Line - Shall be installed on the site by the contractor. Diameter of pipe and grade and schedule as called out in other sections.

H. Lifting Lugs - Provide lifting lug(s) on all tanks. Lugs shall be capable of withstanding weight of tank with a safety factor of 3 to 1.

PART 3 EXECUTION

3.01 INSTALLATION

A. Tanks shall be installed with pea gravel and in accordance with current installation instructions of the tank manufacturer.

B. Tanks shall be air tested to 5 PSI at the job site.

UNDERGROUND FUEL STORAGE TANK SCHEDULE

	T-113	T-130	T-131
Tank Nominal Capacity	6,000 gal	6,000 gal	10,000 gal
Tank Size	7'8" OD x 19'3"	7'8" OD x 19'3"	7'8" OD x 30'2"
Tank Function	Digester Boiler	Emg. Generator	Emg. Generator

Liquid	No. 2 Fuel Oil	No. 2 Fuel Oil	No. 2 Fuel Oil
Nozzle:			
Fill	4" flanged	4" flanged	4" flanged
Vent	2" flanged	2" flanged	2" flanged
Supply	2" NPT	2" NPT	2" NPT
Return	2" NPT	2" NPT	2" NPT
Spare	2" NPt w/plug	2" NPT w/plug	2" NPT w/plug
Level	4" flanged	4" flanged	4" flanged
Spare	4" flanged w/blind flg.	4" flanged w/blind flg.	4" flanged w/blind flg.

END OF SECTION

SECTION 15250

PIPING AND EQUIPMENT INSULATION

PART 1 GENERAL

1.01 RELATED WORK

A. Section 15050: Piping Installation

B. Section 15060: Piping Materials

1.02 JOB CONDITIONS

A. Deliver material to job site in original non-broken factory packaging, labelled with manufacturer's density and thickness.

B. Perform work at ambient and equipment temperatures as recommended by the adhesive manufacture.

PART 2 PRODUCTS

2.01 INSULATION THICKNESS

A. Pipe and fittings sizes up to 100 mm: 25 mm.

B. Pipe and fittings sizes 150 mm and larger: 50 mm.

2.02 PIPING INSULATION - INDOORS

A. Cold Piping: Fine fibrous glass insulation, with factory applied vapor barrier jacket, molded to conform to piping, "K" value at 75 degrees F. (24 degrees C.) maximum 0.22 btu/in./sq.ft./degrees F./hr. (0.032 W/m/degrees C.).

B. Hot Piping: Fine fibrous glass insulation with factory applied standard weight canvas jacket, molded to conform to piping, "K" value at 75 degrees F. (24 degrees C.) maximum 0.22 btu/in./sq.ft./degrees F./hr. (0.032 W/m/degrees C.).

C. Aluminum jackets: 0.40 mm, corrugated.

D. Bands: 12 mm wide x 0.40 mm thick stainless steel.

2.03 PIPING INSULATION - OUTDOORS ABOVE GRADE

A. Exposed process piping shall be insulated with premolded fiberglass sectional pipe insulation with factory applied standard weight canvas jacket.

B. Fittings and valves shall be insulated with premolded insulation fittings of the same material as the pipe insulation.

C. Outdoor process piping, above grade, shall have 0.016 inch thick corrugated aluminum moisture barrier jacket.

D. Fittings and valves for jacketed pipes shall be coated with vapor seal mastic of a color to match the jackets.

PART 3 EXECUTION

3.01 PREPARATION

A. Do not install covering before piping and equipment has been tested and approved.

B. Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application. Finish with systems at operating conditions.

3.02 INSTALLATION

A. Ensure insulation is continuous through inside walls. Pack around pipes with fire proof self-supporting insulation material, fully sealed.

B. Insulate fittings and valves with premolded insulation. Do not insulate unions, flanges, strainers, flexible connections and expansion joints. Terminate insulation neatly with plastic material trowelled on bevel.

C. Finish insulation neatly at hangers, supports and other protrusions.

D. Cover insulation exposed to outdoors with aluminum jacket with bands on 8 inches (203 mm) centers. Lap joints 3 inches (76 mm) minimum and seal with compatible waterproof lap cement.

E. Cold Piping: Cover fittings and valves with insulation material and coat with vapor seal mastic of a color to match jackets.

F. Repair separation of joints or cracking of insulation.

END OF SECTION

SECTION 15400

PLUMBING SYSTEMS

PART 1 GENERAL

1.01 RELATED WORK

A. Section 15060: Pipe Materials

B. Section 15450: Plumbing Fixtures and Trim

PART 2 PRODUCTS

2.01 CLEANOUTS AND CLEANOUT ACCESS COVERS

A. Provide calked or threaded type extended to finished floor or wall surface. Ensure ample clearance at cleanout for rodding of drainage system.

B. Floor Cleanout access covers in unfinished areas: Round with nickel bronze scored frames and plates. Provide round access covers in finished areas with depressed center section to accommodate floor finish. Wall cleanouts to have chrome plated caps.

2.02 FLOOR DRAINS

A. Floor drains: Lacquered cast iron body with double drainage flange, weep holes combined two piece body reversible clamping device and adjustable nickel-bronze strainer. Shower and washroom floor drains with removable perforated sediment bucket.

B. Floor drains in equipment rooms with polished bronze funnel type strainer and extension for floating floor.

2.03 AREA DRAINS

A. Area drain: Lacquered cast iron body with adjustable collar and galvanized ductile iron locking grate.

2.04 DOMESTIC HOT WATER HEATERS

A. Provide automatic electric hot water heater storage capacity 6 gallons.

PART 3 EXECUTION

3.01 INSTALLATION

A. Bury outside water and drainage pipe minimum of 3 feet (1.0 meters).

B. Install cast iron connections from drain tile to sanitary drainage system including backwater valve, deep seal P-trap and cleanout. Provide access for servicing of backwater valve.

C. Lubricate cleanout plugs with mixture of graphite and linseed oil. Prior to building turnover remove cleanout plugs, re-lubricate and re-install using only enough force to ensure permanent leakproof joint.

D. Install vacuum breakers on plumbing lines where contamination of domestic water may occur and on boiler make-up lines, hose bibbs and flush valves.

E. Where floor drains are located over occupied areas, provide waterproof installation.

F. Install trap primer.

G. Slope drainage lines 1/4 inch per foot.

H. Install pressure reducing valves to limit maximum static pressure at plumbing fixtures to 50 psi, if necessary.

3.02 SERVICE CONNECTIONS

A. Provide all sanitary sewer services. Before commencing work check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.

B. Provide all water service. Provide thrust blocks on underground water piping. Provide sleeve in wall for service main and support at wall with reinforced concrete bridge. Caulk enlarged sleeve and make watertight with pliable material. Anchor service main inside to concrete wall.

END OF SECTION

SECTION 15450

PLUMBING FIXTURES AND TRIM

PART 1 GENERAL

1.01 RELATED WORK

A. Section 15400: Plumbing Systems

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS

A. Submit manufacturers' product data and installation instructions in accordance with Section 01340.

1.04 GENERAL REQUIREMENTS

A. Provide new fixtures, free from flaws and blemishes with finished surfaces clear, smooth and bright.

B. Provide plumbing fittings. Visible parts of fixture brass and accessories shall be heavily chrome plated.

C. Fixtures shall be product of one manufacturer. Fittings of same type shall be product of one manufacturer.

D. Protect fixtures against use and damage during construction.

1.05 JOB CONDITIONS

A. Conform location and size of fixtures and openings before rough-in and installation.

PART 2 PRODUCTS

2.01 WATER CLOSET

A. Bowl: Floor mounted, siphon jet, vitreous china, (457 mm) high close-coupled closet combination with elongated rim, insulated tank, flapper type flush valve, and china bolt caps.

B. Seat: Five ply, solid white plastic, open front extended back, less cover, complete with self-sustaining hinge.

2.02 URINAL

A. Urinal: Vitreous china wall hung, wash-out urinal with shields, integral trap integral flushing rim, removable SS strainer, (20 mm) top spud.

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B. Flush Valve: Exposed chrome plated, diaphragm type with oscillating handle, escutcheon, integral screwdriver stop and vacuum breaker.

2.03 WASH FOUNTAINS

A. Bowl: 27-1/2 inches wide by 16 inches from wall, stainless steel.

B. Accessories: Foot controlled self-closing valve, spray head, liquid soap dispenser, manual mixing valve, supporting tube, spud and strainer, operating mechanism, foot lever, combination stop, strainer and check valves.

2.04 SERVICE SINK

A. Sink: 559 mm x 457 mm enameled cast iron, plain back with wall hanger, rim guard, and cast iron P-trap (80 mm) with strainer.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install each fixture with trap, easily removable for servicing and cleaning. At completion thoroughly clean plumbing fixtures and equipment.

B. Provide chrome plated rigid or flexible supplies to fixtures with screw driver stops, reducers and escutcheons.

C. Mount wash fountain 760 mm to top of basin rim above finished floor with expansion bolts.

D. Mount urinal 560 mm to top of bowl rim above finished floor with expansion bolts.

E. Solidly attach floor mounted water closets to floor with lag screws. Lead flashing shall not hold closet in place.

F. Mount service sink 667 mm to top of sink rim above finished floor.

3.02 FIXTURES ROUGH-IN SCHEDULE

A. Rough-in fixture piping connections in accordance with following table of minimum sizes or as required for particular fixtures.

	Hot Water	Cold Water	Waste	Vent
Wash Fountain	(13 mm)	(13 mm)	(50 mm)	(32 mm)
Water Closet (Tank Type)	--	(13 mm)	(100 mm)	(50 mm)
Urinals (Flush Valve)	--	(20 mm)	(50 mm)	(38 mm)
Floor Drains	--		(80 mm)	
Service Sink			(80 mm)	

END OF SECTION

SECTION 15616

PREFABRICATED CHIMNEY & BREECHING

PART 1 GENERAL

1.01 DESCRIPTION

A. Provide low temperature boiler chimneys and boiler breeching, including clean-out section, roof thimbles, support brackets, flashing, counter flashing, rain cap, fly ash screen, cement, and all required accessories.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 11315: Digester

1.03 SUBMITTALS

A. Shop Drawings shall be submitted in accordance with Section 01340.

B. Procedures for initial firing-up and drying out of chimney shall be submitted to the Engineer for his review at least 10 days prior to the scheduled date of boiler start-up.

PART 2 PRODUCTS

2.01 CHIMNEY

A. Chimney shall be "Metalbestos" Model PS or equal, factory made double wall type, with inner wall constructed of type 316 stainless steel and outer wall of type 304 stainless steel.

B. Provide annubar air space, between inner and outer walls, not less than one inch wide.

C. Inside diameter shall be not less than recommended by the boiler manufacturer.

D. Supports, thimbles and guider shall be factory made by the same manufacturer as the chimney.

2.02 BREECHING

A. Breeching shall be the same material as the chimney.

B. Breeching shall be reinforced, with flanged connections at boiler outlet and the chimney.

C. Inside diameter shall be not less than recommended by the boiler manufacturer.

D. Breeching shall be gas tight.

E. Breeching shall be supported in place with provision for heat expansion.

F. Clean out doors shall be provided at locations convenient for access and complete dismantling of breeching.

G. A barometric damper shall be provided if required for satisfactory operation of the boiler.

PART 3 EXECUTION

3.01 INSTALLATION

A. Chimney shall be installed with silicone joint cement and silicone sealant as recommended and supplied by the chimney manufacturer.

B. Install breeching with positive slope back to boiler.

END OF SECTION

SECTION 15740

TERMINAL HEAT TRANSFER UNITS

PART 1 GENERAL

1.01 WORK INCLUDED

A. Unit heaters Hot Water.

B. Unit heaters electric.

C. Duct heaters electric.

D. Duct heater hot water.

1.02 RELATED WORK

A. Section 16152: Non-process motors

B. Section 15060: Pipe and Pipe Fittings

1.03 QUALITY ASSURANCE

A. Terminal heat transfer units: Products of manufacturer regularly engaged in production of such units and issuing complete catalog data on such product.

1.04 SUBMITTALS

A. Submit shop drawings, product data and samples in accordance with Section 01340.

B. Show mechanical and electrical requirements.

PART 2 PRODUCTS

2.01 PERFORMANCE

A. See attached schedule.

2.02 UNIT HEATERS (HOT WATER)

A. Casing: 18 gage (1.20 mm) steel with threaded connections for hanger rods.

B. Coils: Seamless copper tubing, 0.025 inch (0.64 mm) minimum wall thickness, silver brazed to steel headers, and with evenly spaced aluminum fins mechanically bonded to tubing.

C. Fan: Direct drive propeller type, statically and dynamically balanced. Horizontal models complete with sleeve bearings and fan guard. Vertical models complete with grease lubricated ball bearings.

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D. Air Outlet: Adjustable pattern diffuser on projection models and four-way louvers on horizontal throw models.

E. Hot water heater capacities are based on a water entering temperature of 200 degrees F and a water leaving temperature of 180 degrees F.

2.03 ELECTRIC HORIZONTAL UNIT HEATERS

A. All steel welded construction with baked enamel finish.

B. Built-in contactors.

C. Unit to be factory wired.

D. Provide automatic reset thermal limit switch.

E. Aluminum bladed fan wheels

F. Provide Unit mounted thermostat.

G. Power supply to unit shall be 380/220 volts, 50 Hz 3 phase, 4 wire.

H. Units shall require only one electric supply.

I. Units shall be provided with adjustable louver vanes.

J. Units to be with hanger bracket.

K. See attached electric unit heater shcedule for size and location.

ELECTRIC UNIT HEATER SCHEDULE

ITEM NO.	LOCATION	KW	CFM	THROW (Ft)	MGT. HGT	OUTLET Temp. deg.F
UH-1	Prim.Sludge Pump Station	5	460	32	11	95
UH-2	Prim.Sludge Pump Station	5	460	32	11	95
UH-3	Prim.Sludge Pump Station	5	460	32	11	95
UH-4	Septage Pump Rm	4	292	18	8	104
UH-5	Septage MCC Rm	7-1/2	545	35'	12	103
UH-6	Septage Bathroom	5	460	32	11	95
UH-7	Chlorine Cly.Rm	6	460	30	10	101
UH-8	Chlorine Cly.Rm.	6	460	30	10	101
UH-9	Chlorine Chlorinator Rm	5	460	32	11	95
UH-10	Trickling Filter Penthse.	4	292	18	8	104
Uh-11	Sludge Transfer P.S. Penthse.	4	292	18	8	104

UNIT HEATER HOT WATER SCHEDULE

Item No.	Location	MBH	CFM	GPM
UH-20	Digester Bldg. Polymer Rm	20.0	591	2.06
UH-21	Digester Bldg. Polymer Rm.	20.0	591	2.06
UH-22	Digester Bldg. Chem. Storage	20.0	591	2.06

2.04 DUCT HEATERS ELECTRIC

A. provide open coil electric duct heater size as shown on schedule.

B. Heating coils shall be the highest quality 80% nickel, 20% Chromium coiled resistance wire. The resistance wire shall be supported with reinforcing brackets. Bracket

bushings and terminal insulators shall be securely positioned and made of high grade ceramic.

C. All frame members, control box and associated sheet metal parts shall be of heavy gauge, die-formed, aluminized steel.

D. Mounting: Heaters shall be insert with flanges for duct mounting.

E. All heaters shall be UL listed for zero clearance to combustible surfaces and meet the requirements of the 1971 National Electrical Code.

F. Heaters shall be designed for side entry in a horizontal duct or side entry in a vertical duct with air flow direction as scheduled.

G. Wiring: All factory wiring in the power circuit to be insulated copper conductors rated for 105 degrees C. Wiring from each element or bank shall be brought to clearly marked terminals. A complete wiring diagram shall be furnished with each heater.

H. Overheat Controls: All heaters shall be equipped with automatic reset and manual reset disc type thermal cutouts. Fuse links are not acceptable.

I. OVercurrent protection: Fuses shall be provided in accordance with the 1971 National Electric Code on all heaters exceeding 48 amperes. All fuses shall be dual element design for cooler operation and have a 100,000 ampere, or higher, short circuit interrupting rating.

J. Provide 1/8" asbestos mill board insulating barrier between the terminal box and the duct to prevent condensation.

ELECTRIC DUCT HEATER SCHEDULE

Item No.	DH-1
Quantity:	1
Mounting:	Flanged
Duct Dimensions (inches):	
Width	34
Height	20
Heating Capacity	
KW	28
BTUH	95,564
Volts:	380
Phase:	3
Control Circuit Volts:	220V
Location	Trickling Filter Pump Sta.

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Item No.;	DH-2
Quantity:	1
Mounting:	Flanted
Duct Dimensions (Inches):	
Width	24
Height	24
Heating Capacity	
KW	28
BTUH	95,564
Volts:	380
Phase:	3
Control Circuit Volts:	220V
Location:	Chlorine Building

Item No.:	DH-3
Quantity:	1
Mounting:	Flanted
Duct Dimensions (Inches):	
Width	24
Height	24
Heating Capacity:	
KW	28
BTUH	95,564
Volts:	380
Phase:	3
Control Circuit Volts	220V
Location:	Chlorine Building

Item No.:	DH-4
Quantity:	1
Mounting:	Flanted
Duct Dimensions (Inches):	
Width	30
Height	20
Heating Capacity:	
KW	28
BTUH	95,564
Volts:	380
Phase:	3
Control Circuit Volts	220V
Location:	Sludge Transfer Pump Sta.

2.05 DUCT HEATER HOT WATER

A. Capacity and size of heaters shown on attached schedule.

B. Heating coil primary surface shall be 1/2" O. D. seamless copper tubing. Tubing shall be straight tube construction with no hair pin bends. Tubes shall be permanently expanded to form fin bond and provide burnished, work-hardened interior surface. Return bends shall be die-formed and brazed to tubes.

SECTION 15820

AIR DISTRIBUTION EQUIPMENT (FANS)

PART 1 GENERAL

1.01 RELATED WORK

A. Section 15210: Vibration Isolation

B. Section 15840: Ductwork

C. Section 16152: Non-Process Motors

1.02 QUALITY ASSURANCE

A. Conform to AMCA Bulletins regarding construction and testing. Fans shall bear AMCA certified rating seal.

1.03 SUBMITTALS

A. Submit shop drawings in accordance with Section 01340.

B. Submit with shop drawings, operating point plotted on curves.

C. Submit manufacturers' printed installation instructions.

1.04 JOB CONDITIONS

A. Do not operate fans for any purpose, temporary or permanent until ductwork is clean, bearings lubricated and fan has been run under observation.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide and install items as listed in schedule at end of this section.

B. Manufacturer named items are for standard of reference and do not necessarily limit supply to named manufacturer. Items of same physical size, function and performance are acceptable.

C. Equivalent fan selections shall not decrease motor horsepower (wattage), increase noise level, increase tip speed by more than 10%, or increase inlet air velocity by more than 20%, from that specified.

D. Fan performance shall be based on 1500 feet (460 m) above sea level.

C. Heaters shall be copper construction with non-ferrous supply, return, drain and vent connections. All threaded supply and return connections are to be MPT with large and drainable returns at the bottom. Joints between copper tubing and copper headers to be of a brazed construction.

D. Extended surface shall be aluminum plate fins, designed to cause an air flow pattern for maximum heat transfer.

E. Circuiting shall be non-trapping, drainable design to facilitate gravity drain. Coils shall produce equal surface temperature throughout the entire coil length.

F. Casings shall be fabricated from 16 gauge aluminum, designed to mount and support coils in duct work. The casing shall be furnished with a minimum of 1-1/2 inch wide flange on each of the four sides, both front and back, with mounting slots punched on 3 inch centers throughout. Coils shall not sag or bow. Center core supports to be furnished whenever finned length spans exceed 30 inches unsupported. Tubes are to fit snugly into the casing end panels with no air leakage.

DUCT HEATER HOT WATER SCHEDULE

	DH-5	DH-6
Location	Digester Bldg Basement	Digester Bldg Gas Piping Rm
Air FLow Thru Coil	4,000 CFM	3,542 CFM
Heating Load	85.3 MBH	78.5 MBH
Ent. Water Temperature	200 Deg. F	200 Deg. F
Water Temp. Drop	20 Deg. F	20 Deg. F
Heater Dimensions (Finned Surface)	36" W x 24" H	32" W x 24" H

PART 3 EXECUTION

3.01 INSTALLATION

A. Provide each hot water unit heater with shut-off valve on supply and lockshield balancing valve on return piping.

B. Provide each unit at high points with easily accessible manual air vent. If not easily accessible, extend vent to exterior surface of cabinet for easy servicing. For fan coil units and unit heaters provide float operated automatic air vents with stop valve.

END OF SECTION

2.02 SELECTION AND BALANCING

A. Provide fans capable of accommodating static pressure variations of plus or minus 10%.

B. Statically and dynamically balance fans to eliminate vibration or noise transmission to occupied areas of the building.

C. Provide belt guards on belt driven fans.

D. Provide safety screen where inlet or outlet is exposed.

2.03 PAINTING

A. Prime coat fan wheels and housing factory inside and outside. Prime coating on aluminum parts is not required.

B. Provide two additional coats of paint on fans handling air downstream of humidifiers.

2.04 FAN MOTORS

A. Conform to Section 16152.

B. 220V/1/50 for motor under 1.0 hp. 380/3/50 for motor larger than 1.0 hp.

2.05 CENTRIFUGAL BLOWER

A. Fabricate with multi-blade wheels in steel housing reinforced as necessary.

B. Provide V-belt drives with fan and motor mounted on reinforced, rigid steel base with adjustable motor mount.

C. Provide heavy duty, self-aligning, anti-friction bearings with external lubrication.

D. Provide access door and drain connection to scroll.

2.06 ROOF VENTILATOR (CONVENTIONAL)

A. Provide V-belt drives with fan and motor mounted to main housing through neoprene anti-vibration pads.

B. Provide aluminum dome type housings.

C. Provide multi-blade, rattle free, backdraft damper with felt lined blade edges, birdscreen, curb caps and roof curbs.

D. Fan manufacturer to provide roof curb and back draft damper.

2.07 INLINE FAN

A. Provide either adjustable die cast impeller blades with motor integral part of hub design or die formed blades with belt drive and motor mounted outside air stream.

B. Extend lubrication fittings to outside of fan casing. Provide terminal box.

C. Provide flanges on housing for connection of ductwork. When not connected to duct work, provide inlet cones.

D. Provide easy access to fan wheel for varying blade angle setting during air balancing.

E. Fans operating at over 1.5 inch w.g. (374 Pa) shall be of vane-axial design for improved operating efficiency.

F. Provide fan bracket support where shown on the Drawings.

2.08 PROPELLOR FAN

A. Directly connect steel or aluminum blade fans with heavy hubs to motor.

B. Provide motor with self-aligning ball or sleeve bearings and adequate lubricating arrangements.

C. Cast or die form mountings to smooth curves. Supply size to fit openings provided.

D. Provide safety screens in inlet and backdraft dampers on outlet.

E. Use neoprene vibration isolation between fan assembly and mounting plate.

2.09 INLINE ROOF VENTILATION

A. Roof ventilation to be inline fan mounted in the vertical position on a roof curb, used for intake or exhaust.

B. Intake roof ventilator to be supplied with spun aluminum dome with insect screen and back draft damper.

C. Exhaust roof ventilator to be supplied with discharge head and damper.

D. The fan shall meet the requirement of Section 2.07 INLINE FAN of this specification.

E. All inline roof ventilation shall be supplied with a roof curb.

2.10 TURBO PRESSURE BLOWER

A. Blower to be direct connected to motor with welded backward inclined centrifugal wheel.

B. Fan housing shall be all welded steel and provided with drain connection.

C. Blower and motor to be mounted on common base and be supplied with vibration pads.

D. Blower to have flanged inlet and outlet.

E. Blower will be handling water laden air and the wheel and housing shall be coated to prevent corrosion.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install fan as shown on the Drawings.

B. Set roof mounted fans on curbs.

C. Pipe drainage from centrifugal fans to floor drain.

3.02 FAN SCHEDULE

FAN NO.	LOCATION	TYPE	CAPACITY CFM	S.P. IN.(w.g.)
F-1	Primary Sludge Pump Station	Roof/ Inline		
F-2	Septage Building MCC Room	Roof	374	1/8
F-3	Septage Building Pump Room	Blower	551	1/2
F-4	Septage Building Bathroom	Roof	240	1/8
F-5	Trickling Filter Pump Station Intake	Blower	3456	0.75
F-6	Trickling Filter Pump Station	Roof	1154	0.00
F-7	Trickling Filter Pump Station	Roof	2286	0.00
F-8	Chlorine Building Cyl. Room	Wall	6050	0.25
F-9	Chlorine Building Chlorination Room	Wall	2840	1/8
F-10	Trickling Filter Penthouse	Roof	1143	0.10
F-11	Sludge Transfer Pump Station	Roof/ Inline	3820	0.625
F-12	Sludge Transfer Pump Station	Roof/ Inline	3429	0.375
F-13	Sludge Transfer Pump Station MCC Room	Roof	230	1/8
F-14 A,B,C&D	Trickling Filter Forced Ventilation	Inline	3235	0.5
F-15 A,B,C&D	Trickling Filter Forced Ventilation	Inline	3235	0.5
F-01A&B	Septage Tank	Turbo Blower	1000	8 oz.
F-20	Digester Bldg. Polymer Rm	Roof Intake Blower	1505	1/4
F-21	Digester Bldg.	Roof	1505	1/4

FAN NO.	LOCATION	TYPE	CAPACITY CFM	S.P. IN.(w.g.)
	Boiler Rm.	Intake Blower		
F-22	Digester Bldg. Chem. Storage	Roof Intake Blower	1505	1/4
F-23	Digester Bldg. MCC Rm	Roof Exhaust	223	1/4
F-24	Digester Bldg. Gas Piping Rm	Roof Explosion & Spark Proof	3635	1/4
F-25	Digester Basement	Inline Blower	3937	0.625
F-26	Digester Basement	Inline Blower	4100	1/4

END OF SECTION

SECTION 15840

DUCTWORK

PART 1 GENERAL

1.01 RELATED WORK

A. Section 15090: Supports, Anchors and Seals

B. Section 15820: Fans

C. Section 15860: Duct Accessories

1.02 REFERENCE STANDARDS

A. Fabricate in accordance with SMACNA duct manuals and ASHRAE handbooks.

B. Construct ductwork to NFPA 90A, Air Conditioning and Ventilating Systems and NFPA 90B, Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

1.03 DEFINITIONS

A. Duct Sizes: Inside clear dimensions.

B. Low Pressure: Static pressure in duct less than 2 inch w.g. (498 Pa) and velocities less than 2,000 fpm (10 meters/second).

1.04 SUBMITTALS

A. Submit in accordance with Section 01340.

B. Submit shop drawings and samples of duct fittings, including particulars such as gage sizes, welds, and configurations prior to start of work.

C. Confirm ductwork has been fabricated and installed in accordance with recommendations and SMACNA standards.

PART 2 PRODUCTS

2.01 MATERIALS

A. Ducts: Galvanized steel lock forming quality, having zinc coating of 1.25 ounces per square foot (382 g/square meter) for each side.

B. Fasteners: Use rivets and bolts throughout; sheet metal screws accepted on low pressure ducts.

C. Sealant: Water resistant, fire resistive, compatible with mating materials.

D. Flexible Ducts: Corrugated aluminum or fabric supported by helically wound steel wire or flat steel strips.

2.02 FABRICATION

A. Size round ducts installed in place of rectangular ducts from ASHRAE table of equivalent rectangular and round ducts. No variation of duct configuration or sizes permitted except by written permission.

B. Complete metal ducts within themselves with no single partition between ducts. Where width of duct exceeds 18 inches (457 mm), cross break for rigidity. Open corners are not acceptable.

C. Lap metal ducts in direction of air flow. Hammer down edges and slips to leave smooth duct interior.

D. Where rectangular elbows are used, provide air foil type turning vanes.

E. Increase duct sizes gradually, not exceeding 15 degrees (0.26 rad) divergence wherever possible. Maximum divergence upstream of equipment to be 30 degrees (0.52 rad) and 30 degrees (0.52 rad) convergence downstream.

F. Rigidly construct metal ducts with joints mechanically tight, substantially airtight, braced and stiffened so as not to breathe, rattle, vibrate, or sag. Caulk duct joints and connections with sealant as ducts are being assembled.

G. Provide easements where low pressure ductwork conflicts with piping and structure where easements exceed 10% duct area, split into two ducts maintaining original duct area.

2.03 LOW PRESSURE DUCT GAGES

A. Rectangular Ducts

Maximum Width In Inches (mm)	Minimum USS Gage (mm)
Up to 12 (305)	26 (0.50)
13 to 30 (330 to 762)	24 (0.60)
31 to 54 (787 to 1372)	22 (0.80)
55 to 84 (1397 to 2134 mm)	20 (0.90)
85 and Over (8159)	18 (1.20)

B. Round Ducts

Duct Diameter In Inches (mm)	Minimum USS Gage (mm)
Up to 13 (330 mm)	26 (0.50)
14 to 22 (356 to 559)	24 (0.60)
23 to 36 (584 to 914)	22 (0.80)
37 to 50 (940 to 1270)	20 (0.90)
51 to 60 (1295 to 1524)	18 (1.20)
61 to 84 (1549 to 2134)	16 (1.50)

PART 3 EXECUTION

3.01 INSTALLATION

A. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

END OF SECTION

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SECTION 15860

DUCT ACCESSORIES

PART 1 GENERAL

1.01 RELATED WORK

A. Section 15840: Ductwork.

1.02 REFERENCE STANDARDS

A. Accessories shall meet the requirements of NFPA 90A, Air Conditioning and Ventilating Systems.

B. Fabricate in accordance with ASHRAE handbooks and SMACNA duct manuals.

1.03 SUBMITTALS

A. Submit in accordance with Section 01340.

B. Submit shop drawings of factory fabricated assemblies.

C. Submit manufacturers' printed installation instructions.

PART 2 PRODUCTS

2.01 DAMPERS

A. Fabricate of galvanized steel, minimum 16 gage (1.5 mm), and provide with quadrants or adjustment rod and lock screw.

B. Fabricate splitter dampers of double thickness sheet metal to streamline shape, properly stiffened to avoid vibration. Size on basis of straight air volume proportioning.

C. Fabricate single blade dampers for duct sizes to 9-1/2 inch x 30 inch (241 mm x 762 mm).

2.02 FLEXIBLE CONNECTIONS

A. Fabricate of neoprene coated flameproof fabric approximately 2 inch (51 mm) wide tightly crimped into metal edging strip and attach to ducting and equipment by screws or bolts at 6 inch (152 mm) intervals.

B. Provide flexible connections immediately adjacent to equipment in ducts associated ducts associated with fans and equipment subject to forced vibration.

Duct Diameter In Inches (mm)	Minimum USS Gage (mm)
Up to 13 (330 mm)	26 (0.50)
14 to 22 (356 to 559)	24 (0.60)
23 to 36 (584 to 914)	22 (0.80)
37 to 50 (940 to 1270)	20 (0.90)
51 to 60 (1295 to 1524)	18 (1.20)
61 to 84 (1549 to 2134)	16 (1.50)

PART 3 EXECUTION

3.01 INSTALLATION

A. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

END OF SECTION

PART 3 EXECUTION

3.01 INSTALLATION

A. Install items in accordance with manufacturer's printed instructions.

B. For connections to medium and high pressure fans, install 1/2 inch (12 mm) thick neoprene pad over fabric and hold in place with additional metal straps.

END OF SECTION

SECTION 15890

DUCT SUPPORTS AND SEALS

PART 1 GENERAL

1.01 WORK INCLUDED

A. Duct hangers and supports.

B. Flashing for mechanical equipment.

C. Sleeving for mechanical equipment.

1.02 RELATED WORK

A. Section 15840: Ductwork

1.03 REFERENCE STANDARDS

A. Duct Hangers: SMACNA Duct Manuals.

PART 2 PRODUCTS

2.01 INSERTS

A. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms.

B. Size inserts to suit threaded hanger rods.

2.02 DUCT HANGERS AND SUPPORTS

A. Hangers: Galvanized steel band iron or rolled angle and 3/8 inch (9.5 mm) rods.

B. Wall Supports: Galvanized steel band iron or fabricated angle bracket.

C. Vertical Support at Floor: Rolled angle.

2.03 FLASHING

A. Steel Flashing: 26 gage (0.50 mm) galvanized steel.

B. Caps: Steel, 22 gage (0.80 mm) minimum, 16 gage (1.50 mm) at fire resistance structures.

2.04 SLEEVES galvanized steel.

A. Round Ducts: Form with galvanized steel.

B. Rectangular Ducts: Form with galvanized steel or wood.

C. Size large enough to allow for movement due to expansion and to provide for continuous insulation.

PART 3 EXECUTION

3.01 INSERTS

A. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.

B. Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying ducts over 60 inches (1524 mm) wide.

C. Where concrete slabs form finished ceiling, finish inserts, flush with slab surface.

D. Where inserts are omitted, drill through concrete slab from below and provide rod with recessed square steel plate and nut above slab.

3.02 LOW VELOCITY DUCT HANGERS AND SUPPORTS

A. Hanger Minimum Sizes:
1. Up to 30 inches (762 mm) wide: 1 inch (5.4 mm) x 16 ga (1.50 mm) at 10 feet (3.05 m) spacing
2. 31 inches (787 mm) to 48 inches (1200 mm) wide: 1-1/2 inches (38 mm) x 16 ga. (1.50 mm) at 10 feet (3.05 m) spacing
3. Over 48 inches (1219 mm) wide 1-1/2 inches (38 mm) x 16 ga (1.50 mm) at 8 feet (2.44 mm) spacing:

B. Horizontal Duct on Wall Supports Minimum Sizes:
1. Up to 18 inches (457 mm) wide: 1-1/2 inches (38 mm) x 16 ga (1.50 mm) or 1 inch x 1 inch x 1/8 inch (25 x 25 x 3.2 mm) at 8 feet (2.44 m) spacing
2. 19 inches (483 mm) to 40 inches (1016 mm) wide: 1-1/2 inches x 1-1/2 inches x 1/8 inches (38 x 38 x 3.2 mm) at 4 feet (1.22 m) spacing.

C. Vertical Duct on Wall Supports Minimum Sizes:
1. At 12'-0 inch (0.305 m) spacing;
2. Up to 24 inches (610 mm) wide: 1-1/2 inches (38 mm) x 16 ga.; 25 inches (635 mm) to 36 inches (914 mm) wide: 1 inch x 1 inch x 1/8 inch (25 x 25 x 3.2 mm);
3. 37 inches (940 mm) to 48 inches (1219 mm) wide: 1-1/4 inches x 1-1/4 inches x 1/8 inches (32 x 32 x 3.2 mm).

D. Vertical Duct Floor Supports Minimum Sizes:
1. Riveted or screwed to duct;
2. Up to 60 inches (1524 mm) wide: 1-1/2 inches x 1-1/2 inches x 1/8 inches (38 x 38 x 3.2 mm);
3. Over 60 inches (1524 mm) wide: x 2 inches x 1/8 inches (51 x 3.2 mm):

3.03 MEDIUM AND HIGH VELOCITY DUCT HANGERS AND SUPPORTS

A. Rectangular Duct Hangers Minimum Sizes:
   1. Up to 36 inches (914 mm) wide: 2 at 1 inch (25 mm) x 16 ga. (1.50 mm) at 10 feet (3.05 m) spacing
   2. 37 inches (940 mm) to 60 inches (1524 mm) wide: 2 at 1 inch (25 mm) x 16 ga (1.50 mm) at 8 feet (2.44 m) spacing and 2 inches x 2 inches x 1/4 inch (51 x 51 x 6.4 mm) trapeze x 2-1/2 inches x 3/16 inch (64 x 64 x 4.8 mm) trapeze;

B. Round Duct Hangers Minimum Sizes:
   1. At 10 feet (3 m) spacings;
   2. Up to 18 inches (457 mm) diameter: 1 inch (25 mm) x 16 ga. (1.50 mm)
   3. 19 inches (483 mm) to 36 inches (914 mm) diameter: 1 inch (25 mm) x 12 ga. (2.50 mm)
   4. 37 inches (940 mm) to 50 inches (1270 mm) diameter: 1-1/2 inches (38 mm) x 12 ga. (2.50 mm)

C. Vertical Duct Floor Supports Minimum Sizes:
   1. Rivet to duct and tie angles together with rod, angles or cinch band.
   2. Up to 48 inches (1219 mm) wide: 1-1/2 inch x 1-1/2 inch x 1/8 inch (38 x 38 x 3.2 mm);

D. Angle reinforcing may be used for support omitting trapeze.

3.04 PRIMING

3.05 FLASHING

A. Flash and counterflash where mechanical equipment passes through weather or water proofed walls, floors, and roofs.

B. Flash vent and soil pipes projecting 3 inch (76 mm) minimum above finished roof surface with lead worked 1 inch (25 mm) minimum into hub, 8 inch (203 mm) minimum clear on sides with minimum 24 inch x 24 inch (610 mm x 610 mm) sheet size. For pipes through outside walls turn flange back into wall and caulk.

C. Flash floor drains over finished areas with lead 10 inch (254 mm) clear on sides with minimum 36 inch x 36 inch (914 mm x 914 mm) sheet size. Fasten flashing to drain clamp device.

3.06 DUCT SLEEVES

A. Set sleeves in position in advance of concrete work. Provide suitable reinforcing around sleeves.

B. Extend sleeves through potentially wet floors 1 inch (25 mm) above finished floor level. Caulk sleeves full depth and provide floor plate.

C. Where ductwork passes through floor, ceiling or wall close off space between pipe or duct and construction with non-combustible insulation. Provide tight fitting metal caps on both sides and caulk.

END OF SECTION

SECTION 16010

ELECTRICAL - GENERAL

PART 1 GENERAL

1.01 RELATED WORK

A. Section 13440: Instrumentation General.

1.02 DESCRIPTION

A. The electrical work shall include, but is not limited to, the following:
   1. Power Distribution System
   2. Lighting System
   3. Motor Control System
   4. Ground Systems
   5. Instrumentation and Control Systems Wiring

B. The instrumentation work covered under the provisions of this Section includes furnishing and installing wire, conduit, ductwork, raceway support, wire labeling, wiring connections as required by the wiring drawings prepared by the Instrumentation and Control System Vendor for all equipment specified in Section 13440. The instrumentation wiring shall conform to Section 13440.

1.03 STANDARDS

A. The work manufactured and furnished under this Specification shall conform to the following:
   1. Applicable Federal, State and Local Codes, Ordinances and Regulations in force in the locality of the Project.
   2. Regulations of local utility.
   3. Applicable standards of ANSI, IEEE, ISA, NEMA, UL and NEC.

B. Where standards differ, the Contractor shall state which standard applies. Unless modified by provisions of this specification, these standards apply, whether mentioned in the text or not. The Contractor shall also note where existing standards are not satisfied or only partially satisfied. Where non-standard hardware, or services are offered, the Contractor shall defend their adequacy in relation to the functions to be performed, and the cost of fully satisfying existing standards.

C. All materials, equipment and lighting fixtures shall bear a UL label or shall be UL listed, unless UL does not have an examination service for the item in question.

D. Before submitting Tenders, consult the above necessary provisions for Tender, and call to the Engineer's attention, any work conflicting with the above codes,

regulations and requirements so proper addendum may be issued.

1.04 ELECTRICAL WORK

A. In addition to requirements specified under other sections of electrical work, the following work shall be included:
1. Furnish all labor; and furnish, install, connect, test and adjust all equipment and materials to form a complete operating installation, including without limiting the generality of the foregoing: hangers, supports for equipment, cables, conduits, pull boxes, anchors and inserts; identification plates; signs and tags for equipment, conduits, wiring, and wire labels.
2. Clean and lamp all lighting fixtures after installation and wiring. Install all fuses. All lighting fixtures shall be clean at time of final acceptance.
3. Wire and connect all electrical equipment which has been split or sectionalized for shipping purposes.
4. Provide all wiring during testing and trials, for all required corrections, changes, additions, completions and adjustments until final acceptance of the Work.
5. Coordinate numbers and label all field wiring between equipment of the various electrical equipment suppliers.
6. Install the electrical work in a manner and at times to minimize cutting and patching of the building structure.
7. Repair any damage to work already in place, as a result of electrical work at no expense to the Owner.
8. Provide all sleeves, inserts, and other embedded items required in the Work.
9. Provide all conduit, wiring, wiring devices and connections for the instrumentation and control.
10. Provide all conduit, wires, and switches necessary for heating, air conditioning, ventilating fans, lighting fixtures and ballasts, motors, and other electrical loads.
11. Provide all wires, cable, wiring devices, conduits, manholes, ductbanks and ducts, including excavation and backfill for underground conduits.
12. Provide all starters, contactors, circuit breakers, pushbuttons, limit switches, float switches, relays, including structural supports as shown on the Drawings, specified herein, and as required.

1.05 OUTAGES

A. Schedule any and all power outages required during construction with the Owner.

1.06 SHOP DRAWINGS AND MANUALS

A. Submit Shop Drawings in accord with Section 01340 giving performance data, physical size, wiring diagrams, and materials, on following items:
1. Lighting fixtures

2. Motor control centers and motor controllers
3. Substations and switchgear
4. Panelboards
5. Pushbutton stations
6. Conduit
7. Cable and wire
8. Terminal panels and pull boxes
9. Emergency generators

B. Submit Shop Drawings showing detailed conduit routing, wiring and equipment locations in accord with Section 01340.

C. Submit Operation and Maintenance Manuals for substations, switchgear, motor control centers, emergency generators, and panelboards in accord with Section 01730.

D. Identify requirements of each electrical system before submission of Shop Drawings. Identify all necessary accessory parts required between items of electrical equipment (on separate drawings, if necessary, showing the particular system) in sufficient detail to prove that the total equipment furnished and installed will operate as specified and shown on the Drawings.

1.07 FINAL ACCEPTANCE

A. The Engineer will consider final acceptance of the power and control systems when all wiring considered as a complete system functions to operate all connected electrical equipment in the manner as indicated in the detailed specifications and Drawings. Complete the following before acceptance:
1. Motors shall be connected to protective devices and control panels to provide proper motor acceleration, and correct motor rotation as shown on the Drawings and as required by the driven equipment.
2. Control wiring shall be connected to all the control devices associated with a machine or a group of machines to produce the correct operating, timing and sequencing necessary for the proper functioning of the mechanical equipment as set forth by the Specifications.
3. All necessary adjustments and alterations necessary from start of operations.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 16111

CONDUIT

PART 1 GENERAL

1.01 RELATED WORK

A. SECTION 16010: Electrical General

1.02 INTERFACE WITH ADJACENT WORK

A. The conduit shown on the Drawings is schematic. Schematic does not mean the system design may be changed. Schematic only refers to the exact run of a raceway between given points.

B. The Drawings indicate approximate locations of outlets, apparatus and equipment.

C. Secure all Shop Drawings affecting conduit termination to equipment to verify conduit locations before installation.

D. Coordinate the locations of outlets, apparatus and building equipment, to avoid interference with other trades.

E. Actual routing, location and termination shall be governed by structural conditions, obstructions and the verification of Shop Drawings by the Contractor.

1.03 REGULATORY REQUIREMENTS

A. Conform to NEC.

B. Conduits shall have a UL Label.

PART 2 PRODUCTS

2.01 CONDUIT

A. Material: rigid threaded both ends, hot-dipped galvanized after threading.

B. Furnish conduit in straight 10 foot lengths free from defects.

C. Threads: conform to standard pipe thread length specifications.

D. Couplings: threaded.

E. Fittings: threaded malleable iron, cadmium plated with internal protection for wires against abrasion.
1. Do not reduce or restrict nominal inside diameter of conduit.

2. Provide gasketed covers for fittings used outdoors, or in wet locations.
3. Provide expansion fittings with bonding jumpers compatible with conduit material.

2.02 FLEXIBLE CONDUIT

A. Acceptable manufacturer: Thomas and Betts, Appleton, or equal.

B. Material: Aluminum Steel armour Flexible plastic jacketed type with liquidtight connectors. Minimum size 3/4 inch.

C. Connectors: provide internal protection to wires from abrasion. Do not restrict or reduce internal diameter of conduit. Have captive locking rings.

D. Flexible conduits where used in Class I areas shall be labeled for Class I areas.

2.03 CONDUIT RACKS

A. Material: galvanized steel channel, prefabricated.

2.04 CONDUIT DRAIN SEAL

A. Acceptable manufacturer: Crouse-Hinds Model EZD, Appleton Model SF, or equal.

PART 3 EXECUTION

3.01 SIZING

A. Size conduit so the required number conductors can be installed without injury to the insulation or excessive strain.

B. Conduit sizes shown on the Drawings are minimum sizes. The smallest conduit permitted are as follows:
1. Above grade: 3/4 inch.
2. Below grade: one inch.

C. Maximum size of conduit cast in concrete: 1/6 of the least dimension of the concrete member.

3.02 INSTALLATION

A. All conduit unless specified otherwise in these specifications or on the drawings will be rigid.

B. Where specifically shown on the Drawings use electrical metallic tubing.

C. Where specifically shown on the Drawings provide conduits and fittings PVC coated.

D. Install conduits in straight lines with no long bends.

E. Route exposed conduits parallel to or perpendicular to building lines.

F. Where 3 or more conduits are surface mounted and grouped together, install conduit on conduit racks.

G. Install conduits rigidly with supports spaced not more than 2.5 meters apart. Support single exposed conduits as follows:
   1. On masonry: use straps.
   2. On beams: use beam clamps.

H. Install exposed conduits with right angle turns made with manufactured elbows, cast metal fittings or symmetrical bends.

I. Do not fasten conduit to other pipe. Install conduit to allow removal of other pipe for repairs.

J. Install conduits embedded in concrete to require no cutting, bending or displacement or reinforcement from its proper location.
   1. Locate conduits as close as possible to the center of the slab.
   2. The minimum spacing of conduits shall be 150 mm outside to outside.

K. Route conduit to avoid steam and water pipes and heat sources. Install conduit above steam and water pipes. Provide the following minimum separation:
   1. Water pipe 75 mm.
   2. Steam pipes: 300 mm
   3. Flues: 300 mm
   4. Heat sources: 300 mm.

L. Make conduit field cuts square. Ream cut ends on the inside before threading.

M. Do not leave threads exposed where all-thread nipples are used.

N. Install conduits continuous from outlet to outlet, and from outlets to cabinets, junction or pull boxes. Secure conduits to all boxes so each system is electrically continuous from point of service to all outlets. Only threaded connections are acceptable.

O. Where conduits terminate in outlet boxes, cabinets, and troughs, use locknuts and bushings to join the parts and effect good electrical connections for grounding purposes. Use insulating bushings on all conduit thread ends.

P. Weatherproof conduit systems exposed to the weather or where there is danger of water from condensation.

Q. Encase all conduit risers through floor slabs or from below grade to a point not less than four inches above finished grade of floor. Slope top away from conduits for drainage.

R. Clean conduit by swabbing interior before pulling wire. Do not leave parts of swab in conduit.

S. Do not install conduit under acid or water tanks.

3.03 WEATHERPROOFING

A. Make all threads sharp and clean.

B. Brush threads lightly with an electrically conductive sealing compound.

C. Keep exposed threads to a minimum.

D. Conform to NEC for installations in damp or wet locations.

E. Install drain seal and fittings in all vertical conduit runs terminating in pushbuttons, motors, receptacles, and other similar devices at the point where seal will be most effective in keeping water out of equipment.

F. Where conduits terminate in outlet boxes, cabinets, troughs and other similar devices, use weatherproof hubs to join the parts and effect good electrical grounding connections.

G. Provide condensate drainage points in the low points of conduit runs subject to temperature variations. Install seal fittings or devices to stop air passage in conduits, between areas with temperature variations to minimize water accumulation in the conduit system.

H. Install a 12 gauge galvanized steel "fish" wire in all empty conduits or instrument conduits with less than 60% rated fill.

3.04 BENDS

A. The number of bends and offsets between pull points shall not exceed three 90 degree bends.

B. When conduit runs exceed the equivalent of 45 meters of straight run or contain more than three 90 degree bends, provide pull fittings.

C. One 90 degree bend is equivalent to 15 meters straight run.

D. Use factory elbows wherever possible. Where field bends are required, make bends with proper bending tools.

E. Do not heat conduits to facilitate bending.

F. No radius shall be less than the published standards for factory bent elbows.

3.05 SUPPORTS

A. Mount all junction boxes, cabinets, switches and other electrical equipment solidly and independent of the conduit system.

B. Support conduits every 2.5 meters, maximum.

C. Do not cut, drill or burn structural steel for conduit installation.

3.06 PROTECTION

A. Protect conduit immediately after installation with flat non-corrosive, metallic discs and steel bushings, plastic caps or plugs, at each end. Do not remove protection until necessary for pulling cable.

B. Install phenolic insulating bushing on each end of each conduit prior to pulling cable.

3.07 FLEXIBLE CONDUIT

A. Flexible conduit shall be used as indicated and where vibration is a factor such as with motors and where there is restricted space. Use flexible conduit to join the rigid conduit to the motor, equipment, or device. Use the minimum practicable length except as otherwise specified herein.

3.08 FITTINGS

A. Install fittings with covers to the side or bottom.

B. Provide expansion fittings and bonding jumpers at expansion joints of the building and every 50 meters of straight conduit run.

3.09 IDENTIFICATION

A. Identify conduits at every junction box and termination with 20 mm diameter brass tag, with stamped identification indicating the system and voltage. Attach tag with soft brass wire.

END OF SECTION

SECTION 16120

WIRE AND CABLE

PART 1 GENERAL

1.01 RELATED WORK

A. Section 16010: Electrical General.

B. Section 16111: Conduit.

C. Section 16161: Grounding.

1.02 WIRING SYSTEM

A. Size wires in accord with the Drawings or codes, whichever requires the larger size.

1.03 MARKING

A. Mark size, grade of insulation, voltage capacity, manufacturer's name and UL label on the wires and cables at regular intervals.

1.04 WIRE MANUFACTURE AND TEST

A. Manufacture and test wire and cable according to the following:
1. Rubber and rubber-like insulated: IPCEA Publ. No. S-19-81.
2. Thermoplastic insulated: IPCEA Publ. No. S-61-402.
3. Cross-linked polyethylene: IPCEA Publ. No. S-66-524.

1.05 REGULATORY REQUIREMENTS

A. Conform to the following:
1. National Electric Code
2. National Electrical Safety Code

1.06 REFERENCE STANDARDS

A. Insulated Power and Cable Engineer's Association (IPCEA)
1. S-19-81: Rubber-insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
2. S-61-402: Thermoplastic-insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
3. S-66-524: Cross-linked-thermosetting-polyethylene-insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

1.07 SUBMITTALS

A. Submit cable Shop Drawings in accord with Section 01340.

B. Submit cable splicing materials and methods for cables above 600 volts.

C. Submit splicing schedule for cables above 600 volts in accord with Section 01340. Show the following for each splice:
   1. Identify spliced cable and location of splices.
   2. Identify type of splice related to type of cable and approved splice Shop Drawings.

D. Submit certified insulation test records in accord with Section 01340.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Specified Products: General Electric.

B. Acceptable substitutions: Okonite, Rockbestos, or equal.

C. Substitutions: Items of same function and performance are acceptable in conformance with Section 01630.

2.02 CONDUCTORS

A. Copper: 98 percent conductivity

2.03 CONDUCTOR SIZE

A. Minimum conductor size:
   1. Power conductors: No. 12 AWG.
   2. Control conductors: No. 14 AWG.

2.04 CONDUCTOR INSULATION

A. Type XHHW: UL labeled, moisture and heat resistant, cross-linked, thermosetting, polyethylene, 600 volt, for conductor temperatures: 75°C wet or dry locations.

B. Type PVC coated XHHW: Moisture and heat resistant, cross-linked, polyethylene, coated with PVC 600 volt, for conductor temperature: 75°C wet or dry locations.

2.05 POWER WIRE AND CABLE

A. 600V Single Conductor Cable: single conductor, stranded, copper, XHHW, manufactured by General Electric, catalog number SI-58053.

B. 600V Multi-conductor Cable sizes 12 AWG through 500 MCM: consist of single conductor cable, specified above, identified according to paragraph 5.6.1 of IPCEA S-19-81, cabled together with bare, stranded, ground conductor(s), minimum size 12 AWG with total area equal to 50% of total circular mil area of power conductors, and suitable fillers in the interstices giving the completed cable a

circular cross section. Provide Flamenol overall jacket, manufactured by General Electric, Catalog Number S1-58281.

C. 15KV Single Conductor Cable, stranded, conductor covered with semi-conducting tape and XHHW insulation covered with a semi-conducting coating and tape with a bare copper concentric wire shield and polyester film tape all covered with a PVC jacket. Cable shall be for an ungrounded neutral system with 133% insulation level.

2.06 CONTROL WIRE AND CABLE

A. Single conductor cable: single conductor, 7 strand copper, 12 or 14 AWG with 30 mil thick XHHW insulation, manufactured by General Electric Catalog Number S1-58053.

2.07 PORTABLE CORDS

A. Portable cords: consist of flexible, bunch stranded, plain annealed copper conductors with a 600 volt heat and moisture resistant rubber insulation for conductor temperature of 60°C. Color code individual conductors and cable with a green ground conductor and suitable high strength fillers giving completed cable a circular cross section. Provide heavy duty neoprene overall jacket. Conform to NEC type SO and to IPCEA Specification S-19-81.

2.08 SINGLE CONDUCTOR CONNECTORS

A. Compression connections: crimp type, insulated, manufactured by Thomas and Betts Stakon type, Burndy Hylug type, or equal.

B. Bolted Connections: clamp or bolted type manufactured by Thomas and Betts Locktite type, or equal.

2.09 CABLE CONNECTORS

A. Type: splice and connection kits as recommended by cable manufacturer.

2.10 LUBRICANTS

A. Lubricants for pulling wire and cable: nonflammable types having a neutral effect on both metallic and non-metallic materials, with no aging or deteriorating effect on natural or synthetic covering of wire.

PART 3 EXECUTION

3.01 INSTALLATION

A. Conform to manufacturer's instructions.

B. Cable pulling forces shall not exceed cable manufacturer's recommended maximum values.

C. Where single conductor wire is used in large boxes, group single conductor wires comprising a circuit and lace together using nylon self-locking cable ties.

D. Identify all conductors by circuit number and phase, at each terminal or splice connection. Color code control wires. Identify and color code wires with adhesive backed cable marking tapes of subsurface printed polyester film suitable for a temperature range of -20 degrees C to 40 degrees C.

E. Where cables are supported by cableracks or tray, lace cables to rack or tray rungs with nylon self-locking cable ties.

F. Where multiple circuits are run together in a single conduit, increase wire sizes in accord with NEC to allow for derated ampacities.

3.02 CONNECTIONS

A. Install conductors continuous from box to box. Splices are not permitted in conduits.

B. Make splices, taps or connections for 600 volt cable using compression type connectors, unless otherwise specified.

C. Where terminals, lugs, connections or splices are to be used or made for 600 volt cable, it is of prime importance that proper adhesion between wires and connectors is provided to secure maximum mechanical strength and electrical conductiveity. Wrap splice connection with insulation putty in tape form until two times the cable insulation thickness is reached and cover with at least two layers of plastic electrical tape manufactured by Scotch, type 33, Plymouth, type 7, or equal. Friction tape is not permitted.

D. Make high voltage cable termination only by experienced mechanics.

E. Install high voltage cables, continuous, from origin to termination. Where continuous runs are impossible, splice cables in manholes as specified below:
   1. Make splices in cables which have a metallic shield with grounding conductor brought out from the splice and connected to the system ground conductor in the manhole.

F. When continuous runs of control alarm and instrumentation cables from origin to termination are impossible, splice cable with waterproof RFI junction box with terminal panels.

G. Make cable splices in manholes within the packed span of the cables. Splices are not permitted within 3 feet of the ductbank bell-end in which the spliced cable is installed.

H. Cable splices are not permitted in the ducts of the ductbank.

I. Do not make cable splices until after the cable is installed in the ductbanks of the underground system.

3.03 TESTS

A. After the installation of apparatus and wiring, test all electrical conductors to insure continuity, phasing, proper splicing, freedom from unwanted grounds, and insulation values in accordance with Underwriters requirements.

B. Use a 1000 volt hand driven megger on all 480 volt service conductors and a 500 volt hand driven megger on all lower voltage service conductors. Isolate conductors from other equipment during test.

C. Check all cables above 600 volts with a high potential DC non-destructive "Proof Test" in accordance with IPCEA Recommendations.

D. Apply all megger and high potential tests of multiple conductor cables between one conductor and ground with all other conductors connected to the same ground. Test each conductor in like manner.

E. Replace all wiring not conforming to cable manufacturer's recommended, minimum megger readings.

F. Make tests with all conductor splices and terminations completed and with lightning arrestors removed and disconnections made at points of final termination.

END OF SECTION

SECTION 16131

BOXES AND WIRING TROUGHS

PART 1 GENERAL

1.01 RELATED WORK

A. Section 16010: Electrical - General.

1.02 REFERENCE STANDARDS

A. Conform to the following:
1. National Electric Code.

PART 2 PRODUCTS

2.01 TYPES

A. Boxes and troughs: standard code boxes of proper size and design for use in location shown or specified.

B. Provide boxes and troughs UL approved, vaporproof, weather-proof or explosion-proof where required by code or Drawings.

C. Boxes for use in dry locations, unless otherwise specified: steel, either hot-dip galvanized or rust-proofed after fabrication with one coat of zinc chromate primer and one coat of tough enamel. Provide gasketed covers fastened with Minimum No. 10 brass machine screws.

D. Boxes in finished non-hazardous areas: galvanized or sherardized formed sheet steel with plaster rings and fixture studs where required, 4 inch octagonal, 2-1/8 inches deep for exposed or hung ceiling work and 3 inches deep for poured concrete work.

E. Boxes for use in wet locations or outdoors: galvanized cast iron for steel conduits, with gasketed cover, conduit bosses, and mounting lugs.

F. Provide ground lugs or bushing suitable for grounding to the equipment ground system for all boxes.

2.02 TERMINAL STRIPS

A. Acceptable manufacturers: Allen Bradley, Bulletin 1492, Square D Class 9080, or equal, rated as follows for:
1. All instrument junction boxes and/or terminal panels rated 300 volts.
2. Control junction boxes and/or terminal panels rated 600 volts.

B. Provide required number of terminal strips with 25% spare terminal.

C. Provide terminal strips only in boxes required for instrument and control cable splices and taps.

2.03 SIZE

A. Size wiring troughs, pull and junction boxes and manholes for the number and size of conductors and conduits in accord with the National Electrical Code.
   1. Group wires by circuit and tie with ty-raps, where unjacketed single conductors are used.
   2. For cables 500 MCM and above, group cables by circuit and tape with glass tape to restrict damage in case of fire.

B. Keep the box depth to a minimum. Arrange conduit runs involving boxes with the maximum number of conduits in a vertical plane for vertical boxes and in a horizontal plane for horizontal boxes.

C. Size termination boxes or panels to accomodate terminal strips. Space terminal strips not closer than four inches to the side wall of the box and eight inches on centers.

PART 3 EXECUTION

3.01 MOUNTING

A. Install boxes and troughs at least 0.5 meters above finished floor.

B. Set off all boxes and troughs attached to vertical surfaces not less than 25 mm and not more than 50 mm from surface.

C. Provide fixture studs in outlet boxes securely fastened to the boxes.

D. Mount outlet boxes for lighting switches 1.2 meters above finished floor to center of box.

E. Mount boxes for receptacles in process areas 1 meter above finished floor to center of box.

3.02 VOLTAGE SEPARATION

A. Provide separate terminal boxes for different voltages, or use code approved barriers in the boxes to separate the voltages.

3.03 IDENTIFICATION

A. Provide identification labels on box cover plates to identify function and voltage levels within.

END OF SECTION

599 545

SECTION 16141

SWITCHES

PART 1 GENERAL

1.01 RELATED WORK

A. Section 16131: Boxes and Wiring Troughs

1.02 REGULATORY REQUIREMENTS

A. Switches located in hazardous areas shall be suitable for Class I, Division IandClass I, Division II areas.

1.03 SUBMITTALS

A. Submit product data in accordance with Section 01340.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Substitutions: Items of same function and performance are acceptable in conformance with Section 01630.

2.02 220 VOLT SWITCHES

A. Acceptable manufacturers:
1. For non-hazardous areas: Hubbell Arrow-Hart, Bryant, or equal.

	Single Pole	Three Way
	(220V)	(220V)
Hubbell Model	(9815)	(9943)
Arrow-Hart Model	(1541)	(1543)
Bryant	(5861)	(5863)

2. For hazardous areas: Appleton, Crouse-Hinds, or equal.

B. Type: Quiet slow make, slow break design, Toggle Type, "T"-rated with totally enclosed phenolic case, rated 20 ampere at 250 volts, specification grade Provide matching two pole, 3 way, and 4 way switches.

2.03 SWITCH AND PILOT LIGHT

A. Type: Push action type with red handle, integral long-life neon pilot light, rated at 20 ampere, 240 volts.

2.04 SAFETY SWITCHES

A. For single phase motors: heavy duty, snap type with NEMA enclosure suitable for location.

B. For three phase motors: heavy duty horsepower rated, fused or unfused as shown on the Drawings with NEMA enclosure suitable for location.
   1. Enclosed circuit breaker may be used in lieu of safety switch.

2.05 SWITCH COVERS

A. Acceptable manufacturers: Arrow-Hart or Hubbell Models 93071, 93072, 93073 or equal.

B. For Indoor, non-hazardous areas: stainless steel.

PART 3 EXECUTION

3.01 INSTALLATION

A. Color: Provide brown switches.

B. Mount switches 1.2 meters above floor.

C. Coordinate switch mounting location with architectural detail.

D. Provide safety switches or circuit breakers as shown on the Drawings and where required by the National Electrical Code. Under certain conditions, disconnect switches will be furnished with selected items of mechanical equipment. The Contractor shall examine the mechanical Drawings and Specifications to determine the number of switches required.

END OF SECTION

SECTION 16145

RECEPTACLES

PART 1 GENERAL

1.01 RELATED WORK

A. Section 16010: Electrical General

B. Section 16134: Outlet Boxes

PART 2 PRODUCTS

2.01 STANDARD DUPLEX RECEPTACLE

A. Acceptacle manufacturers: Hubbell Model 5462, Arrow Hart or equal.

B. Type: Full gang size, polarized, duplex, parallel blade, U-grounding slot, specification grade, rated at 20 amperes at 250 volts, with phenolic molded bases.

C. Color: Provide ivory receptacles in areas with light wall finish. Provide brown receptacles in areas with wood or dark wall finish.

2.02 HAZARDOUS AREA RECEPTACLE

A. Acceptable Manufacturers: Crouse Hinds or Appleton.

B. Type: CPS as manufactured by Crouse Hinds rated 20 amperes at 250 volts.

C. Single gang unit Crouse Hinds Catalog No. CPS152-201.

D. Factory sealed unit for Class I Groups C,D.

E. Provide 10 matching plugs.

2.03 STANDARD COVER PLATES

A. Acceptable manufacturers: Hubbell Model 93101, Arrow Hart Model 93101, or equal.

B. Type: stainless steel.

2.04 WEATHERPROOF COVER PLATE

A. Acceptable manufacturers: Hubbell Model 5206, Leviton Model 4942, Crouse-Hinds Model DS701G, or equal.

B. Type: weatherproof, with two spring loaded covers.

PART 3 EXECUTION

3.01 INSTALLATION

A. Mount receptacles vertically at 300 mm above finished floor, with grounding pole at bottom.

B. Mount receptacles vertically at 1 meter above finished floor, with grounding pole at the bottom in wet locations or outdoors.

C. Coordinate receptacle height with benches and counters.

D. When mounting height exceeds 1 meter above floor, mount horizontally with grounding pole at left.

E. Install standard duplex receptacles with standard cover plate at all other locations.

END OF SECTION

SECTION 16151

PROCESS MOTORS

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. Motors shall conform to OSHA Standards and NEMA Standards for motors and generators, Publication MG1.

1.02 SERVICE CONDITIONS

A. Motors shall be designed to operate satisfactorily with a reasonable service life when operated either intermittently or continuously in a moist and corrosive atmosphere typical of waste treatment plants (NEMA STD MG1-14.03 1c and 1f).

B. All motors 1 HP and above shall be Mill and Chemical Duty Rated.

1.03 SUBMITTALS

A. Submit Shop Drawings for all motors furnished in accord with Section 01340. Curves and data which show the starting, accelerating and running characteristics throughout the speed range of the machine shall be supplied, including:
   1. Current in amperes.
   2. Torque in pound-feet, ounce-feet, ounce-inches, synchronous horsepower, percent of torque at rated horsepower.
   3. Output in horsepower or percent of rated horsepower.
   4. Speed in revolutions per minute, percent of synchronous speed or percent of speed at rated horsepower.
   5. Efficiency in percent.
   6. Power factor in percent.
   7. Voltage in volts or percent of rated voltage.
   8. Current, power factor, and efficiency vs load at 100%, 75%, 50% load.

      Determine by IEEE Standard 112 Test Method B and include all stray losses.

B. Submit operation and maintenance manual in accord with Section 01730.

1.04 SHIPMENT PREPARATION

A. Attach adequate lubrication and handling instructions to the motor at time of shipment.

SSO

PART 2 PRODUCTS

2.01 CHARACTERISTICS

A. Motor type: Below 15 HP - suitable for full voltage start, NEMA Design B; 15 HP and above - reduced voltage.

B. Manufacturer shall advise exceptions when they exist.

2.02 NAMPELATE INFORMATION

A. Attach nameplate to all motors with information as required by NEMA Standard MG1-10.39. Nameplate shall also provide the bearing numbers for both bearings.

2.03 RATINGS

A. Duty: continuous duty with rated temperature rise not exceeding NEMA Class B or F rises.

B. Service factor for non-explosionproof motors 1 HP and larger: 1.15.

C. Service factor for all other motors: 1.0.

2.04 VOLTAGE, PHASE, FREQUENCY

A. Motors 1 HP and larger: 380 volt, 3 phase, 50 hertz except where specified otherwise.

2.05 METHOD OF CONNECTION TO LOAD

A. Each motor shall be suitable for the type of connection used between the motor and the driven equipment, namely: direct connection, flat belt, V-belt, chain or gear connection.

B. Provide standard long shaft extension for all motors, suitable for V-belt and direct connection unless otherwise specified.

2.06 INSULATION

A. Insulation system: suitable for service conditions using NEMA Class B or F materials.

B. Protect integral horsepower motors with epoxy coatings and insulation against the adverse effects of service conditions.
   1. Random wound stator coils: use Class F material.
   2. Phase insulation and wedge materials: nonhygroscopic material fully compatible with other components.
   3. Encapsulate or seal completely wound stator assembly units for protection against high humidity.

2.07 FRAMES

A. Frame assignments: in accord with NEMA Standard MG1, unless otherwise specified.

2.08 ENCLOSURES

A. Totally enclosed motors as defined by NEMA Standards, unless specified otherwise.

B. Integral horsepower motor frame and end shields: cast construction for frames 56 through 449T, for frames larger than 449T steel frames with chemical resistant epoxy finishes will be acceptable.

C. Provide drain plug(s) to allow drainage of moisture from low spot(s) of motor.

D. Conduit box: cast construction, extra large design for rotating conduit entrances with threaded hub or tap for rigid conduit connection. Bolt box to frame with a gasket between the box and the frame and between the halves of the box. Locate boxes on right hand side when facing end of motor opposite shaft extension. Boxes shall contain a ground lug.

E. For integral horsepower motors, use non-braided, non-wicking lead insulation on stator leads to prevent moisture from entering the stator.

F. On integral horsepower motors, install a seal around the stator leads where leads enter stator frame from conduit box. Provide complete moisture protection between box and stator.

G. Explosionproof motors: Conform to NEMA Standards Section MGI-1.26 C or D, whichever applies.

2.09 COOLING

A. Totally enclosed motors 1 HP and larger shall be TEFC. Smaller motors may be furnished in TENV construction.

B. Provide cooling fans suitable for rotation in either direction. Where design considerations require their use, unidirectional fans are acceptable, provided written approval is obtained from the Owner and direction of rotation is specified. Such motors shall be provided with a motor mounted plate indicating required direction of rotation.

2.10 BEARINGS AND LUBRICATION

A. Bearings for horizontal motors: double shielded, premium antifriction ball bearings.

B. Bearings for integral horsepower motors: regreaseable, anti-friction bearings with bearing housings equipped with

grease inlet and outlet accessible from the exterior of the motor. Design bearing housing and shaft to keep grease or oil from being drawn into winding.

C. Grease fittings: 1/4 inch Alemite type grease fittings provided in each bearing housing for integral horsepower motors.

D. Direct connected integral horsepower motors shall have a minimum 25,000 hours B-10 life.

E. As a minimum requirement, motor bearing life shall be equal to the bearing life of the driven equipment.

F. Provide motor bearings suitable for the intended application (e.g. thrust bearings shall be provided where the driven equipment transmits a thrust load to the motor).

2.11 MISCELLANEOUS (Integral Horsepower Motors)

A. Nameplates: stainless steel attached by pins of similar material.

B. All machine bolts and screws: hex head type. All hardware shall be corrosion resistant coated.

C. Provide a replaceable shaft slinger or shaft rotating seal of noncorrosive materials to retard the entrance of contaminants into the bearing housing at the shaft extension end of anti-friction bearing motors.

D. Parts fabricated of aluminum or of sheet carbon steel less than one-quarter inch thick shall be furnished with a coating to resist the deteriorating effects of service conditions.

E. Grease all bearing housing fittings and threaded parts during original assembly.

F. Provide lifting eyebolts on frames 254T and larger.

PART 3 EXECUTION

3.01 INSTALLATION

A. Conform to requirements of equipment specifications.

3.02 EFFICIENCY SCHEDULE

MOTOR EFFICIENCY AND POWER FACTOR

HP	SPEED (RPM)	FRAME	MINIMUM EFFICIENCY FL	NOMINAL EFFICIENCY FL	NOMINAL POWER FACTOR FL
1	1800	143T	83.0	84.0	73.0
1	1200	145T	75.0	76.0	55.5
1.5	3600	143T	78.0	79.0	84.0
1.5	1800	145T	83.0	84.0	76.0
1.5	1200	182T	81.0	82.0	62.0
2	3600	145T	79.0	80.0	86.0
2	1800	145T	83.0	84.0	78.0
2	1200	184T	83.0	84.0	62.0
3	3600	182T	81.0	82.0	83.0
3	1800	182T	83.5	84.5	80.5
3	1200	213T	83.5	84.5	65.0
5	3600	184T	83.5	84.5	85.5
5	1800	184T	85.0	86.0	84.0
5	1200	215T	84.0	85.0	65.0
7.5	3600	213T	85.0	86.0	85.5
7.5	1800	213T	87.0	88.0	84.5
7.5	1200	254T	86.0	87.0	69.0
10	3600	215T	86.5	87.5	85.5
10	1800	215T	88.0	89.0	84.0
10	1200	256T	86.5	87.5	82.5
15	3600	254T	86.0	87.0	88.5
15	1800	254T	89.0	90.0	83.2
15	1200	284T	87.5	88.5	81.1
20	3600	265T	86.5	87.5	88.0
20	1800	265T	90.0	91.0	85.2
20	1200	286T	88.0	89.0	81.0
25	3600	284TS	88.5	89.5	85.0
25	1800	284T	90.5	91.5	88.2
25	1200	324T	90.0	91.0	84.0

HP	SPEED (RPM)	FRAME	MINIMUM EFFICIENCY FL	NOMINAL EFFICIENCY FL	NOMINAL POWER FACTOR FL
30	3600	286TS	89.0	90.0	88.0
30	1800	286T	91.0	92.0	89.1
30	1200	326T	90.5	91.5	85.5
40	3600	324TS	90.0	91.0	87.0
40	1800	324T	91.5	92.5	88.5
40	1200	364T	91.0	92.0	86.5
50	3600	326TS	-	90.0	89.1
50	1800	326T	-	91.5	89.5
50	900	404T	-	88.5	83.5
60	3600	364TS	-	90.7	89.7
60	1800	364T	-	91.5	87.0
60	1200	404T	-	90.6	85.7
75	1800	365T	-	92.1	86.9
75	1200	405T	-	92.3	85.4
75	900	444T	-	92.0	75.5
100	1800	405T	-	92.4	86.8
100	1200	444T	-	92.2	83.7
125	1800	444T	-	91.9	87.1
125	1200	445T	-	92.9	82.4
150	1800	445T	-	92.6	86.2
150	900	5008	-	91.0	83.0

Test Method shall be the United States IEEE Standard 112 A, test method B.

END OF SECTION

SECTION 16152

NON-PROCESS MOTORS

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. Motors shall conform to NEMA Standards for motors and generators, Publication MG1.

1.02 SERVICE CONDITIONS

A. Motors shall be designed to operate satisfactorily with a 10,000 hour service life when operated either intermittently or continuously in a moist and corrosive atmosphere typical of waste treatment plants (NEMA STD MG1-14.03 1c and 1f).

1.03 SUBMITTALS

A. Submit Shop Drawings for all motors furnished in accord with Section 01340. Curves and data which show the starting, accelerating and running characteristics throughout the speed range of the machine shall be supplied, including:
   1. Current in amperes.
   2. Torque in pound-feet, ounce-feet, ounce-inches, synchronous horsepower, percent of torque at rated horsepower.
   3. Output in horsepower or percent of rated horsepower.
   4. Speed in revolutions per minute, percent of synchronous speed or percent of speed at rated horsepower.
   5. Voltage in volts or percent of rated voltage.

B. Submit operation and maintenance manual in accord with Section 01730.

1.04 SHIPMENT PREPARATION

A. Attach adequate lubrication and handling instructions to the motor at time of shipment.

PART 2 PRODUCTS

2.01 CHARACTERISTICS

A. Motor type: suitable for full voltage start, NEMA Design B.

B. Manufacturer shall advise exceptions when they exist.

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2.02 NAMPELATE INFORMATION

A. Attach nameplate to all motors with information as required by NEMA Standard MG1-10.39. Nameplate shall also provide the bearing numbers for both bearings.

2.03 RATINGS

A. Duty: continuous duty with rated temperature rise not exceeding NEMA Class B rises.

B. Service factor for all motors 1 HP and larger: 1.0. Provide manufacturer's standard service factor for all other motors.

2.04 VOLTAGE, PHASE, FREQUENCY

A. Motors 1 HP and larger: 380 volt, 3 phase, 50 Hertz except where specified otherwise.

B. Motors less than 1 HP: 220 volt, single phase, 50 Hertz, except where specified otherwise.

C. Refer to drawings for available wiring.

2.05 METHOD OF CONNECTION TO LOAD

A. Each motor shall be suitable for the type of connection used between the motor and the driven equipment, namely: direct connection, flat belt, V-belt, chain or gear connection.

B. Provide standard long shaft extension for all motors, suitable for V-belt and direct connection unless otherwise specified.

2.06 INSULATION

A. Insulation system: suitable for service conditions using NEMA Class B materials.

2.07 ENCLOSURES

A. Provide motors open drip-proof when located indoors and totally enclosed when located outdoors as defined by NEMA Standards.

B. Motor frame and end shields: cast construction for frames 56 through 449T, for frames larger than 449T steel frames with chemical resistant epoxy finishes will be acceptable.

C. Conduit box: cast construction, extra large design for rotating conduit entrances with threaded hub or tap for rigid conduit connection. Bolt box to frame with a gasket between the box and the frame and between the halves of the box. Locate boxes on right hand side when facing end of motor opposite shaft extension. Boxes shall contain a ground lug.

D. Explosionproof motors: Conform to NEMA Standards Section MGI-1.26 C or D, whichever applies.

2.08 COOLING

A. Totally enclosed motors 1 HP and larger shall be TEFC. Smaller motors may be furnished in TENV construction.

B. Provide cooling fans suitable for rotation in either direction. Where design considerations require their use, unidirectional fans are acceptable, provided written approval is obtained from the Owner and direction of rotation is specified. Such motors shall be provided with a motor mounted plate indicating required direction of rotation.

2.09 BEARINGS AND LUBRICATION

A. Bearings for horizontal motors: double shielded, premium antifriction ball bearings.

B. Direct connected integral horsepower motors shall have a minimum 10,000 hours B-10 life.

C. As a minimum requirement, motor bearing life shall be equal to the bearing life of the driven equipment.

2.10 MISCELLANEOUS (Integral Horsepower Motors)

A. Nameplates: stainless steel attached by pins of similar material.

B. All machine bolts and screws: hex head type. All hardware shall be corrosion resistant coated.

C. Provide a replaceable shaft slinger or shaft rotating seal of noncorrosive materials to retard the entrance of contaminants into the bearing housing at the shaft extension end of anti-friction bearing motors.

D. Parts fabricated of aluminum or of sheet carbon steel less than one-quarter inch thick shall be furnished with a coating to resist the deteriorating effects of service conditions.

E. Grease all bearing housing fittings and threaded parts during original assembly.

F. Provide lifting eyebolts on frames 254T and larger.

PART 3 EXECUTION

3.01 INSTALLATION

A. Conform to requirements of equipment specifications.

SS8

END OF SECTION

SECTION 16155

MOTOR STARTERS (Separate Mounted)

PART 1 GENERAL

1.01 RELATED WORK

A. Section 16010: Electrical General.

1.02 REQUIREMENTS OF REGULATORY AGENCIES

A. Provide motor protection switches of the appropriate NEMA size. For units not using NEMA rating use equivalent NEMA size.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manufacturer and Class: 8539 type manufactured by Square D.

B. Other Acceptable Manufacturers:
1. Allen Bradley.
2. Cutler Hammer.

C. Substitutions: Items of same function and performance are acceptable in conformance with Section 01630.

2.02 MANUAL MOTOR PROTECTION SWITCHES

A. For single phase motors provide either toggle or key operated switches with thermal overload complete with pilot light.

2.03 COMBINATION MOTOR STARTER

A. Provide fused 3 pole load break disconnect switches with current limiting time delay fuses, operating handle, and lock-off facility.

B. Restrict opening of switch enclosure by the use of a defeater screw unless switch is in the OFF position.

C. Provide contactors with three overload relays.

D. 220 volt holding coil.

E. Provide pilot light in cover, red type.

F. Provide reset button, and control switch or pushbutton in cover. Type of control device indicated on schematics.

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G. Provide One set of normally open and normally closed auxiliary contacts in addition to standard auxiliary holding contacts supplied with each contactor.

H. Provide surface mounted starters in NEMA Type 1 enclosure.

PART 3 EXECUTION

3.01 INSTALLATION

A. In finished areas, mount motor protection switches flush and install suitable coverplates.

B. Install heaters correlated with full load current of motors provided.

END OF SECTION

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SECTION 16160

PANELBOARDS

PART 1 GENERAL

1.01 RELATED WORK

A. Section 16010: Electrical General

1.02 REQUIREMENTS OF REGULATORY AGENCIES

A. Construct panelboards to UL and NEC standards and provide UL labels.

1.03 REFERENCE STANDARDS

A. Federal Specifications
1. W-P-115a Panel, Power Distribution.

PART 2 PRODUCTS

2.01 ENCLOSURES

A. Panels: Surface mounted as scheduled complete with panel trim having concealed hinges and trim mounting screws conforming to W-P-115a. Provide locking door with spring latch and tumbler lock.

B. Provide 20% minimum spare circuit breakers, with 20A minimum trip, or as shown on panelboard circuit schedule, whichever is greater.

C. Do not provide more than the maximum number of overcurrent devices allowed by NEC.

D. Bus: Copper.

E. Provide ground bus to which all circuit ground wires shall be connected.

F. Provide dead front interior assembly with panelboard front removed.

G. Keys: Provide six keys for each panel. Make keys interchangeable for panels of same voltage.

2.02 220/380 VOLT PANELBOARDS

A. Acceptable manufacturers: Square D I-Line, Cutler Hammer, or equal.

B. Panelboards: 3 phase, 4 wire, solid neutral design with sequence style bussing and full capacity neutral, composed of an assembly of bolt-on molded case automatic circuit breakers with thermal and magnetic trip and trip free

position separate from either "ON" or "OFF" positions. Provide common simultaneous trip for 2 and 3 pole breakers.

C. Breakers shall be bolt on type rated as shown on the panelboard schedule with minimum interrupting rating of 22,000 AIC.

2.03 FABRICATION

A. Provide mounting brackets, busbar drillings, and filler pieces for unused spaces.

PART 3 EXECUTION

3.01 INSTALLATION

A. Prepare and affix typewritten directory with clear plastic cover to inside cover of panelboard indicating loads controlled by each circuit. Circuit numbers shown on Drawings and schedules are for identification only.

B. Install lock-on devices on circuits shown on Panelboard Circuit Schedule.

C. Balance the loads between each phase wire throughout the electrical system by using a calibrated clamp-on ammeter at all panelboards. The maximum unbalance shall not exceed 10 percent.

3.02 PANELBOARD CIRCUIT SCHEDULES

A. See drawings.

END OF SECTION

SECTION 16205

PACKAGE ENGINE GENERATOR SET

PART 1 GENERAL

1.01 RELATED WORK

A. Section 01657: Starting Process Systems.

B. Section 01669: Testing Process Systems.

1.02 DESCRIPTION OF SYSTEM

A. Provide standby power systems for supply of power in event of failure of normal supply, consisting of liquid cooled, diesel engine directly coupled to ac generator complete with fittings, connections, auxiliaries, control panels, safety devices, meters necessary for complete operating system suitable for outdoor service.

B. Provide fully automatic operation so that unit takes full load within 10 seconds after power failure. On resumption of normal power after time delay on transfer switch, automatically retransfer load to normal power and automatically shut down generator, returning to starting condition ready for another operating cycle.

C. Provide Two Engine Generator Sets EP1 & EP2.

1.03 REQUIREMENTS OF REGULATORY AGENCIES

A. Conform to National Electrical Code.

B. Generator manufactured to NEMA standards.

1.04 SHOP TEST

A. Shop test generator set in accordance with manufacturer's standard procedures.

1.05 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 01340, including the following:
   1. Full technical data list of installations of comparable size in local area service and parts facilities complete with manufacturer's published data.
   2. Engine data with:
      a. Number of cylinders
      b. Piston displacement
      c. Break mean effective pressure
      d. Piston speed
   3. Generator short circuit current vs time curve and main circuit breaker tripping current vs time curves.
   4. Generator and exciter characteristics:

a. Generator subtransient reactance: X"d
b. Generator synchronous reactance: Xd
c. Generator transient reactance saturated: Xd'
d. Generator open-circuit transient time constant: Tdo'
e. Speed of response of exciter in seconds: R
f. Generator rated voltage, amperes, power factor and kilowatts 50 Hertz.

5. Submit manufacturer's installation instructions.

B. Submit Operation and Maintenance Manual in accordance with Section 01730.

C. Submit Certificate of shop test and test readings made after installation in accordance with Section 01340.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manufacturer and Type: DFX type manufactured by ONAN

B. Other Acceptable Manufacturers:
1. Caterpillar
2. Cummins

C. Substitutions: Items of same function and performance are acceptable in conformance with Section 01630.

D. The engine, generator, and all major items of auxiliary equipment shall be products of manufacturers regularly engaged in the production of such equipment.

2.02 RATING

A. Size generator sets in accordance with the manufacturer's recommendation to start and power the scheduled loads for continuous electrical service during interruption of the normal utility source.

B. Minimum size: 500 kW based on a maximum of 20% voltage dip during the loading sequence. Following a sudden load change, the voltage shall recover to and remain within the regulation band within one half second.
1. Verify all scheduled horsepower with actual equipment installed.

C. Substantiate ratings with manufacturer's standard published curves. Special or maximum ratings are not permitted.

2.03 GENERATOR

A. Generator: 0.8 power factor, 625 KVA, 220/380 volts, 3 phase, 4 wire, 50 Hz, single bearing, synchronous type.

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B. Stator and rotor insulation: Class F, protected with 100% epoxy impregnation and an overcoat of resilient insulating material to reduce possible fungus and/or abrasion deterioration.

C. Excitor: Brushless, directly coupled with plus or minus 2 percent regulation from No load to Full Load.

D. Voltage regulator: solid state, volts per Hertz type, with characteristics to match generator and engine. Provide accessible voltage droop, voltage level and voltage gain controls.
   1. Voltage level adjustment: minimum plus or minus 5%.
   2. Shock mount regulator on generator and epoxy encapsulate for protection against vibration and atmospheric deterioration.

E. Provide an integral series boost and field forcing device to maintain no less than 300% full load current for at least 2 seconds during fault conditions, and to allow coordination of generator breaker with the branch circuit breakers on the switchgear bus.

F. Terminal Box: Provide terminal box for generator and excitor leads.

2.04 ENGINE

A. Engine: In-line or Vee type, four cycle, 1500 rpm diesel.

B. Capacity: 10 percent overload for one hour operating on No. 2 diesel fuel at an ambient temperature of between 0 degrees C and 40 degrees C at an altitude of 600 meters above sea level.

C. Governor: Speed regulation plus or minus 3 percent maximum from No Load to Full Load with two second recovery to steady state.

D. Immersion Heater: Located in cooling jacket complete with thermostat for 220 volt operation. Maintain 49 deg. C jacket temperature at 0 deg. C ambient.

E. Accessories: Provide replaceable type oil filters, dry type air cleaners, automatic choke, lubricating oils and oil coolers, greases, coolant, water pump, 220V, single phase, 50 Hz fuel transfer pump and Engine Driven fuel priming pump.

F. The engine shall be of a manufacturer who has a Jordanian agent with established spare parts and service facilities to ensure prompt servicing.

2.05 COOLING EQUIPMENT

A. Engine: Self contained liquid cooling complete with engine mounted radiator and fan maintaining safe operating

temperature for unit under full load conditions at 40 deg. C maximum ambient temperature.

B. Coolant: Glycol base anti-freeze good to -40 degrees F (-40 degrees C).

C. Provide thermostat temperature control.

2.06 EXHAUST EQUIPMENT

A. Muffler and Piping: Residential type, completely sealed, metal primed finish.

B. Connection: Provide flexible connection from manifold to muffler.

C. Provide an exhaust condensation trap.

2.07 ENGINE ELECTRICAL SYSTEM

A. Battery: 24 volt, 220 amp-hour, lead-acid heavy duty storage type capable of 90 seconds total cranking time without recharging. Provide battery rack, cables and clamps.

B. Starter: positive engagement, 24 volt.

C. Battery Charger: current limiting, automatic, 220 volt, single phase, 50 Hz. with 24 volt, 5 amp output. Float at 2.17 volts per cell and equalize at 2.33 volts per cell. Provide the following:
1. Overload protection.
2. Silicone diode full wave rectifiers.
3. Voltage surge suppressors.
4. DC ammeter.
5. Fused AC input.

2.08 DAY TANK

A. Tank: 25 gallon capacity, with threaded connections complete with the following:
1. Float switch.
2. Fuel gage.
3. Mounting brackets.

B. Provide flexible fuel line connection at engine.

2.09 MAIN LINE CIRCUIT BREAKER

A. Breaker: molded case, UL labeled of required capacity installed as a load circuit interrupting and protection device. Operate both manually for normal switching function and automatically during overload and short circuit conditions.

B. Trip unit for each pole: Provide elements with inverse time delay during overload conditions and short time

adjustable tripping for short circuit protection and coordination with the switchgear branch breakers.

C. Use of generator exciter field circuit breakers for line protection is not permitted.

D. Mount circuit breaker on and wire to generator set.

2.10 GENERATOR CONTROL PANEL

A. Provide all instrumentation and Controls required to operate the equipment as described in this Section. Comply with the requirements of Section 13445 except as noted.

B. Control panel: NEMA 12, vibration insulated, dead front, 14 gage steel, preassembled, wired, piped and tested containing the following:
   1. On the front face:
      a. Voltmeter: 3-1/2 inch face, 2 percent accuracy.
      b. Ammeter: 3-1/2 inch face, 2 percent accuracy.
      c. Ammeter-Voltmeter phase selector switch.
      d. Frequency meter: 3-1/2 inch face, dial type.
      e. Engine oil pressure gage.
      f. Engine water temperature gage.
      g. Voltage level adjustment rheostat.
      h. Four position function switch: auto, manual, off/reset, and stop.
      i. Panel illumination switch and lights.
      j. Fault indicating lights for alarm points.
      k. Two indicating lights to indicate automatic transfer switch position red for emergency power and green for normal power.
   2. Auxilliary dry contacts:
      a. Dry contacts wired to terminal strips to provide common remote alarm signal for alarm points.
   3. Alarm points: Initiate automatic shut down for the following:
      a. Low oil pressure.
      b. High water temperature.
      c. Over speed.
      d. Overcrank.
      e. Engine running dry.

2.11 TOOLS

A. Provide tools required for normal maintenance of unit in metal box complete with lock and keys.

2.12 FABRICATION

A. Mount components on common steel rail base.

B. Mount control panel on and wire to generator set.

C. Provide semi-flexible couplings between generator and engine and protective guards over moving parts.

D. Shop paint with manufacturer's standard enamel finish.

E. Install engine at sufficient height above base to permit dropping oil pan without removing unit.

PART 3 EXECUTION

3.01 INSTALLATION

A. Conform to manufacturer's instructions.

B. Install unit complete and make operational.

C. Insulate exhaust piping to maintain 150° maximum surface temperature. Do not interfere with flexible connections.

D. Provide 12 mm copper drain line with draincock from bottom of muffler trap to nearest floor drain for periodic draining of muffler.

3.02 WIRING AND CONNECTIONS

A. Provide conduit, wiring, and connections required and recommended by unit supplier.

B. Install all control and alarm wiring in rigid steel conduit.

C. Connect neutral point of generator and generator frame to ground by 1#1/0 green insulated copper conductor.

3.03 TESTING

A. Test and adjust unit on site in accord with Section 01657 and Section 01669.

B. Provide full load test utilizing portable test bank, if required, for four hours minimum. Simulate power failure including operation of transfer switch, automatic starting cycle, and automatic shutdown and return to normal.

C. Record in 20 minute intervals during four hour test:
1. Kilowatts
2. Amps
3. Voltage
4. Coolant temperature
5. Room temperature
6. Frequency
7. Oil pressure

D. Test alarm and shutdown circuits by simulating conditions.

3.04 OPERATOR TRAINING

A. Train Owner's operators in accord with Section 01738.

3.05 SPARE PARTS

A. Provide one set of fuses and indicating lights.

3.06 GENERATOR SCHEDULE

A. Loads are tabulated in starting order with time delays shown. The loads listed are estimated only.

SP 0

ENGINE GENERATOR SET EP1

Equipment	Equip. No.	Load	Time Delay
Clarifier P.S. Misc. Loads		50kw	
Trickling Filter P.S. Misc. Loads		75kw	
Other Misc. Loads		20kw	
Septage Mixer	ME-03A	25hp	
Septage Mixer	ME-03B	25hp	
Bar Screen	ME-01A	1hp	
Bar Screen	ME-01B	1hp	
Septage Air Compressor	ME-02A	15hp	
Primary Clarifier Drives	ME-100A1	3/4hp	
Primary Clarifier Drives	ME-100A2	1/2hp	
Primary Clarifier Drives	ME-100B1	3/4hp	
Primary Clarifier Drives	ME-100B2	1/2hp	
Trickling Filter Recycle Pump	P-101A	50hp	
Trickling Filter Recycle Pump	P-101B	50hp	
Trickling Filter Feed Pump	P-100A	50hp	
Trickling Filter Feed Pump	P-100B	50hp	
Trickling Filter Feed Pump	P-100C	50hp	
Trickling Filter Feed Pump	P-100D	50hp	
Aerators: Allowed to run on low speed only. Low Speed hp = 50.	ME-101A1	50hp	
	ME-101A2	50hp	
	ME-101B1	50hp	
	ME-101B2	50hp	

Equipment	Equip. No.	Load	Time Delay
Chlorine Bldg. Misc.		20kw	
Waste Sludge P.S.		20kw	
Control Bldg.		75kw	
Sludge Pump Station (Train I)		10kw	
#Sludge Pump Station (Train II)		10kw	
Sludge Return Pump	P-102A	20hp	
Sludge Return Pump	P-102B	20hp	
Sludge Return Pump	P-102C	20hp	
Sludge Return Pump	P-102D	20hp	
#Sludge Return Pump	P-201A	20hp	
#Sludge Return Pump	P-201B	20hp	
#Sludge Return Pump	P-201C	20hp	
#Sludge Return Pump	P-201D	20hp	
Flocc.-Clarifier	ME-102A1	1hp	
Flocc.-Clarifier	ME-102A2	3/4hp	
Flocc.-Clarifier	ME-102A3	3/4hp	
Flocc.-Clarifier	ME-102B1	1hp	
Flocc.-Clarifier	ME-102B2	3/4hp	
Flocc.-Clarifier	ME-102B3	3/4hp	
#Flocc.-Clarifier	ME-202A1	1hp	
#Flocc.-Clarifier	ME-202A2	3/4hp	
#Flocc.-Clarifier	ME-202A3	3/4hp	
#Flocc.-Clarifier	ME-202B1	1hp	
#Flocc.-Clarifier	ME-202B2	3/4hp	
#Flocc.-Clarifier	ME-202B3	3/4hp	
Sludge Thickener	ME-104	1hp	
Sludge Thickener	ME-105A	2hp	
Sludge Thickener	ME-105B	2hp	
#Sludge Thickener	ME-204	1hp	
#Sludge Thickener	ME-205A	2hp	
#Sludge Thickener	ME-205B	2hp	
Gas Compressor	ME-106A	10hp	
#Gas Compressor	ME-206A	10hp	
Hot Water Circ. P.	P-111A	5hp	
#Hot Water Circ. P.	P-211A	5hp	
Boiler	ME-107	2hp	
#Boiler	ME-207	2hp	
Fuel Oil Pump	P-112	1	
#Fuel Oil Pump	P-212	1	

- Future Equipment

END OF SECTION

SECTION 16310

SUBSTATIONS

PART 1 GENERAL

1.01 RELATED WORK

A. Section 01657: Starting Process Systems

B. Section 01669: Testing Process Systems

C. Section 16010: Electrical - General

1.02 DESCRIPTION

A. Substations shall consist of transformer and 380 Volt switchgear with individual components to provide a complete and workable fully coordinated system.

1.03 UTILITY COMPANY INTERFACE

A. Power available at the utility company feeder termination point is 500 MVA.

B. Verify space and mounting requirements for equipment provided by the utility company.

1.04 DESIGN REQUIREMENTS

A. Design the equipment to withstand and protect against the stresses associated with a fault condition of 500 MVA at a system voltage of 11,000 volts.

B. Switchgear shall be housed in a weatherproof enclosure for outdoor installation.

1.05 SHOP TEST

A. Perform manufacturer's standard shop tests to demonstrate compliance with the specified requirements.

B. Transformer test: Perform standard commercial tests in accordance with NEMA TR-11. Prior to shipment the transformer will be liquid-filled and pressure tested for at least eight hours at the maximum operating pressure for detecting the presence of leaks.

1.06 REFERENCE STANDARDS

A. Conform to applicable portions of ANSI, IEEE and NEMA Standards.

1.07 SUBMITTALS

A. Submit Shop Drawings and Product Data in accord with Section 01340 including the following:

1. Outline dimensions with weights and mounting arrangement.
2. Connection diagrams and schematic diagrams.
3. Manufacturer's recommended spare parts list.
4. Coordination curves showing all trip settings and demonstrating coordination with all up stream and down stream devices including equipment supplied by others. Plot the curves on standard log-time-current characteristics sheets. Make fault calculations required to complete the coordination study and submit them as part of the report. Verify the available power with the utility at the time of preparation of the report. Coordinate emergency generator's available short circuit and circuit breaker with branch circuit breakers.

B. Submit certificates of shop test in accord with Section 01340.

C. Submit operation and maintenance manual in accord with Section 01730.

1.08 STORAGE AND PROTECTION

A. Store switchgear at the job site in a clean, dry and ventilated building free from temperature extremes. Provide heat and/or ventilation to prevent condensation.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Switchgear Manufacturer and Type: AKD-8 type manufactured by General Electric Company.

B. Transformer manufacturer: General Electric Company.

C. Other Acceptable Manufacturers:
1. Westinghouse Electric Company.
2. Square D Company.

D. Substitutions: Items of same function and performance are acceptable in conformance with Section 01630.

2.02 ENCLOSURE

A. Type: Walk-in, protected aisle, for outdoor service, metal construction with removable type circuit breakers.

B. Structure: Rigidly braced, self-supporting framework made of standard steel members arranged for mounting circuit breakers, circuits, buses, transformers, relays, instruments and connections.

C. Construction: Multiple unit, comprised of an assembly of individual standardized enclosed breaker units to form a single compact switchboard. Enclose each breaker in its

own compartment, isolated from all other devices. Provide barriers to eliminate fault communication between functional components (main bus, incoming line, and breakers).

2.03 ENCLOSURE ACCESSORIES

A. Provide one fluorescent fixture 1200 x 300 mm with two 40 Watt lamps and switch.

B. Provide one duplex 220V receptacle in aisle.

C. Provide roof ventilator thermostatically controlled to turn fan on when temperature inside aisle exceeds 30 deg C. Size fan for six air changes per hour. Provide intake louvers with filters.

D. Provide two 50 Watt high pressure sodium light fixtures, controlled by built-in photoelectric cell, on the outside of the secondary switchgear (front and rear). The fixtures shall be Holophone Cat. No. 409 or equal .

E. Provide a panelboard with six single pole 15 ampere circuit breakers to feed the equipment listed above. The lighting receptacle and fan shall be on separate circuits.

2.04 BUSES

A. Main and neutral bus: welded tin plated aluminum rated as scheduled in this Section.

B. Ground bus: copper, extending through all sections with provisions for connection to the substation ground system.

C. Brace buses to withstand short circuit stresses available on transformer secondary.

2.05 CIRCUIT BREAKERS

A. Circuit Breakers: large, fully rated, air, drawout type, manually or electrically operated as specified in this Section, triple pole, single throw, inverse time delayed (long time, short time and instantaneous over-current) trip as specified in this Section.

B. Main current carrying contacts: silver.

C. Provide each breaker with ground fault protection.

D. For electrically operated breakers, operating mechanism shall be trip free, mechanically and electrically.

E. The specified interrupting capacity of circuit breakers is at system voltage. Determine the interrupting rating and interrupting performance of circuit breakers in accord with the NEMA and IEEE Standards, based on the standard two unit operating cycle.

F. Enclosed breakers shall be capable of meeting the specified interrupting rating when in position in the enclosure.

2.06 WIRING

A. Instrument, relay, and control wiring within the enclosure: copper conductor with cross-linked polyethelene insulation meeting UL VW-1 flame resistance rating.

2.07 NAMEPLATES

A. Nameplates: laminated bakelite having white letters on a black background.

2.08 INSTRUMENTS

A. Instruments, meters and relay cases: rectangular with dull black finish, and arranged for semi-flush mounting and back connection. Provide necessary resistors and reactors.

B. Provide alternating current instruments and meters, with 5 ampere and/or 220 volt coils, for operation with instrument transformers.

C. Indicating volt meters and ammeters: General Electric Type AB-40, Westinghouse Type KA-261, or equal .

D. Control transfer switches: heavy duty rotary type fitted with escutcheons marked to show their purpose. Provide red and green indicating lights with the control switches used with electrically operated circuit breakers. Switches shall be General Electric Type SB-1, or equal .

2.09 TRANSFORMERS

A. Current transformers: NEMA accuracy classification for the service for which they are used, provided with 5 ampere, single secondary winding.

B. Instrument potential transformers: adequate capacity (200VA minimum), fitted with cutouts and current limiting fuses and provided with 220 volt secondary winding.

C. Provide control power transformer of suitable rating, complete with primary voltage current limiting fuses to furnish power for electrically operated breakers.

2.10 SUBSTATION TRANSFORMER

A. Type: Outdoor

B. Rating: Three phase, 50 Hertz coolant-oil

C. High Voltage Winding: 11,000 Volts delta

D. Low voltage Winding: 380/220 Volts wye

E. BIL: High voltage 95 BIL

F. Taps: Four 2-1/2 percent full capacity taps, two above and two below normal high voltage, brought out to a no-load tap changer externally operated.

G. Impedance: 5.75% in accordance with NEMA TR-11.

H. Cooling: Complete system including 220 Volts, single phase 50 Hz cooling fans, top oil temperature relay, and all controls required for fan operation. Control the fans from top oil temperature. Provide an overtemperature alarm contact on each transformer.

I. High Voltage Terminations: Locate high voltage bushings on the transformer sidewall in ANSI segment 2 enclosed in an air filled terminal compartment complete with one cell distribution type lightning arrestors rated 12 kV type.

J. Low Voltage Terminations: Locate low voltage bushings on the transformer sidewall in ANSI segment 4 for connection to the low voltage switchgear line-up via a transition compartment.

K. Neutral Termination: Low voltage neutral shall be brought out through bushings on the secondary side.

L. Oil preservation: Sealed tank construction with welded cover. During welding of the transformer cover, permanently place an inorganic gasket between the cover and the tank flange to prevent the entrance of weld spatter into the tank.

M. Features and Accessories:
1. Top filter press connection with one-inch pipe cap.
2. Drain and filter press valve, one-inch globe type, 6 mm sampling valve.
3. No-load tap changer operating handle brought out through cover with provision for padlocking. Provide key interlock with secondary main breaker.
4. Diagrammatic nameplate.
5. Liquid-level gage.
6. Top oil thermometer.
7. Pressure vacuum gage.
8. Two copper-faced ground pads with NEMA drilling located on diagonally opposite corners.
9. Bolted 230 mm diameter round hand-hole on cover.
10. Lifting lugs at each corner of tank for lifting the complete transformer.
11. Jacking facilities at each corner of base for jacking the complete transformer.
12. Base under coating.
13. Base designed for rolling or skidding in either direction.

14. Mechanical pressure relief mounted on handhole with automatic resealing-resetting operation and mechanical signal for indication of device operation.

N. Alarm and Relay Connections: Alarm and relay contacts shall be brought out to a terminal board, with each connection labeled, mounted in a NEMA 12 enclosure, providing 30 percent spare terminal connections and 100 mm of wiring space on the incoming and outgoing side of the terminal board.

2.11 AUTOMATIC TRANSFER SWITCH

A. Type: Double throw operated by a single solenoid mechanism momentarily energized with ampere rating as specified in this Section providing full phase protection of the normal power source.

B. Interlock: Inherently interlocked mechanically and electrically.

C. Operating current: From the source to which the load is to be transferred.

D. Failure of any coil or disarrangement of any part shall not permit a neutral position.

E. Source Lock: Positive, mechanical lock on either source without the use of hooks, catches, semi-permanent magnets, or springs.

F. Main Contacts: Silver surfaced, protected by arcing contacts.

G. Transfer Time: 1/6 second, maximum, in either direction.

H. Switch withstand rating:
1. 2000 Ampere Switch - 85000 symmetrical amperes.

I. UL Listing: Conform to UL-1008.

J. Equip the transfer switch with the following accessories:
1. Time Delay: 3 seconds to transfer to emergency.
2. Time Delay: 5 to 25 minutes on retransfer with 5 minutes unloaded running time.
3. Test Switch.
4. Engine Starting Contact.
5. Auxiliary Contacts: Three normally closed, two normally open.
6. Exerciser: To automatically run the generator for 30 minutes every week.

2.12 ASSEMBLY

A. Factory assemble substation complete, ready for installation.
1. Finish: provide manufacturer's standard finish paint.

2. Attach nameplates with stainless steel screws to the face of the enclosure, labeling each device and switch position.

B. Provide a lifting device for removing circuit breakers.

PART 3 EXECUTION

3.01 INSTALLATION

A. Conform to manufacturer's instructions.

B. Start the substation in accord with Section 01657.

C. Test substation in accord with Section 01669.
1. Conduct built-up, phasing and insulation tests before energizing.

3.02 SPARE PARTS

A. Provide spare parts listed and in the quantities named on the Shop Drawing submittal.

B. Deliver parts in boxes or other suitable packing clearly marked "Spare Parts". Attach a packing list to the outside of the package which includes the name and part number for all parts in the package.

3.03 SUBSTATION SCHEDULE

A. Provide substations in accord with the following requirements:

3.04 SUBSTATION NO. 1P

A. Transformer rating:
1. Temperature rise: 55 degrees/65 degrees C
2. Type: OA/FA
3. 1500/1725 kVA

B. Secondary switchgear shall consist of the following:
1. Transformer to switchgear transition section.
2. Incoming line section with main breaker and metering section consisting of:
a. One set metering current transformers, 2400/5 Amp.
b. One 2400 ampere frame, three pole, circuit breaker having 65000 rms symmetrical short circuit current interrupting rating at 380 volts, having 2000 Amp SST solid state selective trip units with targets and completely field adjustable for time band with long time and short time delay characteristics and ground fault protection, with one, NO and one, NC auxiliary contacts, having connections to automatic transfer switch.
c. One ammeter with ammeter 4 position selector switch.
d. Two volt meters, 0-600 scale with switch.

e. Two potential transformers; 380/220 volts, with primary and secondary fuses.
f. One set distribution type lightning arresters with surge capacitors.

3. Automatic Transfer Switch Section:
a. Normal supply for switch: receive through the main breaker and a standby supply from an emergency generator.
b. Generator feeders: 3-350MCM copper cables per phase with 4/0 neutral and 1/0 ground all entering the section from below .
c. Transfer Switch: 2000 amperes. Down stream of the transfer switch shall be feeder sections.

4. Feeder Sections Consisting of:
a. One 1600 and one 1200 ampere frame, three pole feeder circuit breakers having 65000 rms symmetrical short circuit current interrupting rating at 380 volts having 1200 and 1000 Amp, respectively, SST solid state selective trip units with targets, completely field adjustable for time band with long time and instantaneous characteristics and ground fault protection, with one NO and one NC auxiliary contacts, having connections for three 600 and three 500 MCM, respectively copper cables per phase.

3.05 SUBSTATION NO. 2P

A. Transformer rating:
1. Temperature rise: 55 degrees/65 degrees C
2. Type: OA/FA
3. 1500/1725 kVA

B. Secondary switchgear shall consist of the following:
1. Transformer to switchgear transition section.
2. Incoming line section with main breaker and metering section consisting of:
a. One set metering current transformers, 2400/5 Amp.
b. One 2400 ampere frame, three pole, circuit breaker having 65000 rms symmetrical short circuit current interrupting rating at 380 volts, having 2000 Amp SST solid state selective trip units with targets and completely field adjustable for time band with long time and short time delay characteristics and ground fault protection, with one, NO and one, NC auxiliary contacts, having connections to automatic transfer switch.
c. One ammeter with ammeter 4 position selector switch.
d. Two volt meters, 0-600 scale with switch.
e. Two potential transformers; 380/220 volts, with primary and secondary fuses.
f. One set distribution type lightning arresters with surge capacitors.
3. Automatic Transfer Switch Section:
a. Normal supply for switch: receive through the main breaker and a standby supply from an emergency generator.

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b. Generator feeders: 3-350MCM copper cables per phase with 4/0 neutral and 1/0 ground all entering the section from below .
c. Transfer Switch: 2000 amperes. Down stream of the transfer switch shall be feeder sections.

4. Feeder Sections Consisting of:
   a. Two 800 and one 1200 ampere frame, three pole feeder circuit breakers having 65000 rms symmetrical short circuit current interrupting rating at 380 volts having 800 and 1000 Amp, respectively, SST solid state selective trip units with targets, completely field adjustable for time band with long time and instantaneous characteristics and ground fault protection, with one NO and one NC auxiliary contacts, having connections for two 600 and three 500 MCM, respectively, copper cables per phase.

SECTION 16442

PRIMARY SWITCHGEAR

PART 1 GENERAL

1.01 RELATED WORK

A. Section 01657: Starting Process Systems

B. Section 01669: Testing Process Systems

C. Section 16010: Electrical - General

1.02 DESCRIPTION

A. Switchgear shall consist of individual fused load interruptor switches and utility company metering section to provide a complete and workable fully coordinated system.

1.03 UTILITY COMPANY INTERFACE

A. Power available at the utility company feeder termination point is 500 MVA.

B. Verify space and mounting requirements for equipment provided by the utility company.

1.04 DESIGN REQUIREMENTS

A. Design the equipment to withstand and protect against the stresses associated with a fault condition of 500 MVA at a system voltage of 11,000 volts.

B. Switchgear shall be housed in a weatherproof enclosure for outdoor installation.

1.05 SHOP TEST

A. Perform manufacturer's standard shop tests to demonstrate compliance with the specified requirements.

1.06 REFERENCE STANDARDS

A. Conform to applicable portions of ANSI, IEEE and NEMA Standards.

1.07 SUBMITTALS

A. Submit Shop Drawings and Product Data in accord with Section 01340 including the following:
   1. Outline dimensions with weights and mounting arrangement.
   2. Connection diagrams and schematic diagrams.
   3. Manufacturer's recommended spare parts list.

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4. Coordination curves showing all trip settings and demonstrating coordination with all up stream and down stream devices including equipment supplied by others. Plot the curves on standard log-time-current characteristics sheets. Make fault calculations required to complete the coordination study and submit them as part of the report. Verify the available power with the utility at the time of preparation of the report.

B. Submit certificates of shop test in accord with Section 01340.

C. Submit operation and maintenance manual in accord with Section 01730.

1.08 STORAGE AND PROTECTION

A. Store switchgear at the job site in a clean, dry and ventilated building free from temperature extremes. Provide heat and/or ventilation to prevent condensation.

PART 2 GENERAL

2.01 ACCEPTABLE MANUFACTURERS

A. Specified Products: Breakmaster, manufactured by General Electric Company.

B. Acceptable substitutes:
1. Square "D" Company
2. Westinghouse

2.02 ENCLOSURE CONSTRUCTION:

A. Bus: welded aluminum

B. Provide separate doors for switch and fuse compartments interlocked to prevent opening door when switch is closed or closing the switch when the door is open.

C. Provide safety glass window in door for viewing switch contacts.

D. Make provision for padlocking the switch in an open position.

E. Finish: manufacturers stnadard, minimum of 2 mils thick.

2.03 AIR INTERRUPTER SWITCHES

A. Stored energy type utilizing direct acting spring charged mechanism for both closing and opening functions.

B. Provide separate main, make and break contacts to provide maximum endurance for fault close and load interrupting duty. Arcing contacts: spring loaded on make and break,

designed to be last in and last out. Provide a spring-defeat mechanism to permit slow closing and opening of switch during routine maintenance.

C. Provide 220V space heaters in each compartment for connection to externally supplied power.

2.04 FUSES

A. Type: self contained current limiting designed to operate during the first half cycle on maximum fault conditions with no expulsion of gases or foreign matter from the tube.

2.05 COMPARTMENT ARRANGEMENT

A. Place the first compartment on the right and arrange for receiving the incoming 11,000 Volt supply from below. The compartment shall house one set of distribution type lightning arrestors.

B. In the second compartment provide the main non-fused load break switch, rated 15kV 600 amperes continuous and interrupting. Provide ground bus and space heaters in this compartment.

C. The third compartment shall be one instrument compartment consisting of the following:
1. Three phase insulated bus, 600 amperes.
2. Mounting only for utility company current transformers.
3. Mounting only for utility company potential transformers.
4. Necessary interconnections for above equipment.
5. Space heaters.

D. Compartments four, five and six shall be feeder compartments each consisting of the following:
1. One fused load break switch rated 15kV, 600 amperes, continuous and interrupting.
2. Three Power Fuses, General Electric type EJO-1 with door to fuse compartment mechanically interlocked with the load break switch to prevent access to the fuse compartment unless the switch is open.
3. One set of clamp type terminals of suitable rating for feeders leaving below.
4. One ground bus.
5. Space heaters.

E. Provide seventh compartment complete for installation of a future feeder load break switch.

2.06 ASSEMBLY

A. Factory assemble switchgear, complete ready for installation.

PART 3 GENERAL

3.01 INSTALLATION

A. Conform to manufacturer's instructions.

B. Start the switchgear in accord with Section 01657.

C. Test the switchgear in accord with Section 01669.

3.02 SPARE PARTS

A. Provide spare parts listed and in the quantities named on the Shop Drawing submittal.

B. Deliver parts in boxes or other suitable packing clearly marked "Spare Parts". Attach a packing list to the outside of the package which includes the name and part number for all parts in the package.

END OF SECTION

SECTION 16450

GROUNDING

PART 1 GENERAL

1.01 RELATED WORK

A. Section 16010: Electrical General.

B. Section 16120: Wire and Cable.

1.02 DESCRIPTION OF SYSTEM

A. Provide an effective ground system. Install the ground system so that the line to ground circuit has an impedance sufficiently low to limit the potential above ground and to facilitate the operation of the overcurrent devices in the circuit.

B. Provide ground conductors as short and straight as possible, protected from mechanical injury and, where possible, without splices or joints.

1.03 CODES AND APPROVALS

A. Conform to the following as a minimum:
1. National Electrical Code.
2. IEEE Publication No. 142.

1.04 SUBMITTALS

A. Submit ground resistance test results in accord with Section 01340 showing temperature, humidity and soil conditions.

PART 2 PRODUCTS

2.01 CONDUCTORS

A. Conform to Section 16120.

2.02 SYSTEM NEUTRAL GROUND

A. Conductor: white insulated, current carrying neutral, over which the unbalanced load currents may flow.

2.03 EQUIPMENT GROUND

A. Conductor: green (black where green is not available) insulated, one size smaller than phase conductors.
1. Maximum size: 4/0 AWG.
2. Minimum size: 12 AWG.

B. Provide green identification tape at each junction box or device enclosure if black insulation is used.

2.04 BUILDING STRUCTURAL GROUND

A. Conductor: bare, 4/0 AWG.

B. Electrodes: 20 mm x 3 meters long, copperweld ground rods with threaded bronze couplings.

PART 3 EXECUTION

3.01 SYSTEM NEUTRAL GROUND

A. Originate neutral conductor at the grounded wye secondary of the distribution transformers.

B. Solidly ground the wye connected secondary neutral point of the transformer to the primary source equipment ground, the secondary equipment neutral ground bus, and to two separate joints of the building structural ground system.

3.02 EQUIPMENT GROUND

A. Establish the equipment ground at each transformer secondary winding at the same point that the system neutral originates.

B. Do not use the equipment ground conductor as a load current-carrying conductor. Make the equipment ground conductor electrically and mechanically continuous from the source of supply to the equipment to be grounded. Provide a low impedence path for line-to-ground fault currents. Bond all non-current carrying enclosures together including raceways, fixtures, panels, controls, motors, disconnect switches, exterior lighting standards, transformer neutrals, and building structural grounds.

C. Provide equipment ground conductor for each power and lighting conduit.

D. Connect the armor of interlocked armor cable, wiring channels, cable trays and all metallic conduit including rigid, electrical metallic tubing, and flexible conduits at each end to the equipment ground conductor with a conduit ground bushing.

E. Provide switchgear, panelboards and motor control panels with an equipment ground bus (including lug or screw terminals) securely bonded to the enclosure. Provide junction boxes and other enclosures with an equipment ground bus or lug as required to securely bond the equipment ground conductor to the enclosure.

F. Connect lighting fixtures to the equipment ground conductor. A continuous row of fluorescent fixtures mechanically joined to provide good electrical contact may be considered as one fixture with the equipment ground conductor connected at only one point.

G. Connect motors to the equipment ground conductor. Bolts, nuts and washers shall be bronze, cadmium plated steel, or other non-corrosive material.

3.03 BUILDING STRUCTURAL GROUND

A. Provide a ground bus loop buried a minimum of 600 mm below finished grade and 600 mm outside the structural footing around the entire perimeter of buildings.

B. Extend loop as shown on the Drawings to provide for grounding of equipment located in the field.

C. Provide electrodes as shown on the Drawings. Connect each electrode to the grounding system. Drive 3 meters long electrode until the top of the ground electrode is 150 mm below grade.

D. Make below grade connections by brazing or thermite welding.

E. After installation of the ground bus and ground electrodes, provide ground resistance testing prior to interconnection of other grounding systems.
   1. Test ground resistance with a Ground Resistance Direct-Reading single test meter utilizing the AC Fall-of-Potential Method and two reference electrodes.
   2. Orient the ground electrode to the tested and the two reference electrodes in a straight line spaced 15 meters apart.
   3. Drive the two reference electrodes 1.5 meters deep.
   4. The use of chemicals such as sodium chloride, copper sulphate, magnesium sulphate, calcium chloride and/or other forms of soil treatment to reduce soil resistivity and to obtain the required grounding resistance is not permitted.
   5. Where the ground resistance exceeds 3 ohms, do not proceed without Engineer's additional instructions.

F. Connect monorails and crane rails to the grounding system.

G. Connect domestic metallic water pipes to the grounding system.

H. Connect miscellaneous metal objects including piping, vessels and structural shapes within six feet of metallic objects connected to the ground system and which are not interconnected mechanically with the grounding system, with a minimum No. 5 AWG bare copper conductor.

I. Where structural steel is used in a grounding circuit, use welded connections or brazed or "Cadwelded" shunts in the ground current circuit. Bolted or riveted structural connections are not permitted as current carrying connections.

J. Connect all exterior metal tanks, railings, and walkways to the ground system.

END OF SECTION

SECTION 16510

LIGHTING

PART 1 GENERAL

1.01 RELATED WORK

A. Section 16010: Electrical General

B. Section 16120: Wires and Cables

1.02 LIGHTING REQUIREMENTS

A. All fixtures and lamps within one room or area shall be of one type.

1.03 REQUIREMENTS OF REGULATORY AGENCIES

A. Provide ballasts that meet standards of an electrical testing laboratory and the Certified Ballasts Manufacturers' Association.

B. Provide UL label on all lighting fixtures.

1.04 CERTIFICATION

A. Fluorescent ballasts: for full light output with maximum average input of 80 watts when operating two fluorescent lamps as specified. Ballasts shall be certified for Class "P" CBM/ETL.

1.05 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 01340 for the following:
1. Lamps
2. Ballasts
3. Luminaires
4. Mounting fixtures and poles

B. Submit Certificate of Compliance for ballasts in accord with Section 01340.

C. Submit samples of luminaires prior to final production.

D. If requested by the Engineer, provide complete photometric data and heat dissipation reports from independent testing laboratory.

1.06 COORDINATION

A. Confirm compatibility and interface of other materials with luminaire and ceiling system. Report discrepancies to the Engineer, and defer ordering until clarified.

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B. Supply plaster frames, trim rings and backboxes to other trades.

C. Coordinate with Division 15 to avoid conflicts between luminaires, supports, fittings, and mechanical equipment.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Only one manufacturer is listed for each Product in the Lighting Schedule. This listing shall mean the listed manufacturer, or equal is acceptable.

B. Substitutions: Items of function and performance are acceptable in conformance with Section 01630.

2.02 LAMPS

A. Incandescent Lamps: 2500 hour, 220 volt, inside frosted extended service. Provide special lamps from longest life available in each category
   1. Lamps under 300 watts: medium base
   2. Lamps 300 watts and more: mogul base.

B. Fluorescent lamps: T12, rapid start cool white Minimum 3050 Lumens initial output while consuming 34 watts maximum.

C. High pressure sodium lamps: As scheduled.

D. Low pressure sodium lamps: As scheduled.

2.03 BALLASTS

A. Interior Fluorescent Ballasts: 220 volt, automatic reset, thermal protection with 90 percent power factor, class P rated, Group B noise rating;
   1. Utilize two-lamp ballasts wherever possible.
   2. Supply ballasts complete with heat radiators to prevent nuisance tripping.
   3. Equip ballasts with capacitors and pressure relief devices to prevent rupturing
   4. Provide average ballast life of 10-12 years.

B. Exterior Fluorescent Ballasts: as specified above, low temperature type, providing reliable starting to -20 degrees F (-29 degrees C);

C. High Intensity Discharge Ballast: 220 volt, single lamp of the constant wattage high power factor, stabilized auto transformer type.
   1. Select exterior ballasts for reliable starting to -20 degrees F (-29 degrees C).

2.04 FLOURESCENT LUMINAIRES

A. Prime coat and finish in high reflectance baked white enamel, two coats minimum on exposed and reflective surfaces, giving reflectance of 85 per cent.

B. Reflective plates may be 22 gage (0.80 mm) metal.

C. Provide 20 gage (0.90 mm) steel housing.

D. Design luminaire to dissipate ballast and lamp heat.

E. Use formed or ribbed backplates, endplates, reinforcing channels,

2.05 RECESSED LUMINAIRES

A. Recessed incandescent luminaires: Prewired type with junction box forming an integral part of the assembly.

B. Supply recessed luminaire complete with trim type required for ceiling system installed. Before ordering, confirm ceiling construction details and architectural finish for each area.

C. including mounting yokes or bridges. Minimum distance from backface of luminaire or lens to center of lamp (63.5 mm).

D. Select reflector and lamp positions to provide high efficiency, and even brightness to eliminate lamp lines.

E. Provide integral encapsulated ballasts for recessed high intensity discharge luminaires.

F. Provide hinged frames with catches; removable for cleaning without tools. Support lay-in lenses on four sides with flip ends on short dimension.

G. Provide gasketing, stops, and barriers to form light traps and prevent light leaks.

H. Provide virgin acrylic diffusers, (3 mm) thick minimum.

PART 3 EXECUTION

3.01 SUPPORTS

A. Support pendant fluorescent luminaires directly from building structure by rod hangers and inserts. Recessed fluorescent luminaries shall be supported by wire or metal angle headers supported from framing structure of ceiling suspension system.

B. Support luminaires more than 2 ft (610 mm) wide by four hangers per luminaire minimum independent of ceiling structure or tee bars.

3.02 RECESSED LUMINAIRES

A. Install recessed luminaires to permit removal from below, to gain access to outlet or prewired fixture box.

B. Connect recessed luminaire to boxes with flexible conduit and fixture wire.

C. Mounted in suspended ceiling with exposed tee bar grid system, support from the ceiling tee bar grid structure and secure thereto.

3.03 BALLAST INSTALLATION

A. Provide ballasts of compatible design to lamps specified.

B. Mount high intensity discharge ballasts on rubber grommets to reduce noise transmission.

3.04 LAMP INSTALLATION

A. Install lamps in accordance with manufacturer's instructions.

3.05 ALIGNMENT

A. Align luminaires and clean diffusers prior to final acceptance.

3.06 FIXTURE SCHEDULE

A. Only one manufacturer's fixture of each type is listed in the following Schedule to establish the type and quality of fixtures required. Fixtures of other manufacturers, equal in quality and performance, will be acceptable.

Type	Description
A	Fluorescent, pendant mounted, industrial 1' x 4'-0" with 2-35 watt rapid start lamps w/procelain enamel reflector; similar to Columbia Cat. No. FI-240-M17, except with energy saving ballast rated 220 volt - 50 Hz.
A1	Fluorescent, pendant mounted, industrial 4'-0" length with 1-35 watt rapid start lamp w/procelain enamel symmetric reflector; similar to Columbia Cat. No. FS-140-M4, except with energy saving ballast rated 220 volt - 60 Hz.
A2	Fluorescent, pendant mounted, industrial 2' x 4'-0" with 4-35 watt rapid start lamps w/procelain enamel reflector; similar to Columbia Cat. No. FI-440-M17,

except with energy saving ballast rated 220 volt - 50 Hz.

B — High pressure sodium vapor, stanchion mounted, 70 watt asymmetrical refractor, enclosed and gasketed, with photocontrol; similar to Holophane Cat. No. 1946NS-ST-07978, except to contain ballast rated for 220 volt - 50 Hz.

B1 — High pressure sodium vapor, wall mounted, 70 watt, symmetrical refractor, enclosed and gasketed, with photocontrol; similar to Holophane Cat. No. 1945NS-WL-07980, except to contain ballast rated for 220 volt - 50 Hz.

B2 — High pressure sodium vapor, wall mounted, 100 watt, die-cast aluminum housing, suitable for wet locations; similar to Holophane Cat. No. 1487-240, except to contain ballast rated for 220 volt - 50 Hz.

B3 — High pressure sodium vapor, pendant mounted, 150 watt, closed bottom reflector, enclosed and gasketed; similar to Holophane Cat. No. 346NSC-100, except to contain ballast rated for 220 volt - 50 Hz.

B4 — High pressure sodium vapor, pendant mounted, 250 watt, reflector lens, enclosed and gasketed; similar to Crouse Hinds Cat. No. VMVS2C250RD4, except to contain ballast rated for 220 volt - 50 Hz.

B5 — High pressure sodium vapor floodlight, pole mounted, 250 watt, heavy-duty die cast housing with tempered glass lens, w/trunnion and PE receptacle; similar to General Electric HLX Powerflood Cat. No. C675NO75, except 50 contain ballast and photoelectric control rated for 220 volt - 50 Hz.

B6 — High pressure sodium vapor roadway luminaire, pole mounted, 400 watt, die cast aluminum housing with prismatic glass lens for Type III IES light distribution, with PE receptacle, similar to General Electric M-400A power/Door Cat. No. C724N547, except to contain ballast and photoelectric control rated for 220 volt - 50 Hz.

C — Incandescent, 100 watt, w/4" box-mounted wall bracket, die-cast

aluminum-enclosed and gasketed, with glass globe and cast guard, with photocontrol - 220 volt - 50 Hz; Keene/Stonco Cat. No. VWXL-11GC.

D Emergency lighting unit, maintenance free, medium life, sealed lead battery and solid-state fully automatic voltage regulated charger able to recharge the battery in accordance with U.L. Standard 924. Unit to include "Push-to-Test" switch, led Charge Monitor, two (2) tungston halogen lamp heads, AC fuse, and AC power - On/Off switch; similar to Chloride Cat. No. TMF50-ACF-ACP, except rated for usage on 220 volts - 50 Hz.

7.6 meter aluminum pole for mounting of one (1) floodlight (Item B5); General Electric Cat. No. C895H189.

7.6 meter aluminum pole for mounting of two (2) floodlights (Item B5); General Electric Cat. No. C895H133, with bracket Cat. No. C600H311.

7.6 meter aluminum pole for mounting of three (30 floodlights (Item B5) General Electric Cat. No. C895H133, with bracket Cat. No. C600H314.

7.6 meter aluminum pole for mounting one (1) roadway luminaire (Item B6); General Electric Cat. No. C899H136.

7.6 meter aluminum pole for mounting of one (1) floodlight (Item B5) and one (1) roadway luminaire 9Item B6); General Electric Cat. No. C895H133, with brackets Cat. No. C600H311 and C500H767.

END OF SECTION

SECTION 16760

INTERCOMMUNICATION SYSTEM

PART 1 GENERAL

1.01 RELATED WORK

A. Section 01340: Shop Drawings, Product Data and Samples.

B. Section 01730: Operation and Maintenance Manuals.

C. Section 16010: Electrical General.

1.02 DESCRIPTION OF SYSTEM

A. Furnish and install all necessary equipment including mounting brackets and accessories for a complete operable and working intercommunication system as herein specified and as shown on the Drawings. Station location and type are shown on the Drawings.

B. The system shall be a page-multi party line system to provide voice communication between phone station locations and speaker stations including locations of high ambient noise levels of approximately 80 dbA. These station locations are shown on the Drawings.

C. The system shall provide six independent communications channels, one for paging and five for party-line. The paging channel will be used to call personnel to the nearest phone station or issue plant-wide instructions.

D. The system shall be common-talking, so that all stations may take part in any conversation. For paging, all speakers, except those silenced by handsets in use, shall carry all sides of the conversation. The party-line channels shall be separate from the page channel thereby allowing conversations to take place simultaneously without interference between circuits. Speakers shall not carry the party-line conversation. The speaker silencing circuit shall be so arranged that the speakers adjacent to handset station are not silenced to page call when that handset is in use on a party-line circuit. Handsets shall perform satisfactorily in areas of high ambient noise (including that approaching the threshold of pain) without the use of acoustic protective enclosures or devices.

E. Simultaneous conversations shall be able to be carried on separate channels without interference.

F. Bridging loss, due to as many as eight handsets operating on either channel (paging or party-line) shall not exceed 3 db. The over-all gain of the system shall be great enough to overcome such bridging loss.

G. Speaker amplifiers shall be provided for each re-entrant loudspeaker and for each/or group of direct radiator speakers.

H. Provide a line balance control to enable optimum loading for the party-line circuits and adjustment (which is normally concealed) for optimum loading for the page circuit. Line balance assembly shall be completely assembled and wired within a suitable enclosure for mounting in the location.

I. Field wiring cable shall be furnished by the system manufacturer.

J. The system shall be supplied by Gai-tronic of Reading, Pa. or approved equal.

1.03 QUALITY ASSURANCE

A. All material used in the construction of the intercommunication system shall be new and selected as the best available for the purpose used, considering reliability, long life and best engineering practices. Liberal factors of safety shall be used throughout the design. Only heavy duty industrial components rated to operate within temperature ranges and under environmental conditions of the project site. Entertainment and commercial types of components will not be acceptable.

B. The Owner shall have free entry into shops of the manufacturer at all times while fabrication and testing of the specified equipment is being performed. The manufacturer shall award the Owner, free of cost, all reasonable facilities necessary to satisfy the Owner that the material and fabrication is in accordance with the Specifications. However, such inspection or waivering of inspection by the Owner shall not relieve the manufacturer of his responsibility for furnishing material and equipment to conform to the requirements of the specification, nor invalidate any claim which the Owner may make because of defective or unsatisfactory material and equipment.

C. The manufacturer shall guarantee that no crosstalk, interference nor oscillation will occur due to induced coupling under wiring conditions of this installation when installed in accordance with his field wiring recommendations.

1.04 PERFORMANCE GUARANTEE

A. The Contractor shall warrant that the system shall satisfactorily function and be audible for intelligent voice communication under ambient sound conditions and noise levels of the installation during operating conditions.

B. The Contractor shall warrant the satisfactory and successful operation of all equipment furnished under this Section at the ratings, under the conditions, and for the type of service specified herein. The Contractor further shall warrant all equipment to be as represented by him and as specified and shall warrant against all defects in design, material and workmanship.

C. Upon written notice from the Owner, the manufacturer shall, on a no-charge basis, repair or replace parts which may fail and remedy such defects as may develop within the first year of actual operating service under the specified and ordinary use of the equipment furnished under this Section from the date of acceptance of the Work.

1.05 SUBMITTALS

A. Shop Drawings shall be submitted in accordance with Section 01340.

B. Shop Drawings shall be complete electrically and physically. They shall be coordinated so as to provide complete and concise information for installation and future maintenance.

C. Shop Drawings shall consist of the following:
1. Physical drawings showing outlines and mounting details of all various loudspeakers, handset stations, control stations and all other special devices.
2. Wiring, Schematic Diagrams and interconnection diagrams for all devices, as set forth in (1) above, showing internal wiring with values and replacement nomenclature for all components, terminal blocks with sequential arrangement, cable grouping with color coding and interconnection information.
3. Complete speaker and handset reference index listing locations, types, circuit allocations and assembly components of loudspeakers; locations, types, circuit allocations and speaker silencing data of handset stations and any other pertinent information.

D. Operation and maintenance manuals shall be submitted in accordance with Section 01730.

1.06 SPARE PARTS

A. Spare parts shall be provided as recommended by the system manufacturer and shall include the following:
1. 10% fuses of each size and type with a minimum quantity of three.
2. One spare circuit board or plug-in sub-assembly including a complete amplifier assembly for each different type furnished.

B. One spare hand set complete with cord assembly.
1. One spare speaker assembly of each type.

C. Spare parts shall be individually packaged in hermetically sealed moisture proof see-through enclosures complete with desicant and completely labeled with the item name, part number or assembly number. Fuses may be furnished in boxes or clear plastic envelopes clearly labeled with part number, amperage, voltage and manufacturers identifying numbers.

1.07 FACTORY TESTING AND TRAINING

A. The Manufacturer shall provide a trained, competent field service representative to visit the plant and perform a complete field test of the equipment. At that time, the field service representative shall supervise the orientation of all loudspeakers and the adjustment of all volume, gain and attenuation controls, thus establishing proper operating levels for all equipment.

B. The field service representative shall also instruct the Owner's operating and maintenance personnel on the proper use and care of the Intercommunication system.

PART 2 PRODUCTS

2.01 GENERAL

A. Each phone station with speaker near handset shall consist of a handset with amplifier and shall be complete with channel selector switch, speaker muting, local volume control, and appropriate housing for the area as specified.

2.02 HANDSET AND HANDSET AMPLIFIER

A. All handset stations shall be designed so that maximum safety and isolation from live circuits will be provided for the operator under all conditions. Transmitter units shall be contained in a non-metallic, non-conducting case to provide maximum guard against shock hazard.

B. The handset station amplifier shall consist of a sturdy compact amplifier, employing transistors and printed circuitry and replaceable components and self-aligning plug-in arrangements; providing an output suitable for driving speaker amplifiers (for page channel) and other handset stations (for party-line channel). The front panel which is fitted with a gasket is to provide a sealed cover for the enclosure. Included as part of the amplifier assembly shall be:
   1. Telephone type handset molded of Cycolac (ABS Resin) containing a high sensitivity dynamic receiver and a lower impedence, noise cancelling, balanced line, pressure-differential dynamic transmitter to provide discrimination against surrounding noise. A filter shall protect the transmitter from breath moisture, dirt and other foreign particles.

2. A flush hang-up switch with enclosed snap action contacts which connect the handset and amplifier to external circuits and silence the nearby loudspeaker, if desired.
3. A heavy-duty pushbutton switch for page or party-line channel selection. Pushbutton shall be arranged for push-for-page (spring return to party-line) operation, or button can be rotated 90 degrees to lock-in page position.

C. The electrical characteristics of each type handset station amplifier shall be identical although dimensions and associated components may vary in accordance with application. Electrical requirements shall be as follows:

1.	Power Supply	220 Volts A.C. 50 Hz. fused
2.	Power Consumed	1.5 watts 3.6 V.A.
3.	Ambient Temp. Range	-30 deg. C (-22 deg. F.) to +70 deg. C (158 deg. F.)
4.	Circuit	Class "A" and including anti-sidetone for associated handset receiver
5.	Gain	70 db
6.	Output	Transformer coupled, 1.5 volts (nominal) into 33 ohm load
7.	Frequency Response	250 to 15,000 Hz. (high frequency shall be attenuable to 4,000 Hz.
8.	Controls	Transmission Level, Receiver Volume and Frequency Attenuation (all to be adjustable through access holes in side bracket)

D. Amplifier chassis shall form the front cover of its enclosure. When amplifier is removed from enclosure, it

shall be disconnected from all live circuits by physical interlocking arrangement of plug and receptacle (cable plug and receptacle device, requiring separate operation for disconnection, will not be acceptable.)

2.03 SPEAKER AMPLIFIER

A. Speaker amplifier shall consist of a sturdy, compact amplifier, employing transistors and printed circuitry with replaceable components and self-aligning plug-in arrangement providing sufficient output to directly drive cone or horn type loudspeakers. Front panel shall be fitted with gasket to provide a sealed cover for the indoor enclosures. Electrical requirements shall be as follows:

1.	Power Supply	220 Volts A.C., 50 Hz.
2.	Power Consumption	Zero signal 4 watts, 7 VA; Maximum signal 25 watts, 34 VA
3.	Ambient Temp. Range	-30 deg. C (-22 deg F) to +70 deg C (158 deg F)
4.	Circuit	Push pull, Class B
5.	Input	10,000 ohm, bridging (transformer coupled)
6.	Gain	57 db
7.	Output	8 and 16 ohms impedance, transformer coupled
8.	Power Output	12 watts
9.	Frequency Response	250 to 15,000 Hz. (high frequency shall be attenuable to 2,400 Hz.)
10.	Controls	Volume; concealed but accessible without removing amplifier from enclosure. High frequency attenduation; internal

B. Disconnection arrangement between speaker amplifier and enclosure shall be identical with that described above.

C. Indoor speaker amplifier for speaker not associated with a handset enclosure shall consist of a dustproof steel housing 8" x 8" x 5" containing marked, molded barrier type terminal facilities wired to receptacle for plug-in amplifier. Four combination 3/4"-1" conduit knockouts shall be provided for attachment of field conduit.

D. Weatherproof speaker amplifier enclosure shall contain terminal facilities and receptacle to accept the standard plug-in amplifier and shall be constructed of cast alloy, approximately 9" x 9" x 6" with gasketed front coverplate completely sealing the unit. Threaded hubs shall be provided, top and bottom, for entrance of 1-1/4" conduit.

2.04 LINE BALANCE ASSEMBLY

A. The assembly shall consist of fixed and variable resistors wired to terminals to permit field balancing of the paging system.

2.05 SPEAKER AND SPEAKER STATIONS

A. Each separate speaker station shall be complete with amplifier volume control and speaker. Note that some speakers may have remote volume control.

B. Each speaker shall have independent volume controls.

C. Speaker Types:
1. Type S - Indoor ceiling type cone speaker assembly, frequency response 100-1300 Hz., sound pressure level 85 db.
2. Type S1 - Similar to Type S except mount in a simulated wood grain walnut finish enclosure for wall mounting.
3. Type LS - Loud speaker with all mounting hardware. Frequency response 250-13000 Hz., power rating 30 watts, dispersion 105 deg and sound pressure level 126 db.
4. Hazardous area speakers shall be similar to the above except as approved for Class 1, Division 1 areas.

2.06 WALL STATION

A. Include a handset station with integral handset and speaker amplifier and an enclosure suitable for indoor wall or column mounting.

B. Handset shall be equipped with a standard six foot (extended length) telephone type unshielded, retractile cord to provide freedom of movement for the operator and to prevent tangling with other cables and equipment. Longer length cords (15 foot or 25 foot extended length) shall be furnished as noted on Drawings.

C. The enclosure shall consist of a dustproof steel housing, 12" high x 8" wide x 5" deep containing a five position, ball detent action, enclosed contacts rotary switch for party-line selection, mounted on a 4" high front plate (plug-in amplifier shall occupy the remaining 8" height of the enclosure). Marked molded barrier type terminal facilities shall be internally wired to the party-line selector switch and to the receptacle for the plug-in amplifier. Conduit knockouts shall be provided as specified in paragraph (1) above.

2.07 WEATHERPROOF PHONE STATION

A. Include a handset station with integral amplifiers and weatherproof enclosure. The handset station amplifier shall be identical with that described.
   1. The weatherproof enclosure shall be constructed of cast alloy with gasketed, side hinged, front door equipped with handle operated cam latch. Threaded hubs shall be provided, top and bottom, for entrance of 1-1/4" conduit. This enclosure shall contain marked molded barrier type terminal strip wired to receptacle for plug-in amplifier. This enclosure shall also include a party-line selector switch.

2.08 HAZARDOUS AREA PHONE STATION (FOR DIVISION 1 AREAS)

A. Include handset and retractile cord as specified and attached with sealing connector to an approved (Class 1, Group D) condulet containing hang-up switch and page-party line selector pushbutton ('lock-in page", not required). This subset shall also include a party-line selector switch. For outdoor use, this complete subset assembly shall be contained within a weatherproof enclosure. The amplifiers, identical with those specified, shall be contained within an approved (Class 1, Group D) enclosure with machined surface bolt-in cover. One drilled and tapped hole shall be provided top and bottom to accommodate 1-1/4" field conduit.
   1. Hazardous area speaker amplifier enclosure shall be a heavy casting with machined surface, bolt-on cover and approved for Class 1, Group D, Division 1 and Class 11, Group E, F, and G Division 1 areas. One drilled and tapped hole, top and bottom shall be provided to accommodate 1-1/4" field conduit. Enclosure shall contain marked, molded barrier type terminal strip wired to receptacle for plug-in amplifier.

2.09 DESK TOP PHONE STATION

A. Include a desk top subset and an amplifier with enclosure.
   1. The desk top subset shall consist of a sloping panel turret with side cradle type hag-up switch. The page-party line selector pushbutton (and for multiple party-line, the party-line selector switch) mounted on the sloping panel, and the handset assembly shall be identical with that in paragraph h(1) above. For page calls, a high quality cone speaker with perforated protective grill and volume control shall also be mounted on the sloping panel. All wiring shall be brought out in an eight foot flexible cable and terminated in a connector to plug into the remotely mounted amplifier or enclosure. Amplifier assembly and enclosure shall be identical with that described.

PART 3 EXECUTION

3.01 INSTALLATION

A. Wiring shall be of the type and construction as specified by the system manufacturer and shall be connected according to the Shop Drawings furnished by the system manufacturer.

B. All wiring shall be installed in the duct and conduit system.

C. Unless specified otherwise the interconnection wiring shall consist of one multi-conductor cable for page, party-lines and power circuits, to consist of:
   1. Six twisted pairs with 2.50" (maximum) lay, each conductor No. 18 AWG (16 strands No. 30), soft drawn bare copper with .032" wall of 105 deg C polyvinyl chloride insulation, color coded as follows:
      a. Party Line No. 1 - Red/Black
      b. Party Line No. 2 - Green/Black
      c. Party Line No. 3 - Blue/Black
      d. Party Line No. 4 - Brown/Black
      e. Party Line No. 5 - Yellow/Black
      f. Page Line - Blue/Red
   2. One twisted pair with 3.50" (maximum) lay, each conductor No. 14 AWG (41 strands No. 30), soft drawn bare copper with .047" wall of 105 deg. C polyvinyl chloride insulation, color coded black and white.
   3. All pairs shall be twisted with systematically varying lays to minimize crosstalk, bound into a uniformly round cable, taped with a non-hygroscopic binder and insulated by an overall 600 volt jacket of .060" wall of hard-service dark gray 105 deg C polyvinyl chloride, maximum O.D. 16.635". Cable shall be provided on 1000 foot (one continuous length) non-returnable reels.

D. Communication and A.C. power circuits for the communications system will be run in the same raceways. There will be some conduits that have 220 volt control cables mounted with phone system cables.

END OF SECTION

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SECTION 16900

ELECTRICAL SYSTEM CONTROL DEVICES

PART 1 GENERAL

1.01 RELATED WORK

A. Section 16010: Electrical General

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Substitutions: Items of same function and performance are acceptable in conformance with Section 01630.

2.02 PUSHBUTTONS

A. Selector switches or pushbuttons stations located at motors: provide a lockout on the STOP button, or OFF position.

B. Surface mounted pushbutton stations or selector switches:
1. In non-process and dry locations: heavy duty, oil tight mounted in a NEMA 1 cast enclosure, manufactured by: Square "D" Class 9001, Allen Bradley Bulletin 800T, or equal.
2. In process, wet or chemical locations: heavy duty, watertight, corrosion resistant mounted in a NEMA 4 enclosure, manufactured by: Allen Bradley, Square D, Crouse Hinds, or equal.

2.03 CLOCK TIMERS

A. Timers for automatic motor control: mount in a NEMA 1 enclosure unless otherwise shown on Drawings.

B. Repeat-cycle timers: two time scales, complete with dial, pointer and knob for setting desired "ON" and "OFF" time periods. Driven by a synchronous motor for repeated accuracy, manufactured by: Eagle Signal, ATC, or equal.

2.04 RELAYS - CONTROL

A. Control relays: Pressure molded coils with convertible contacts for continuous current of 10 amperes up to 600 volts, manufactured by: Allen Bradley Type BR, Square D Type H, or equal.

2.05 RELAY - TIMING

A. Acceptable Manufacturers: Agastat Series 2400.

B. Pneumatic time delay relays:
1. Coil: precision wound potted type.

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2. Provide timing head to recirculate air under controlled pressure through a variable orifice to provide linearly adjustable timing without the use of a needle valve.
3. Switch mechanism: designed to provide a no-flutter transfer action with beryllium copper blades and gold-bonded silver-cadium oxide contacts.

2.06 FLOAT SWITCHES

A. Float switches: hermetically sealed, dust proof type mercury switches mounted on a weighted overcenter mechanism operated by a stainless steel shaft on oilite bearings.
1. Float: a 114 mm diameter ceramic float suspended on a 6 mm diameter stainless rod from the switch operating arm.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install devices in accord with manufacturer's instructions.

3.02 IDENTIFICATION

A. Label all pushbutton stations, selector switches and other control devices permanently with engraved plates stating its function and what it controls.

3.03 SPARE PARTS

A. Provide one spare pushbutton and selector switch for each type installed, complete with required type of enclosure, and one normally open and one normally closed contact for each operator or switch position.

END OF SECTION

SECTION 16920

MOTOR CONTROL CENTERS

PART 1 GENERAL

1.01 RELATED WORK

A. Section 16001: Electrical Work.

1.02 REFERENCE STANDARDS

A. Design, build, and test electrical equipment in accord with NEMA 1CS.

1.03 SUBMITTALS

A. Submit shop drawings in accord with Section 01340.

B. Submit operation and maintenance manuals in accord with Section 01738.

C. Submit for approval:
1. Overall dimensions and arrangement.
2. Wiring diagrams
3. Complete nameplate listing.
4. Fuse, breaker and overload siting schedule (can be combined with wiring diagrams).

1.04 STORAGE

A. Store motor control centers inside a clean, dry and ventilated building free from temperature extremes.

B. If storage area is cool or damp, heat shall be provided to prevent condensation.

1.05 ACCESSORIES

A. Provide one set of special tools per center that may be required for withdrawing and inserting control units and for normal maintenance work.

1.06 SPARE PARTS

A. Provide the following spare parts delivered to the Project site after equipment is accepted by Owner.
1. Two of each type of integral control devices.
2. Six of each type of fuse.
3. One complement of overload relays (three of each size use).
4. Three sets of stationary and movable contacts for each size contactor.
5. One operating coil of each size and type used.

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PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

A. Cutler Hammer, Square-D, or equal.

2.02 ENCLOSURE

A. Enclosure:: Vertical sections approximately 500 mm deep, 500 mm wide, and 2.3 meters high joined together to form a rigid free standing, completely dead front assembly.

2.03 BUS WORK

A. For each vertical section, provide 3 phase, main horizontal plated bus rated as specified on Data Sheets but with a 600 amps. minimum.

B. Distribute power to control units with 3 phase, plated vertical bus rated 300 amps. minimum.

C. Brace bus work to withstand available short circuit current.

D. Buss supports: formed of a non-hygroscopic, high dielectric strength, molded compounded with high impact strength and high creepage surface.

E. Extend 3 mm by 2.5 mm copper ground bus the full length of a motor control center.

2.04 CONTROL UNITS

A. Control units: combination type, furnished complete and wired.

B. Control unit Sizes 1, 2, 3 and 4: "draw out" type with stab-on connections to the bus and quick disconnect control terminal strips.

C. Size 5 control unit, or control units above 135 amperes: fixed connection design.

D. Stab-on connectors: silver plated with free floating spring construction to insure positive silver-to-silver contact with vertical bus at all times.

E. Provide means in the stationary structure for supporting and aligning the control units during replacement.

F. Hold units in place by quick captive screw fasteners arranged so that the units can be withdrawn from the vertical section without access to the rear of the structure

G. Each unit occupying a single space shall be interchangeable with every other unit occupying a single space.

H. Construct units to be properly ventilated regardless of location in control grouping.

I. Provide units with complete steel top and bottom plates for maximum isolation between units.

J. Power wiring: No. 12 AWG minimum, within the units.

K. Control wiring: No. 14 AWG minimum, within the units.

L. Divide unused space in Size 1 compartments unless otherwise noted, to facilitate the future installation of Size 1 starters.

2.05 DISCONNECT DEVICES

A. Individual fused switches: 2 or 3 pole, single throw, 600 volt class, ampere rating as required, capable of withstanding the available short circuit current at 380 volt.
   1. Fuses shall be dual element time delay current limiting type.
   2. Fuses shall be sized to provide branch circuit protection.
   3. Fuses shall be Bussmann type SPS-RK with an interrupting rating of 200,000 amperes.

B. Fused switches in combination starters: 3 pole, single throw, 600 volt class, ampere rating as required, capable of withstanding the available short circuit current at 380 volts.
   1. Fuses shall be dual element time delay current limiting type.
   2. Fuses shall be sized to provide branch circuit protection.
   3. Fuses shall be Bussmann type LPS-RK with an interrupting rating of 200,000 amperes.

2.06 MOTOR CONTROL AND CONTACTORS

A. Motor controllers and contactors: combination type enclosed as a unit in an assembly with one door.

B. Interlock door with the disconnect handle so that the handle must be in the OFF position before the door can be opened.

C. Provide means to pad lock the handle in either ON or OFF position.

D. Provide interlocks for interrupting all voltage sources entering the starter before the door can be opened.

E. Provide each motor controller with the following:
   1. thermal overload relays with externally operated non-auto reset button.

2. at least one normally open and one normally closed auxiliary contacts as spares in addition to those used in the schematic diagrams.
3. Mount auxiliary devices including elapsed time meters or ammeters in the unit as required by the schematic diagrams or schedules.

2.07 DIAGRAMS

A. Make NEMA Class II schematic and wiring diagram of each control circuit including devices external to the motor control center.

B. Permanently fasten drawings inside the unit door.

C. Permanently fasten plastic laminated nameplate to the outside of each unit stating the Circuit No., Drive No., Application, and Horsepower for each unit. Fasten a similar nameplate to the drawout portion of the controller to identify it for replacement in the proper cubicle.

PART 3 EXECUTION

3.01 INSTALLATION

A. Conform to Manufacturer's instructions.

3.02 MOTOR CONTROL CENTER SCHEDULE

A. See attached data sheets.

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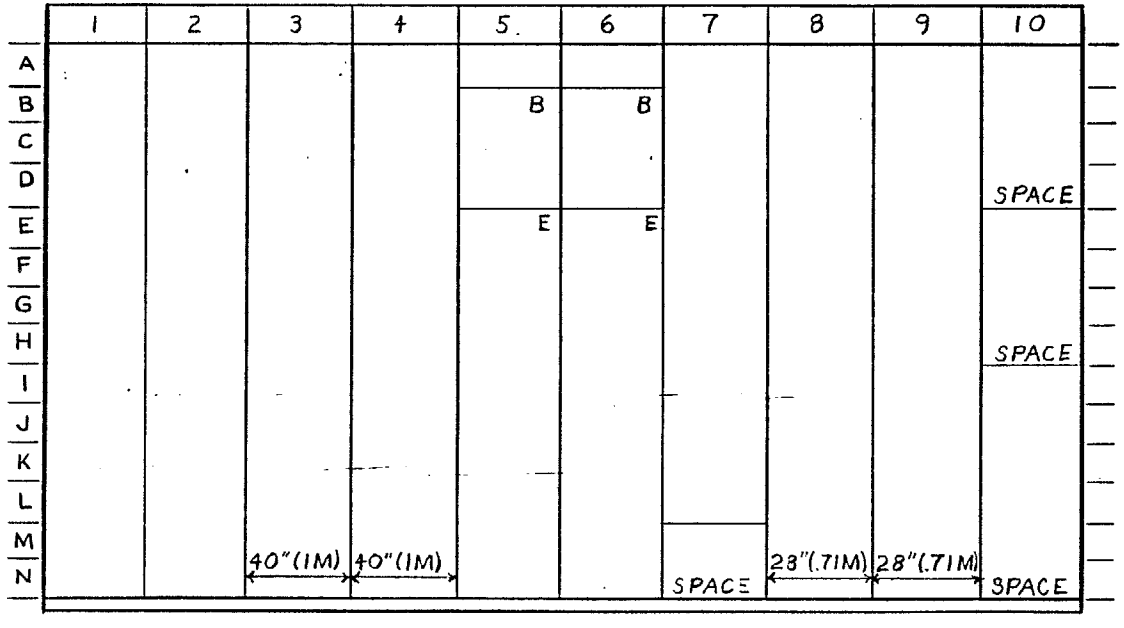
K&E 10 1253 8-80 MC1452a

MOTOR CONTROL CENTER

FRONT ELEVATION



MAIN POWER

380 VOLTS 3 PHASE

50 HERTZ 4 WIRE

CABLE ENTRY

_____ COMPARTMENT 1N

3 600 MCM PER PHASE

BUS

1200 AMP MAIN W/NEUTRAL 1/8"x 1" (MIN.) GROUND

MATERIAL COPPER

22000 AMP SYMMETRICAL BRACING

WIRING

NEMA CLASS II

TYPE B

CONTROL VOLTAGE 220

ENCLOSURE

NEMA 1GASKETED

ARRANGEMENT _____

FINISH _____

UNIT NAMEPLATE MCC 1P1

DEPTH 20"(50.8CM)

SECTION WIDTH 20 (50.8CM)

MCC NO. — 1P1

ROY F. WESTON, INC

WESTON ENVIRONMENTAL CONSULTANTS-DESIGNERS

DRAWN	DATE	DES. ENG.	DATE	W.O. NO.
K.R.	5/6/82			1970-01-07
CHECKED		APPROVED		DWG. NO. 16920-6

16920-5

827

ROY F. WESTON

CIRCUIT NO.	APPLICATION OR DESCRIPTION	NEMA SIZE	MOTOR		CONTROL SCHEMATIC		SWITCH &/OR BREAKER			FUSE TYPE &/OR BKR CODE	REMARKS
			HP.	SPEED	NUMBER	DRAWING	RATE &/OR FR.	POLE	FUSE RATE &/OR TRIP		
2N	FEEDER TO MCC 1P1A						600A	3	600A		
1N	INCOMING LINE						1200A	3	1200A		
8N	TRICKLING FILTER LIFT PUMP P-100C	3 RV 2S	50/ 40	1000/ 750	3B	740		3			TDR
9N	TRICKLING FILTER LIFT PUMP P-100D	3 RV 2S	50/ 40	1000/ 750	3B	740		3			TDR
7L	TRICKLING FILTER RECYCLE PUMP P-101B	3 RV	50	1000	6A	741		3			
3N	AERATOR ME-101A1	4 RV 2S	60/ 50	1000/ 750	3A	740		3			
4N	AERATOR ME-101A2	4 RV 2S	60/ 50	1000/ 750	3A	740		3			
5N	PRIMARY CLARIFIER SLUDGE PUMP P-106A	2 RV	15	1500	6B	741		3			
6N	PRIMARY CLARIFIER SLUDGE PUMP P-106B	2 RV	15	1500	6B	741		3			
5D	PRIMARY CLARIFIER MAIN DRIVE ME-100A1	1	3/4	1500	11	742		3			CR

*RV - Reduced Voltage
2S - 2 Speed

Δ Speed is est. Sync Speed filed varify.

F. WESTON

CIRCUIT NO.	APPLICATION OR DESCRIPTION	NEMA SIZE	O.L.		SCHEMATIC		RATE &/OR FR.	POLE	FUSE RATE &/OR TRIP	TYPE &/OR BKR CODE	REMARKS
			HP.	SPEED	NUMBER	DRAWING					
6D	PRIMARY CLARIFIER AUX. DRIVE ME-100A2	1	1/2	1500	11	742		3			CR

16920-7

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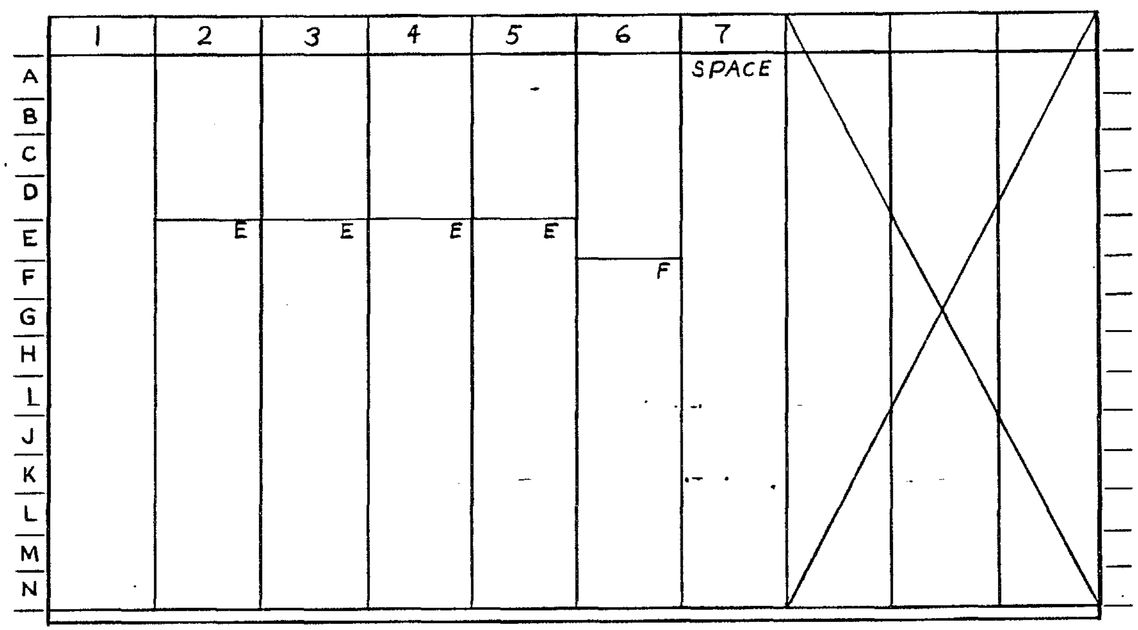
MCC - 1P1 (Page 2)

DCMD 66-6-75

16920-8

MOTOR CONTROL CENTER

FRONT ELEVATION



MAIN POWER

380 VOLTS 3 PHASE

50 HERTZ 4 WIRE

CABLE ENTRY

_______ COMPARTMENT IN

2 350 MCM PER PHASE

BUS

600 AMP MAIN W/NEUTRAL 1/8"x 1" (MIN.) GROUND

MATERIAL COPPER

22000 AMP SYMMETRICAL BRACING

WIRING

NEMA CLASS II

TYPE B

CONTROL VOLTAGE 220

ENCLOSURE

NEMA 1 GASKETED

ARRANGEMENT _______

FINISH _______

UNIT NAMEPLATE MCC 1P1A

DEPTH 20"(50.8CM)

SECTION WIDTH 20"(50.8CM)

MCC NO. — 1P1A

ROY F. WESTON, INC.

ENVIRONMENTAL CONSULTANTS-DESIGNERS

Y F. WESTON

16920-9

CIRCUIT NO.	APPLICATION OR DESCRIPTION	NEMA SIZE	MOTOR HP.	MOTOR SPEED	SCHEMATIC NUMBER	SCHEMATIC DRAWING	RATE &/OR FR.	POLE	FUSE RATE &/OR TRIP	TYPE &/OR BKR CODE	REMARKS
1N	INCOMING LINE						600A	3		600A	
4N	SEPTAGE HOLDING TANK MIXER ME-03A	2 RV	25	1000	6C	741		3			TDR
5N	SEPTAGE HOLDING TANK MIXER ME-03B	2 RV	25	1000	6C	741		3			TDR
4D	SEPTAGE HOLDING TANK EXHAUST FAN F-01A	1	5		7	741		3			
5D	SEPTAGE HOLDING TANK EXHAUST FAN F-01B	1	5		7	741		3			
2N	GRIT BLOWER ME-02A	2 RV	15	1500	6C	741		3			
3N	GRIT BLOWER ME-02B	2 RV	15	1500	6C	741		3			
2D	SEPTAGE TRANSFER PUMP P-01A	1	5	1000	7	741		3			
3D	SEPTAGE TRANSFER PUMP P-01B	1	5	1000	7	741		3			
6N	DILUTION PUMP P-03	2 RV	15	1000	6C	741		3			
6E	LIGHTING PANEL 1P1A							3	100A		

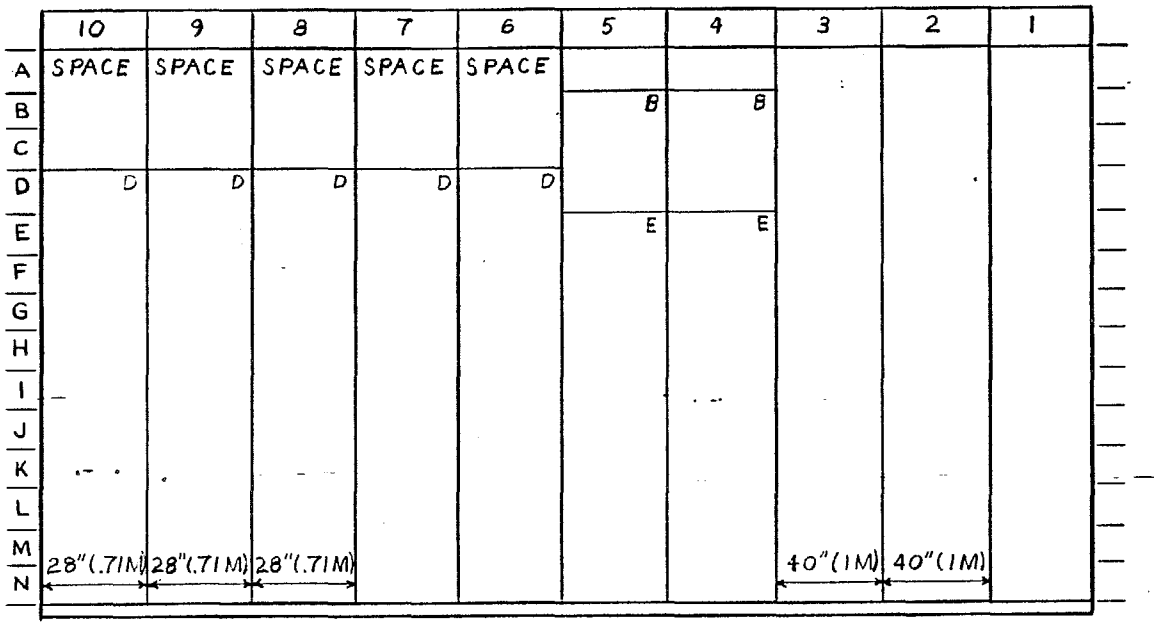
MCC 1P1A

DCMD 66-6-75

K&E 10 1253 8-80 MC14826

MOTOR CONTROL CENTER

FRONT ELEVATION



MAIN POWER

380 VOLTS 3 PHASE

50 HERTZ 4 WIRE

CABLE ENTRY

_____ COMPARTMENT 1N

3 500 MCM PER PHASE

BUS

1000 AMP MAIN W/NEUTRAL 1/8"x 1" (MIN.) GROUND

MATERIAL COPPER

22000 AMP SYMMETRICAL BRACING

WIRING

NEMA CLASS II

TYPE B

CONTROL VOLTAGE 220

ENCLOSURE

NEMA 1GASKETED

ARRANGEMENT _____

FINISH _____

UNIT NAMEPLATE MCC 1P2

DEPTH 20"(50.8 CM)

SECTION WIDTH 20"(50.8 CM)

16920-10

MCC NO. -1P2

ROY F WESTON, INC.

WESTON ENVIRONMENTAL CONSULTANTS-DESIGNERS

DRA | DATE | ID | FILE

F. WESTON

No.

CIRCUIT NO.	[illegible] OR DESCRIPTION	NEMA SIZE	MOTOR		SCHEMATIC		RATE &/OR FR.	POLE	FUSE RATE &/OR TRIP	TYPE &/OR BKR CODE	REMARKS
			HP.	SPEED	NUMBER	DRAWING					
1N	INCOMING LINE						1000A	3	1000A		
2N	AERATOR ME-101B2	4 RV	60/50	1000/750	3A	740		3			TDR
3N	AERATOR ME-101B1	4 RV 2S	60/50	1000/750	3A	740		3			
7N	TRICKLING FILTER RECYCLE PUMP P-101S	3 RV	50	1000/	6A	741		3			
6N	TRICKLING FILTER RECYCLE PUMP P-101A	3 RV	50	1000	6A	741		3			
8N	TRICKLING FILTER LIFT PUMP P-100A	3 RV 2S	50/40	1000/750	3B	740		3			TDR
9N	TRICKLING FILTER LIFT PUMP P-100B	3 RV 2S	50/40	1000/750	3B	740		3			TDR
10N	TRICKLING FILTER LIFT PUMP P-100S	3 RV 2S	50/40	1000/750	3B	740		3			TDR
5N	PRIMARY CLARIFIER SLUDGE PUMP P-106S	2 RV	15	1500	6B	741		3			
4N	LIGHTING PANEL 1P2							3	225		

16920-11

330

MCC = 1P2 (Page 1)

*RV = Reduce voltage
2S = 2 speed

Δ Speed is est. sync speed field varify.

DCMD 66-6-75

ROY F. WESTON

CIRCUIT NO.	APPLICATION OR DESCRIPTION	NEMA SIZE	MOTOR		CONTROL SCHEMATIC		SWITCH &/OR BREAKER				REMARKS
			HP.	SPEED	NUMBER	DRAWING	RATE &/OR FR.	POLE	FUSE RATE &/OR TRIP	FUSE TYPE &/OR HKR CODE	
5D	PRIMARY CLARIFIER AUX DRIVE ME-100B2	1	1/2	1500	11	742		3			CR
4D	PRIMARY CLARIFIER MAIN DRIVE ME-100B1	1	3/4	1500	11	742		3			CR

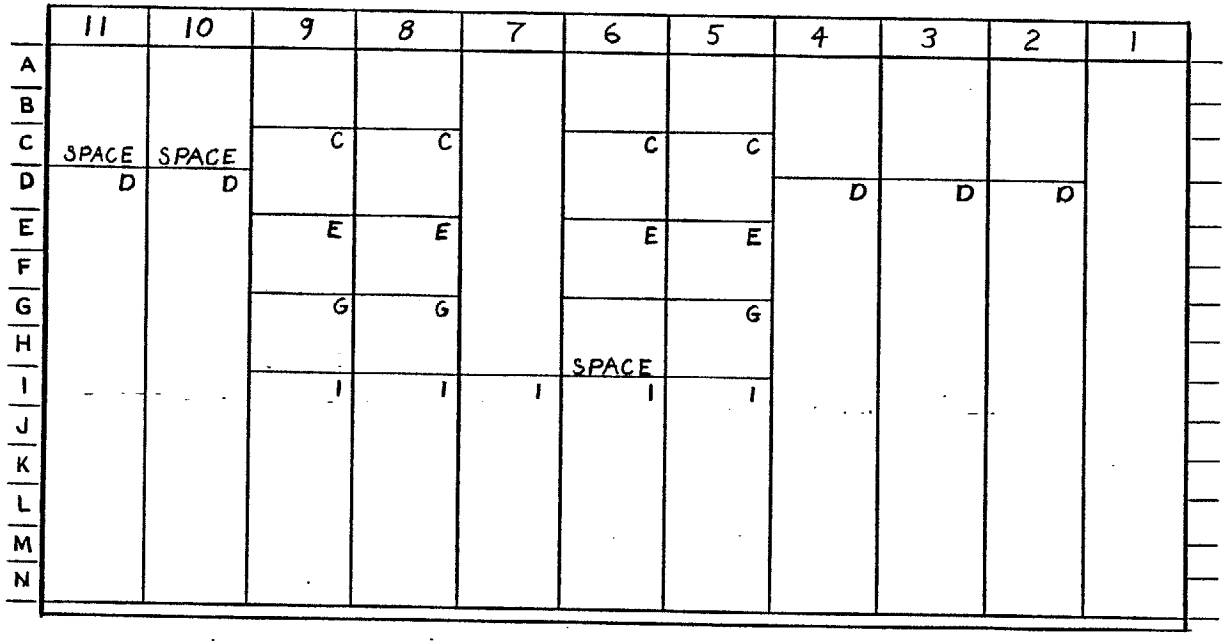
16920-12

619

K&E 19 1283 6-80 MC1482a

MOTOR CONTROL CENTER

FRONT ELEVATION



MAIN POWER

380 VOLTS 3 PHASE

50 HERTZ 4 WIRE

CABLE ENTRY

_____ COMPARTMENT IN

2 600 MCM PER PHASE

BUS

800 AMP MAIN W/NEUTRAL 1/8"x 1" (MIN.) GROUND

MATERIAL COPPER

22000 AMP SYMMETRICAL BRACING

WIRING

NEMA CLASS II

TYPE B

CONTROL VOLTAGE 220

ENCLOSURE

NEMA 1GASKETED

ARRANGEMENT _____

FINISH _____

UNIT NAMEPLATE MCC 2P3

DEPTH 20"(50.8CM)

SECTION WIDTH 20"(50.8CM)

MCC NO.-2P1

ROY F. WESTON, INC.

WESTON ENVIRONMENTAL CONSULTANTS-DESIGNERS

DRAWN	DATE	DES. ENG.	DATE	W.O. NO.
K.R.	6/11/82			1970-01-05
CHECKED		APPROVED		DWG. NO.

ROY F. WESTON

16920-14

CIRCUIT NO.	APPLICATION OR DESCRIPTION	NEMA SIZE	MOTOR		CONTROL SCHEMATIC		SWITCH &/OR BREAKER			FUSE TYPE &/OR BKR CODE	REMARKS
			HP.	SPEED	NUMBER	DRAWING	RATE &/OR FR.	POLE	FUSE RATE &/OR TRIP		
1N	INCOMING LINE						800A	3	800A		
2N	SLUDGE TRANSFER PUMP P-107C	RV 2	15	1500	6B	741		3			
3N	SLUDGE TRANSFER PUMP P-107B	RV 2	15	1500	6B	741		3			
4N	SLUDGE TRANSFER PUMP P-107A	RV 2	15	1500	6B	741		3			
5N	SLUDGE RECYCLE PUMP P-102C	FR 2 2S	20/ 10	1000/ 750	5	741		3			TDR
6N	SLUDGE RECYCLE PUMP P-102D	FR 2 2S	20/ 10	1000/ 750	5	741		3			
7N	SLUDGE RECYCLE PUMP P-102C	FR 2 2S	20/ 10	1000/ 750	5	741		3			
8N	SLUDGE RECYCLE PUMP P-102B	FR 2 2S	20/ 10	1000/ 750	5	741		3			
9N	SLUDGE RECYCLE PUMP P-102A	FR 2	20/ 10	1000/ 750	5	741		3			
2C	FINAL CLARIFIER ME-102B1	1	1	1500	1	740		3			CR

MCC 2P1 (Page 1)

*RV - Reduced voltage
2S - 2 speed

•Speed is est. sync speed field varify

F. WESTON

CIRCUIT NO.	APPLICATION OR DESCRIPTION	NEMA SIZE	MOTOR		SCHEMATIC		RATE &/OR FR.	POLE	FUSE RATE &/OR TRIP	TYPE &/OR MKR CODE	REMARKS
			HP.	SPEED	NUMBER	DRAWING					
3C	FINAL CLARIFIER ME-102A1	1	1	1500	1	740		3			CR
4C	SLUDGE THICKENER ME-104	1	1	1500	1	740		3			CR
9F	HOT WATER CIRCULATING PUMP P-111B	1	5	1500	2	740		3			
9H	HOT WATER CIRCULATING PUMP P-111A	1	5	1500	2	740		3			TDR
5B	FINAL FLOCCULATOR ME-102A2	1	3/4	1500	2	740		3			
5D	FINAL FLOCCULATOR ME-102A2	1	3/4	1500	2	740		3			
5F	FINAL FLOCCULATOR ME-102A3	1	3/4	1500	2	740		3			
5H	FINAL FLOCCULATOR ME-102B3	1	3/4	1500	2	740		3			
6B	SLUDGE WASTING PUMP P103A	1	5	1000	7	741		3			
6D	SLUDGE WASTING PUMP P103S	1	5	1000	7	741		3			

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ROY F. WESTON

16920-16

CIRCUIT NO.	APPLICATION OR DESCRIPTION	NEMA SIZE	MOTOR		CONTROL SCHEMATIC		SWITCH &/OR BREAKER			FUSE	REMARKS
			HP.	SPEED	NUMBER	DRAWING	RATE &/OR FR.	POLE	FUSE RATE &/OR TRIP	TYPE &/OR NKR CODE	
6F	AERATOR BLOWER ME-105		5	1500	2	740		3			
7H	LIGHTING PANEL 2P1							3	225		
8B	SLUDGE RECIRCULATING PUMP A	1	5	1500	2	740		3			
8D	SLUDGE RECIRCULATING PUMP B	1	5	1500	2	740		3			
8F	OIL CIRCULATING PUMP P-112A	1	1 1/2	1500	16	742		3			
8H	OIL CIRCULATING PUMP P-112B	1	1 1/2	1500	16	742		3			
9B	BUILDING HOT WATER CIR. PUMP P-A	1	3	1500	16	742		3			
9D	BUILDING HOT WATER CIR PUMP P-B	1	3	1500	16	742		3			
10N	DIGESTER MIXING PUMP P-A	3 RV	50	1000	6C	741		3			TDR
11N	DIGESTER MIXING PUMP P-B	3 RV	50	1000	6C	741		3			TDR

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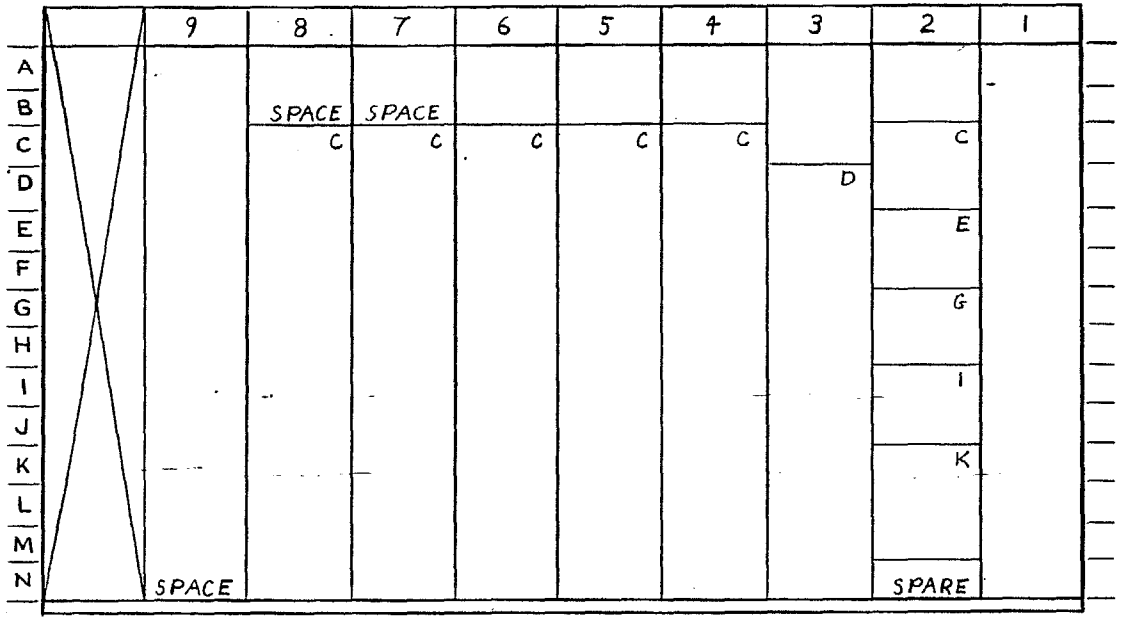
K&E 19 1253 8-80 MC14650

16920-17

MOTOR CONTROL CENTER

FRONT ELEVATION



MAIN POWER

380 VOLTS 3 PHASE

50 HERTZ 4 WIRE

CABLE ENTRY

_____ COMPARTMENT IN

3 500 MCM PER PHASE

BUS

1000 AMP MAIN W/NEUTRAL 1/8"x 1" (MIN.) GROUND

MATERIAL COPPER

22000 AMP SYMMETRICAL BRACING

WIRING

NEMA CLASS II

TYPE B

CONTROL VOLTAGE 220

ENCLOSURE

NEMA 1 GASKETED

ARRANGEMENT _____

FINISH _____

UNIT NAMEPLATE MCC 2P2

DEPTH 20"(50.8CM)

SECTION WIDTH 20"(50.8CM)

MCC NO. – 2P2

ROY F. WESTON, INC.

WESTON ENVIRONMENTAL CONSULTANTS-DESIGNERS

DRAWN K.R.	DATE 5/5/82	DES. ENG.	DATE	W.O. NO. 1920-01-20
CHECKED		APPROVED		DWG. NO. 16920-19

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ROY F. WESTON

CIRCUIT NO.	APPLICATION OR DESCRIPTION	NEMA SIZE	MOTOR		CONTROL SCHEMATIC		SWITCH &/OR BREAKER			FUSE TYPE &/OR BKR CODE	REMARKS
			HP.	SPEED	NUMBER	DRAWING	RATE &/OR FR.	POLE	FUSE RATE &/OR TRIP		
1N	INCOMING LINE						1000A	3	1000A		
2B	CHLORINE MIX TANK MIXER ME-04A	1	3		2	740		3			
2D	CHLORINE MIX TANK MIXER ME-04B	1	3		2	740		3			
2F	UTILITY WATER PUMP P-04A	1	10		7	741		3			
2H	UTILITY WATER PUMP P-04B	1	10		7	741		3			
2J	UTILITY WATER PUMP P-04C	1	10		7	741		3			
3C	SLUDGE THICKENER DRIVE ME-08	1	2		1	740		3			CR
3N	LIGHTING PANEL 2P2					737		3	100		SEE DWG. FOR ARR.
4B	PLANT DRAIN PUMP P-02C	1	10		7	741		3			
4N	PLANT DRAIN PUMP P-02A	3 RV	30		6B	741		3			TDR

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MCC = 2P2 (Page 1) *RV = Reduced voltage

F. WESTON

CIRCUIT NO.	APPLICATION OR DESCRIPTION	NEMA SIZE	HP.	SPEED	NUMBER	DRAWING	&/OR FR.	POLE	RATE &/OR TRIP	&/OR BKR CODE	REMARKS
5N	PLANT DRAIN PUMP P-02B	3 RV	30		6B	741		3			
5B	AERATION BLOWER ME-10	1	5		2	740					
6N	SLUDGE TRANSFER PUMP P-05A	3 RV	50		6B	741		3			TDR
7N	SLUDGE TRANSFER PUMP P-05B	3 RV	50		6B	741		3			TDR
8N	SLUDGE TRANSFER PUMP P-05S	3 RV	50		6B	741		3			TDR
2M	FEEDER FOR LP-CHL. BLDG.							3	225		
6B	UTILITY WATER PUMP P-04S	1	10		7	741		3			

MCC = 2P2 (Page 2) *RV = Reduced voltage

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DCMD 66-6-75

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SITE INVESTIGATION
OF
THE WASTE WATER TREATMENT PLANT
IRBID

NOV 1980

6

TOUKAN & SAKET
Geo. Research & Foundation
Engineering Office

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TOUKAN & SAKET
Geo.- Research & Foundation
Engineering Office

Drilling , Sampling , Testing
Engineering Geology , Foundations
& Geomechanics

مكتب طوقان والساكت
للدراسات الهندسية الجيولوجية والأساسات

تثقيب ، اخذ عينات ، تحليل ،
مسح هندسي جيولوجي ، دراسة
اساسات وميكانيكا الصخور والتربة

Site Investigation of the Waste Water Treatment Plant. Irbid

Introduction:

Upon the request of Messrs Sigma, subsoil investigation has been carried out at the proposed site and at locations representing the construction area.

The investigation was carried out by performing 12 boreholes drilled at the study area to depths of 10.0 m each.

Scope of Work:

The purpose of this study was to determine the ground conditions at the site, in order to provide full informations about the uniformity of the materials interms of density and bearing capacity to avoid any differential settlement and provide informations to the Engineer which could assist him in the design of proper and safe foundation.

Bearing capacity insitu tests were also performed in the drilled boreholes to find out the density and thus the bearing capacity.

Method of Investigation:

All drilling, sampling and testing were performed in-accordance with the ASTM standards.

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ص.ب ٩٢٦٨٩٧ - تلفون ٦٢٤٠٥ - برقياً : طيار - تلكس : ٢١٥٤٢ طوقان جو - عمان - الاردن
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The subsurface was explored by using CME rig advanced by rotary drilling allowing the performance of standard penetration and bearing capacity insitu tests. Representative samples were obtained during the drilling operation and were placed in tight plastic bags for description.

Standard penetration tests were carried out in accordance with the ASTM standards and the results were recorded on the borehole logs at depths to which they refer.

The standard penetration tests were executed with the standard sampling spoon driven by dropping a 140 lb weight hammer with a 30 inches fall height . The 2 inches diameter spoon,lowered to the bottom of the borehole and penetrated about 6 inches into the marl or into any soft materia

The "N" value is the number of blows required to produce one foot of penetration.

In defining the density of the material,very soft material was considered to have standard penetration values less than two blows per foot, soft between 2 and 4 blows per foot, medium material between 4 and 8 blows per foot and stiff material between 8 and 15 blows per foot, very stiff between 15 and 30 blows per foot, hard material more than 30 blows per foot.

In order to confirm the exploration drilling and explore the subsurface structure,mechanized bearing capacity insitu equipment was also employed. Two tests were performed in boreholes 2 and 3. The equipment was calibrated with the standard penetration tests and pressure meter tests.

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The penetrometer is gradually loaded during the test by 5, 25, 50, 75 and 100 kg., frequently the equipment has to be unloaded so that the applied load corresponds to the lowest load at which the sounding rod just penetrates the material. This load is recorded, the tests start after full loading of the equipment and should not be rotated when the applied load is less than 100 kgs.

The penetration resistance is recorded as the number of half-turns required for 20 cm penetration. The engineering mechanism of the test is simply by shearing the material laterally and by applying normal load vertically.

Field Work:

Drilling:

The location of boreholes were chosen so as to represent the construction area and provide as much informations as possible.

A total of 12 boreholes were drilled.The location of the drilled boreholes is shown on the attached plan.

The depth to which boreholes were drilled was 10.0 meters each. No water table was observed during the drilling operations.

Sampling:

Continuous samples of the drilled material were taken at regular depth intervals of 0.5 meters and at lithological changes of the strata. The samples were labelled ,described and logged.

Insitu Testing:

In order to obtain an estimate of the density insitu, standard penetration and bearing capacity insitu tests were performed.

The standard penetration tests results indicate that the material is stiff to hard (SPT ranges between 4 and 40 blows per foot).

Two additional bearing capacity insitu tests were performed on the marly material. The tests results show that the material is soft to hard. These results agree very well with the performed standard penetration tests.

Geo-Mechanics:

The drilling results indicate that the area is covered by a mantle of mediterranean soils composed of sandy silty clay. The thickness of this soil ranges between 1.50 m and 4.0 meters.

This material is classified as CL and CH type according to the Unified Soil Classification System. The CH material has the following engineering properties:

1- Sandy silty clay of medium to high plasticity.
2- Impervious when compacted.
3- Of poor shearing strength.
4- Of poor workability as construction material .
5- It is considered poor as foundation material particularly when subjected to water.

The "CL" type material has almost simillar properties but lower plasticity and has higher percentage of sand and silt size fractions.

The mediterranean soils(overburden) is underlain by marl. The called marl in this report is carbonaceous silty clay (rock flour). This fine grained, very soft when wet and has a moderate to low dry strength. This strength of this material is dependent on the percentage of clay size fractions. The marl "ML" type has the following engineering properties:

1- Silty clay, rock flour.
2- Semi pervious to impervious when compacted.
3- Of poor to fair shear strength when compacted.
4- Of low to medium plasticity.
5- It is considered poor as foundation material.

In order to find out the engineering properties of the existing material within the study area,the following tests were performed on representative samples obtained:

- Natural moisture content.
- Grainsize analysis.
- Atterberg limits.
- Unconfined compression tests.
- Triaxial compression test.
- Compaction and CBR tests.

- The moisture content of the tested samples show a range between 7.0 % and 26.0 %.

- The grainsize analysis show that the material is composed of sand ranges between 4.23 % and 24.94 %, silt ranges between 34.61 % and 69.88 % and clay ranges between 30.12 % and 44.15 % .

- The atterberg limits tests results show that the liquid limit ranges between 26.5 and 52.3 with a plasticity index in the ranges between 6.6 and 25.3 .

- The unconfined compressive strength of the tested samples show a range between 0.6 kg/cm2 and 3.55 kg/cm2 .

- The undrained triaxial tests performed on five samples obtained show that the cohesion is ranging between 0.34 k and 0.75 kg/cm2 with a friction angle ranging between 2 a degrees.

The consolidated undrained tests performed on sample obtained from borehole No 3 at a depth of 4.50 meters sho that the cohesion is 0.45 kg/cm2 with 17 degrees friction angle.

- The compaction and CBR tests performed on a representativ sample obtained show that the maximum dry density is 1.70 gr/cm3 with an optimum moisture content of 8 % . The CBR value was found to be 8 % .

Conclusions and Recommendations:

As a result of this study and tests the following conclusions could be summarized:

- The drilling results show that the material within the study area is uniform interms of lithology and non-uniform interms of density.

- The area is covered by a mantle of overburden, mediterrane soil composed of sandy silty clay. The thickness of this mantle ranges between 1.5 and 4.0 meters.

- The Overburden is underlain by stiff to hard marl. This material is weak and sensitive to any increase in moisture content.
- The study area is considered outside the seismic activity belt.
- No water table was observed during the drilling Operation

In order to have a safe, stable foundation, the following is recommended:

- Owing to the non-uniformity of material within the study area, different bearing capacities will be recommended for each structure as summarized in The following table .

Borehole No	Foundation depth and recommendations	Bearing capacity kg/cm2
1	472 m (0.50 m granular fill. Compaction to a maximum dry density)	1.30
2	471 m (Sacrifying 1.0 m, replaced by granular material and compaction to a maximum dry density)	1.oo
3	473 m	1.70
4	473 m	1,40
5	471 m	1.2
6	473 m	1.60
7	473 m	
8	471 m	1.1
9	473 m	1.4
10	473 m	
11	479 m	1.60
12	477 m	1.60

The suggested bearing capacities were based on the weakest material encountered in the boreholes, the lowest SPT results obtained, the shear strength parameters, and assuming that the area is fully drained.

- The weakest material was encountered in borehole No 2 where soft marl thickness was five meters.

In order to have a safe, stable foundation at the locat of borehole 2, it is recommended to sacrify 1.0 meters belo the proposed foundation level. The 1.5 m weak material shou be replaced by granular material and compacted in maximum 1 inch layers to a maximum dry density by means of heavy vibra ory roller; a minimum of 20 tons is recommended. Further che of the density after compaction is necessary.

- The material at the proposed foundation level of all struct should be compacted by a vibratory roller. Aminimum of eigh passes in an attempt to densify the soft zones within the construction areas. By means of this compaction a uniformit of material interms of density would be achieved.

- Back fill material should be compacted by vibratory roller to 95 % maximum dry density and should not be placed in lay greater than 12 inches. Fill material should be a well grad sand and gravel mixed with the existing mediterranean soil 50/50 to improve the engineering properties. The mediterran soils should not be used as foundation or fill for support structures and pavements . Fill and compaction density and moisture control should be provided through field and labora tory supervision.

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- Slopes of top soil (mediterranean soil) temporary excavation should not exceed one horizontal to two vertical. This proposal is applied to a maximum cut of 4.0 meters. The cuts are assumed to be executed during dry season. In case of excavation during the winter season, sheet piling is recommended to support the side slopes.

- A drainage trench surrounding the construction area should be excavated, filled with filter material, and sloped to drain the water off the area. The material surrounding all the structures should be compacted and the area paved to prevent any percolation of rainwater into the foundation material. Side walks surrounding the buildings should also be wide enough to prevent direct percolation of rainwater into the foundation material .

Unconfined and Triaxial Compression Tests
Results

Sample No & Depth	Unconfined Compressive Strength	Triaxial Compression Tes	
		C(kg/cm2	ø
BH 1 1.5 m	1.40	0.66	3
BH 2 4.5 m	0.60	0.34	2
BH 3 4.0 m	1.80		
BH 4 4.0 m	1.70	0.73	2
BH 5 3.5 m	1.25	0.75	4
BH 6 3.5 m	3.55		
BH 7 4.0 m	2.10		
BH 7 5.5 m	1.90		
BH 8 3.0 m	1.25		
BH 9 3.0 m	2.00		
BH 10 5.5 m	2.30		
BH 11 2.0 m	1.70		
BH 11 3.0 m	2.20		
BH 12 3.0 m	1.45	0.65	3

Summary of Tests Results

e	Grainsize Analysis				Atterberg Limits			Moist. Content	Classification symbol
	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL	PL	PI	(%)	
m	-	4.23	57.01	38.76	36.70	26.6	10.1	11.5	ML
n	-	-	58.97	41.03	39.80	26.5	13.3	7.5	ML
n	-	13.63	42.55	43.82	47.6	24.5	23.10	7.0	CL
m	-	12.77	49.0	38.23	52.3	27.0	25.3	11.5	CH
m	-	-	56.08	43.92	36.7	26.1	10.6	26.0	ML
m	-	6.95	48.90	44.15	46.10	30.5	15.6	21.5	ML
m	7.60	24.94	34.61	32.85	26.5	18.2	8.3	9.0	CL
m	-	-	55.88	44.12	43.20	32.2	11.0	17.0	ML
m	-	6.62	49.45	43.93	51.70	27.3	24.4	13.5	CH
m	-	-	69.88	30.12	29.9	23.3	6.6	8.5	ML

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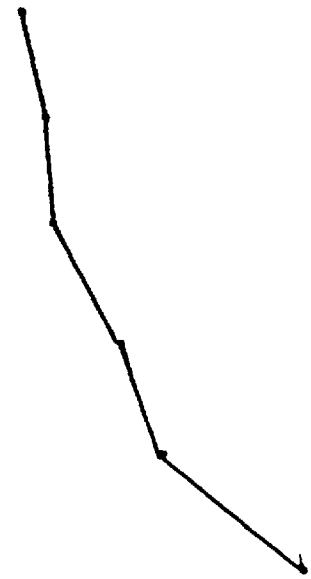
BOREHOLE LOG DATA SHEET

PROJECT :	TYPE & SIZE OF DRILLING Rotary
BOREHOLE NO. : 1	DATE :

DEPTH (M)	LOG	DESCRIPTION	REC. (%)	RQD. (%)	SPT (N) 10 20 30 40 50
1 -		Sandy silty clay , fine to medium			
2 -					
3 -		Very stiff completely weathered, decomposed marl.			
4 -					
5 -					
6 -					
7 -		Very stiff to hard, highly weathered marl.			
8 -					
9 -					
10 -					
11 -					
12 -					
13 -					
14 -					
15 -					
16 -					
17 -					
18 -					
19 -					
20 -					
21 -					
22 -					



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GEO - RESEARCH

BOREHOLE LOG DATA SHEET

PROJECT :	TYPE & SIZE OF DRILLING Rotary
OREHOLE NO. : 2	DATE :

DEPTH (M)	LOG	DESCRIPTION	REC. (%)	RQD. (%)	SPT (N) 10 20 30 40 50
		Sandy silty clay, fine to medium.			
		Soft marl, saturated.			
		Stiff marl, yellowish brownish , moist.			

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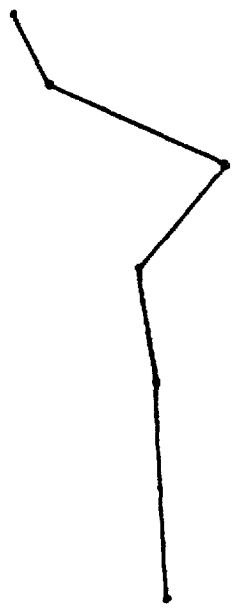
GEO - RESEARCH

BOREHOLE LOG DATA SHEET

PROJECT : Waste Water Treatment Irbed.	TYPE & SIZE OF DRILLING Rotary
BOREHOLE NO. : 3	DATE :

DEPTH (M)	LOG	DESCRIPTION	REC. (%)	RQD. (%)	SPT (N) 10 20 30 40 50
1		Stiff , sandy silty clay, fine grained dark brown.			
2					
3					
4					
5		Very stiff, marl, yellowish brownish.			
6					
7					
8					
9		Very stiff to hard, marl, yellowish.			
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					



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GEO - RESEARCH

BOREHOLE LOG DATA SHEET

PROJECT : Waste Water Treatment Irbed	TYPE & SIZE OF DRILLING Rotary
BOREHOLE NO. : 4	DATE :

TH)	LOG	DESCRIPTION	REC. (%)	RQD. (%)	SPT (N) 10 20 30 40 50
		Stiff sandy silty clay,dark brown.			
		Very stiff,marl,yellowish to brownish.			

3/6

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BOREHOLE LOG DATA SHEET

PROJECT :	TYPE & SIZE OF DRILLING Rotary
BOREHOLE NO. : 5	DATE :

DEPTH (M)	LOG	DESCRIPTION	REC. (%)	RQD. (%)	SPT (N) 10 20 30 40 50
1 - 2 - 3 -		Stiff marl, completely weathered ,			
4 -		Very stiff marl highly weathered moist to saturated.	28		
5 - 6 - 7 - 8 - 9 - 10 -		Very stiff to hard marl, moist			
11 - 12 - 13 - 14 - 15 - 16 - 17 - 18 - 19 - 20 - 21 - 22 -					

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BOREHOLE LOG DATA SHEET

PROJECT : Waste Water Treatment Irbed.	TYPE & SIZE OF DRILLING Rotary
BOREHOLE NO. : 6	DATE :

LOG	DESCRIPTION	REC. (%)	RQD. (%)	SPT (N) 10 20 30 40 50
	Very stiff, sandy silty clay dark brown, fine to medium grained.			
	Very stiff to hard , marl, yellowish brownish, moist.			
	Very stiff to hard , marl , Yellowish.			

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GEO-RESEARCH

BOREHOLE LOG DATA SHEET

PROJECT : Waste Water Treatment Irbed.	TYPE & SIZE OF DRILLING Rotary
BOREHOLE NO. : 7	DATE :

DEPTH (M)	LOG	DESCRIPTION	REC. (%)	RQD. (%)	SPT (N) 10 20 30 40 50
1 - 2 - 3 - 4 -		Stiff to very stiff, sandy silty clay, dark brown, fine to medium grained ,			
5 -		Very stiff,marl,Yellowish brownish			
6 - 7 - 8 - 9 - 10 -		Very stiff to hard, yellowish.			
11 - 12 - 13 - 14 - 15 - 16 - 17 - 18 - 19 - 20 - 21 - 22 -					

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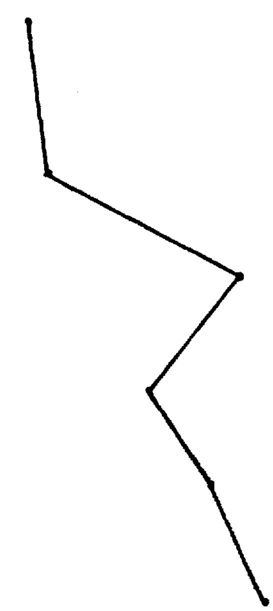
GEO-RESEARCH

BOREHOLE LOG DATA SHEET

..OJECT : Waste Water Treatment Irbed.	TYPE & SIZE OF DRILLING Rotary
OREHOLE NO. : 8	DATE :

)	LOG	DESCRIPTION	REC. (%)	RQD. (%)	SPT (N) 10 20 30 40 50
		Stiff , sandy silty clay, dark brown.			
		Stiff to hard,marl, yellowish brownish.			



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TOUKAN & SAKET
GEO - RESEARCH

BOREHOLE LOG DATA SHEET

PROJECT : Waste Water Treatment. Irbed.	TYPE & SIZE OF DRILLING Rotary
BOREHOLE NO. : 9	DATE :

DEPTH (M)	LOG	DESCRIPTION	REC. (%)	RQD. (%)	SPT (N) 10 20 30 40 50
1 - 2 -		Very stiff (stones) sandy silty clay, with gravels.			
3 - 4 -		Very stiff , marl , yellowish to brownish			
5 - 6 - 7 - 8 - 9 - 10 -		Very stiff to hard, marl, yellowish.			
11 - 12 - 13 - 14 - 15 - 16 - 17 - 18 - 19 - 20 - 21 - 22 -					

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GEO - RESEARCH

BOREHOLE LOG DATA SHEET

PROJECT :	Waste Water Treatment Irbed	TYPE & SIZE OF DRILLING	Rotary
BOREHOLE NO. :	10	DATE :	

DEPTH ()	LOG	DESCRIPTION	REC. (%)	RQD. (%)	SPT (N) 10 20 30 40 50
		Sandy silty clay, dark brownish			
		Very stiff, sandy silty clay with gravels.			
		very stiff to hard, marl, yellowish.			

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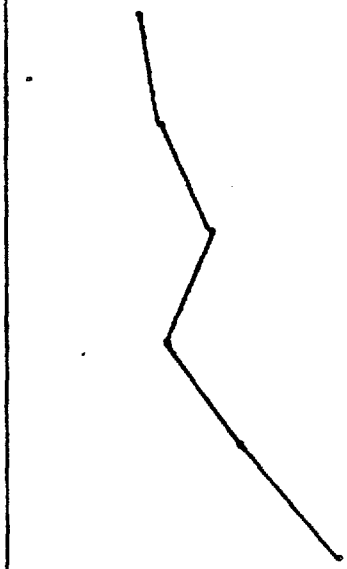
GEO - RESEARCH

BOREHOLE LOG DATA SHEET

PROJECT : Waste Water Treatment. Irbed.	TYPE & SIZE OF DRILLING Rotary
BOREHOLE NO. : 11	DATE :

DEPTH (M)	LOG	DESCRIPTION	REC. (%)	RQD. (%)	SPT (N) 10 20 30 40 50
1 - 2		Very stiff, sandy silty clay, dark brown.			
3 - 4 - 5 - 6		Very stiff, marl, yellowish brownish.			
7 - 8 - 9 - 10		Very stiff to hard, marl, yellowish.			
11 - 12 - 13 - 14 - 15 - 16 - 17 - 18 - 19 - 20 - 21 - 22 -					



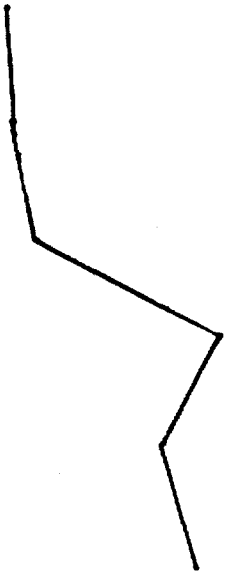
6-39

TOUKAN & SAKET
GEO - RESEARCH

BOREHOLE LOG DATA SHEET

PROJECT : Waste Water Treatment Irbed	TYPE & SIZE OF DRILLING Rotary
BOREHOLE NO. : 12	DATE :

TH)	LOG	DESCRIPTION	REC. (%)	RQD. (%)	SPT (N) 10 20 30 40 50
		Sandy silty clay, dark brown, fine.			
		Stiff, sandy silty clay, gravelly.			
		Stiff to hard, marl, yellowish to brownish			



350

DATE _____

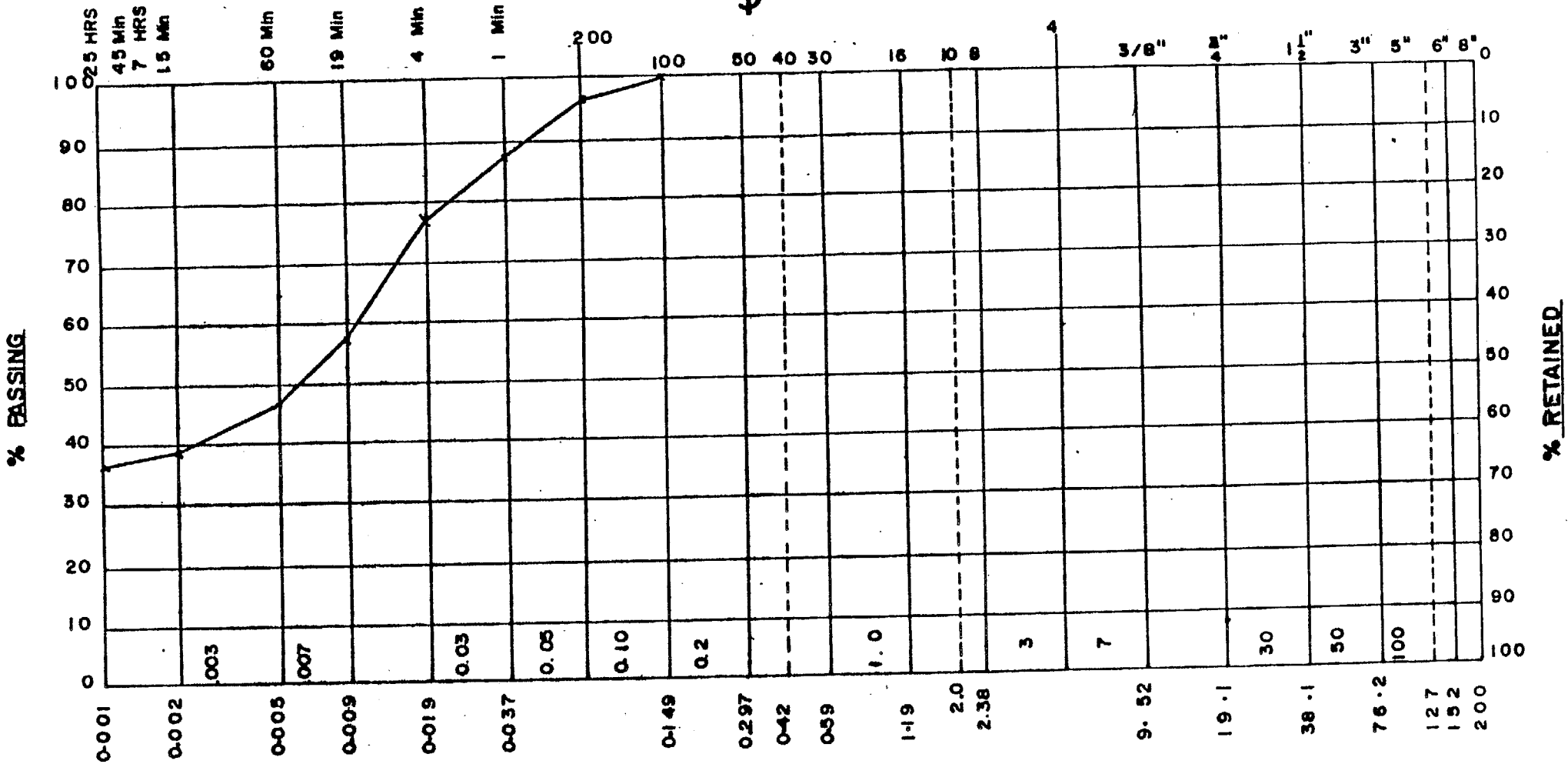
SAMPLE No _____

PROJECT _____

GEO. RESEARCH

HYDROMETER ANALYSIS

SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
1-1				

REMARKS _____

9.9

DATE ____________

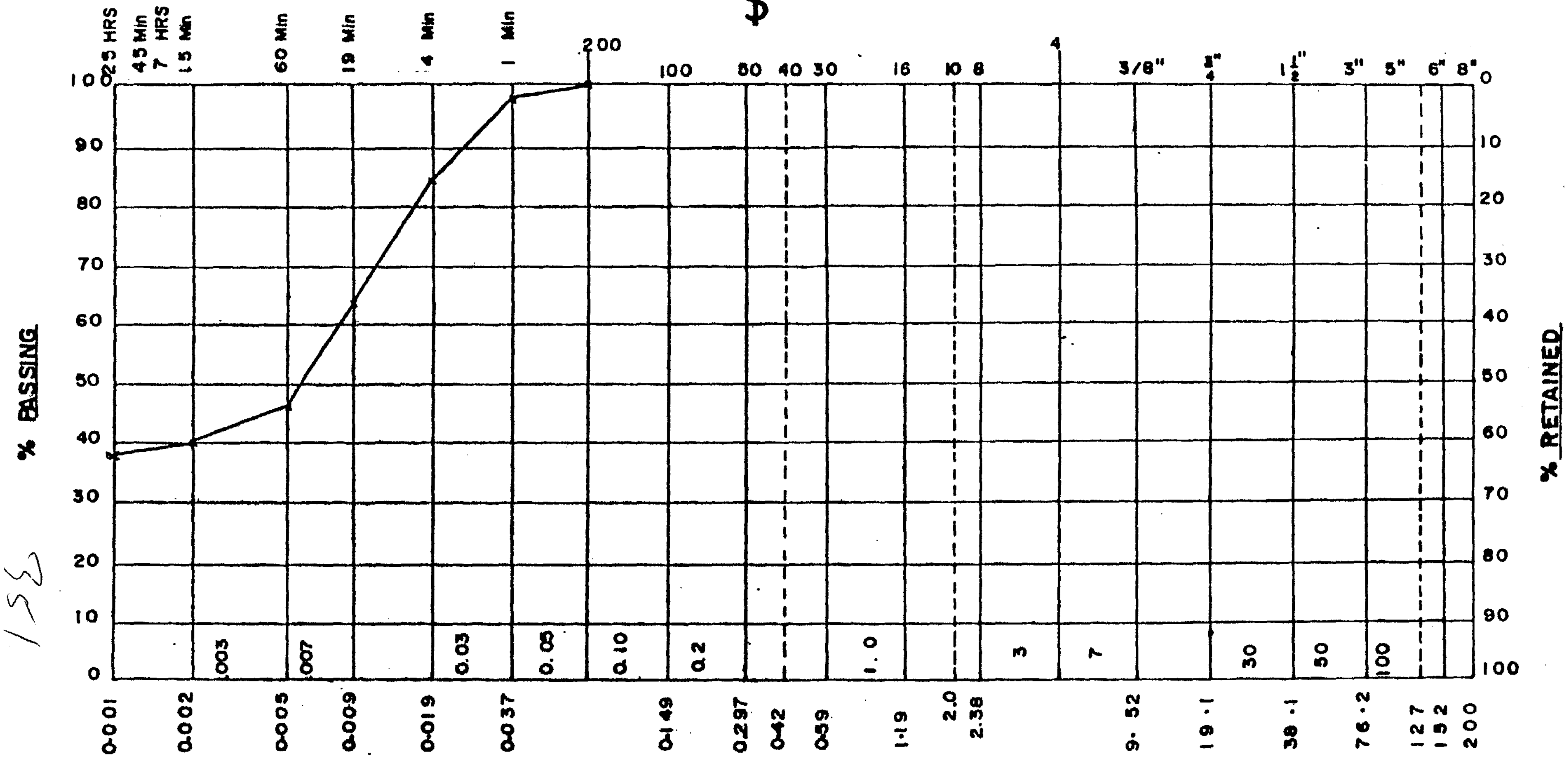
PROJECT ________

GEO.RESEARCH

SAMPLE No ________

HYDROMETER ANALYSIS

SIEVE ANALYSIS



	0.074			4.76		
CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH 2				
	–	–	58.97	41.03
3.50 m				

REMARKS ____________________

PROJECT _____

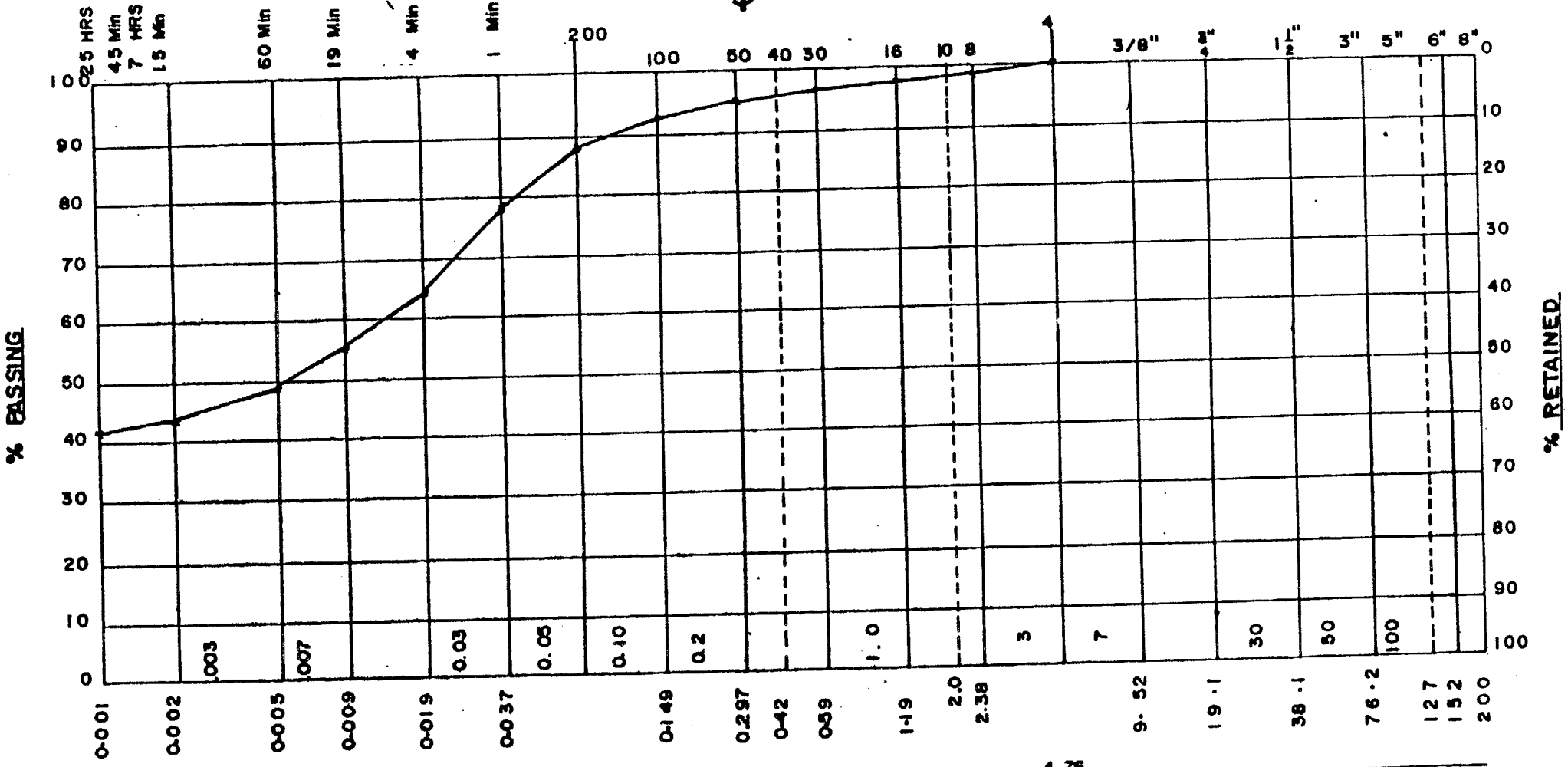
DATE _____

SAMPLE No _____

GEO. RESEARCH

HYDROMETER ANALYSIS

SIEVE ANALYSIS



0.074 4.76

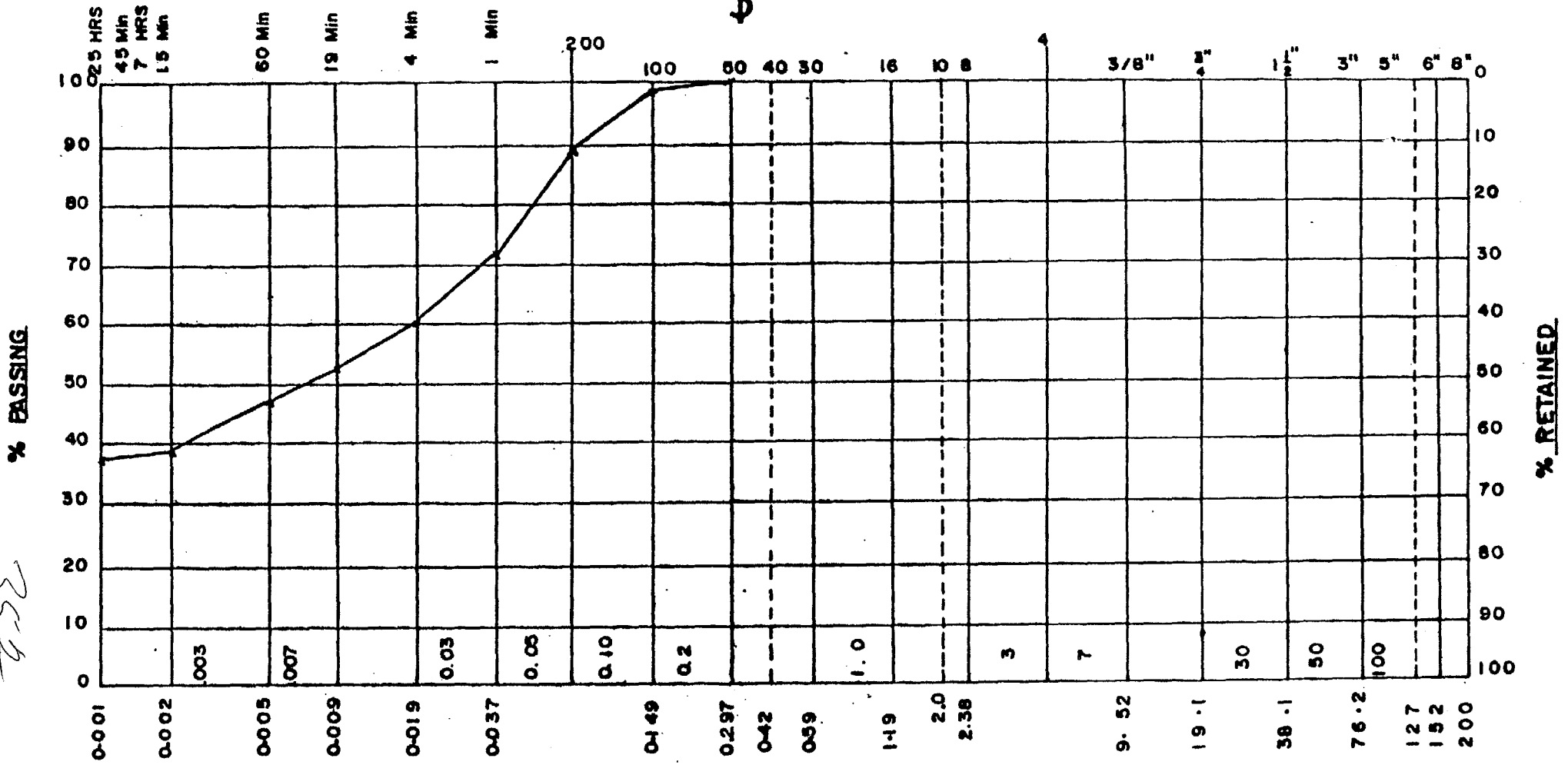
CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %	REMARKS
BH 4					

DATE _____

PROJECT _____ GEO. RESEARCH SAMPLE No _____

HYDROMETER ANALYSIS SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH 6 2.50m	-	12.77	49.0	38.23

REMARKS _____

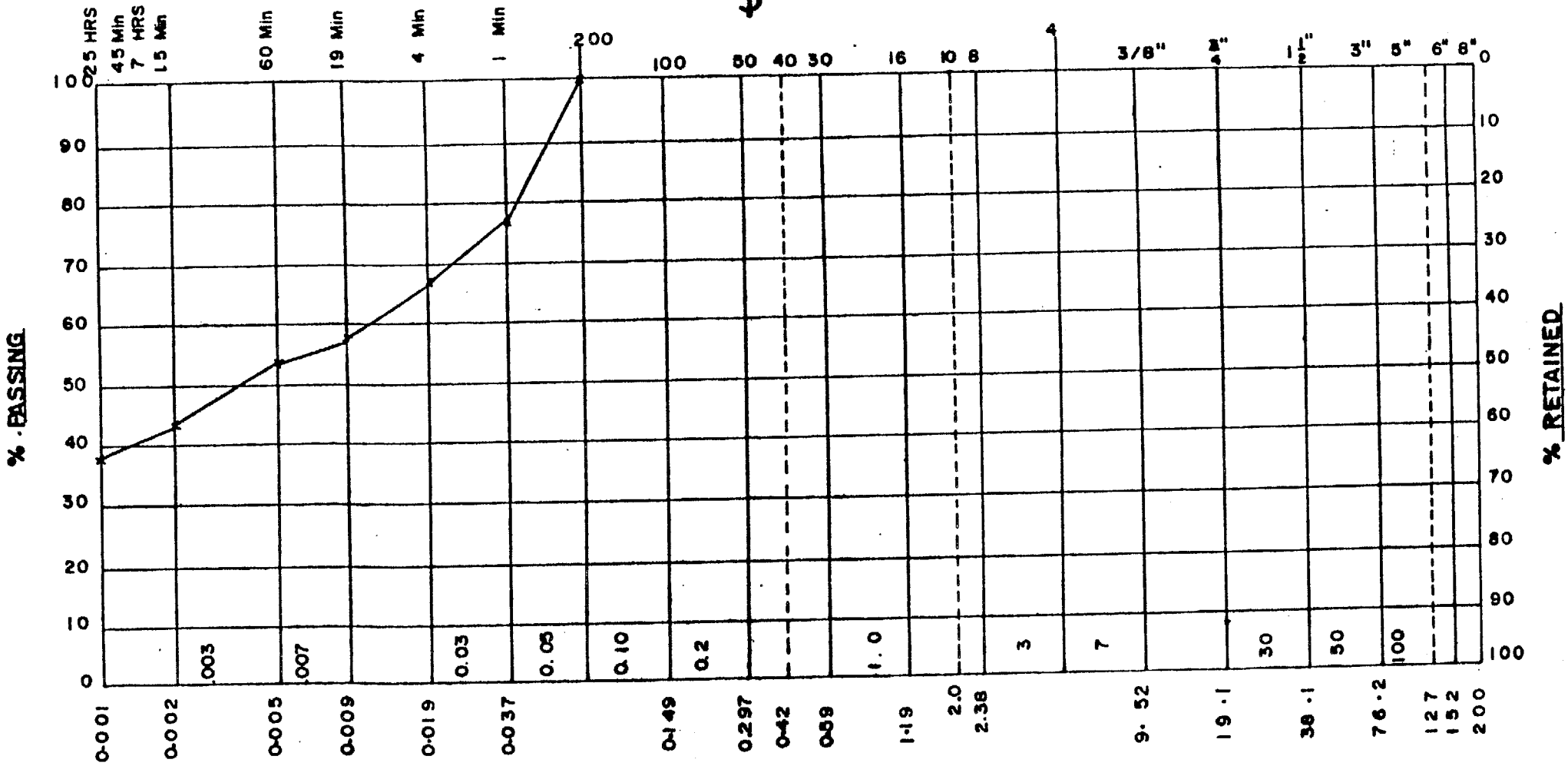
DATE _____

PROJECT _____ SAMPLE No _____

GEO. RESEARCH

HYDROMETER ANALYSIS

SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH 6				3.92

REMARKS _____

PROJECT _____

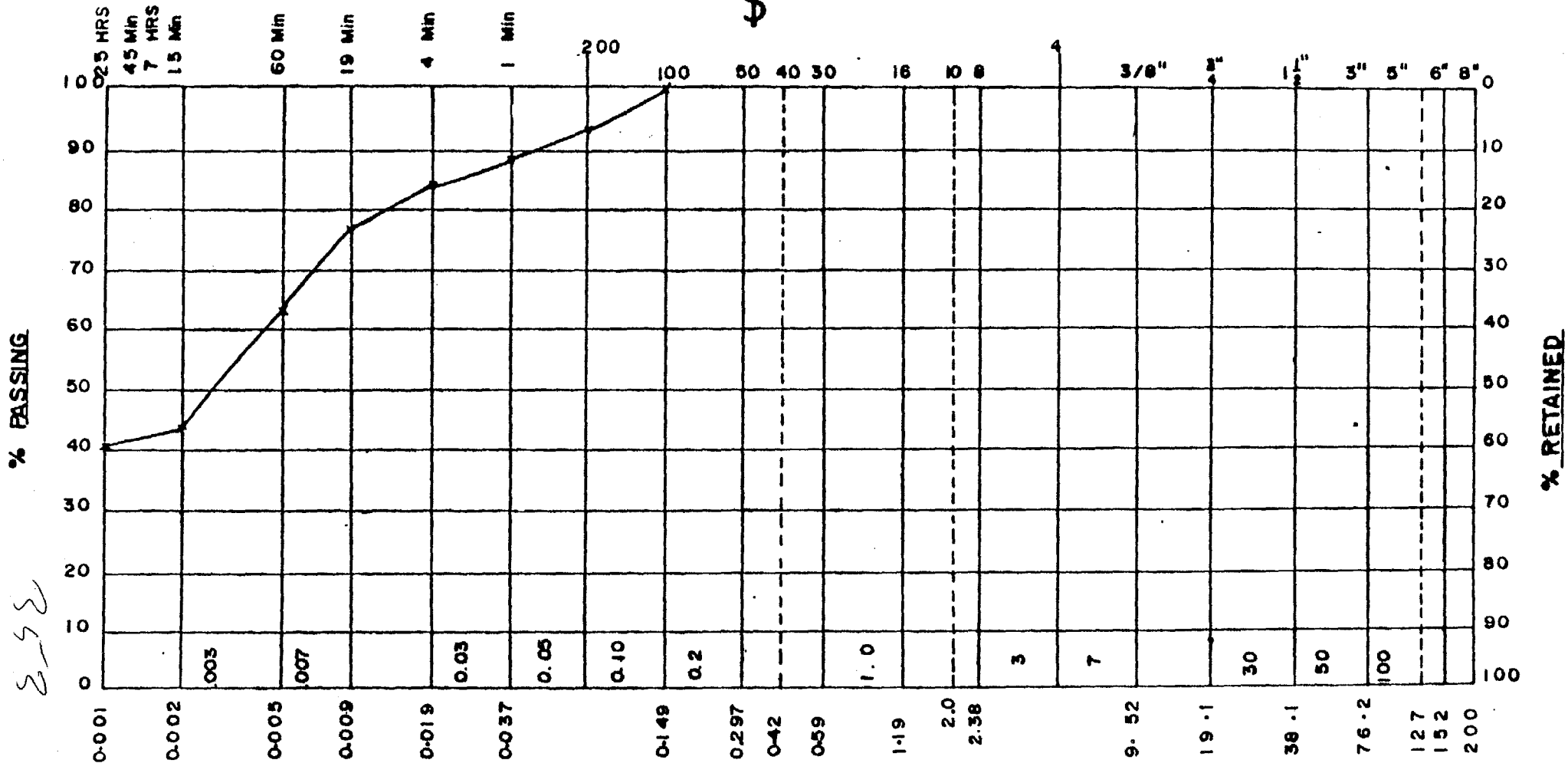
GEO. RESEARCH

DATE _____

SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	
		0.074			4.76		

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH 8				
	-	6.95	48.90	44.15
D: 3.50m				

REMARKS _____

PROJECT _____

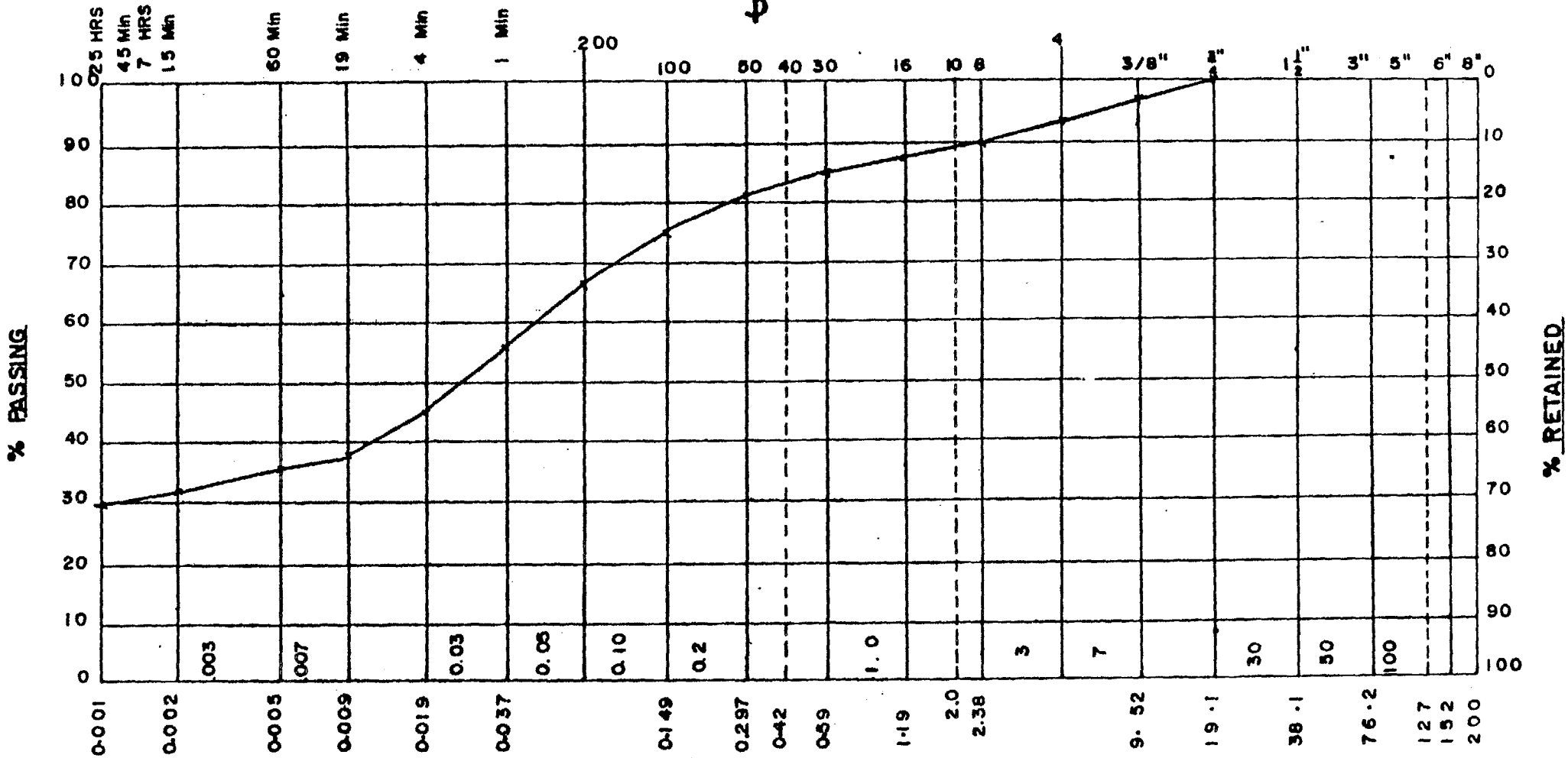
DATE _____

SAMPLE No _____

GEO. RESEARCH

HYDROMETER ANALYSIS

SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

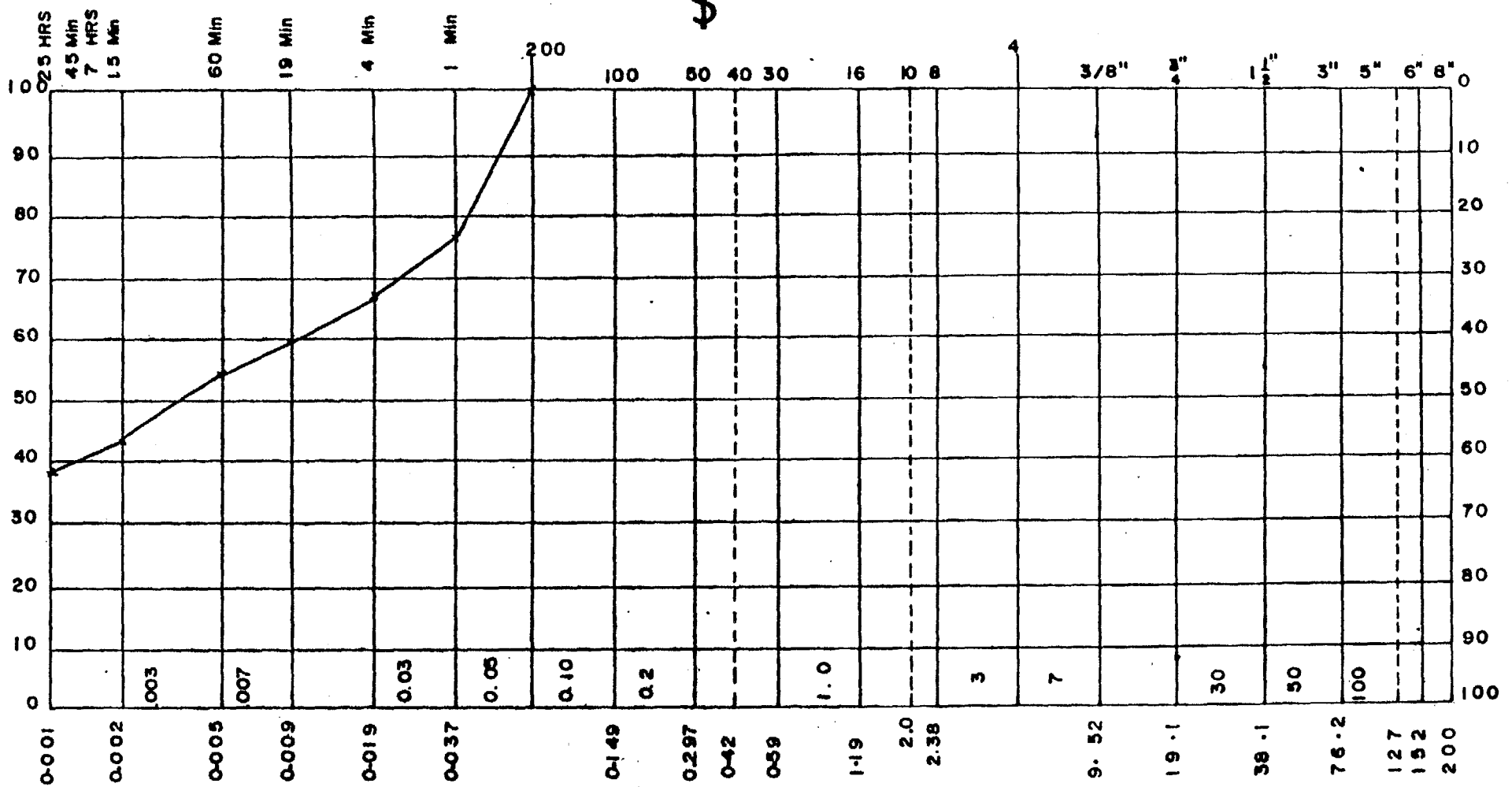
SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
RH 9				

REMARKS _____

DATE _____

PROJECT _____ GEO. RESEARCH SAMPLE No _____

HYDROMETER ANALYSIS SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH 10 4.0m	-	-	55.88	44.12

REMARKS _____

DATE _____

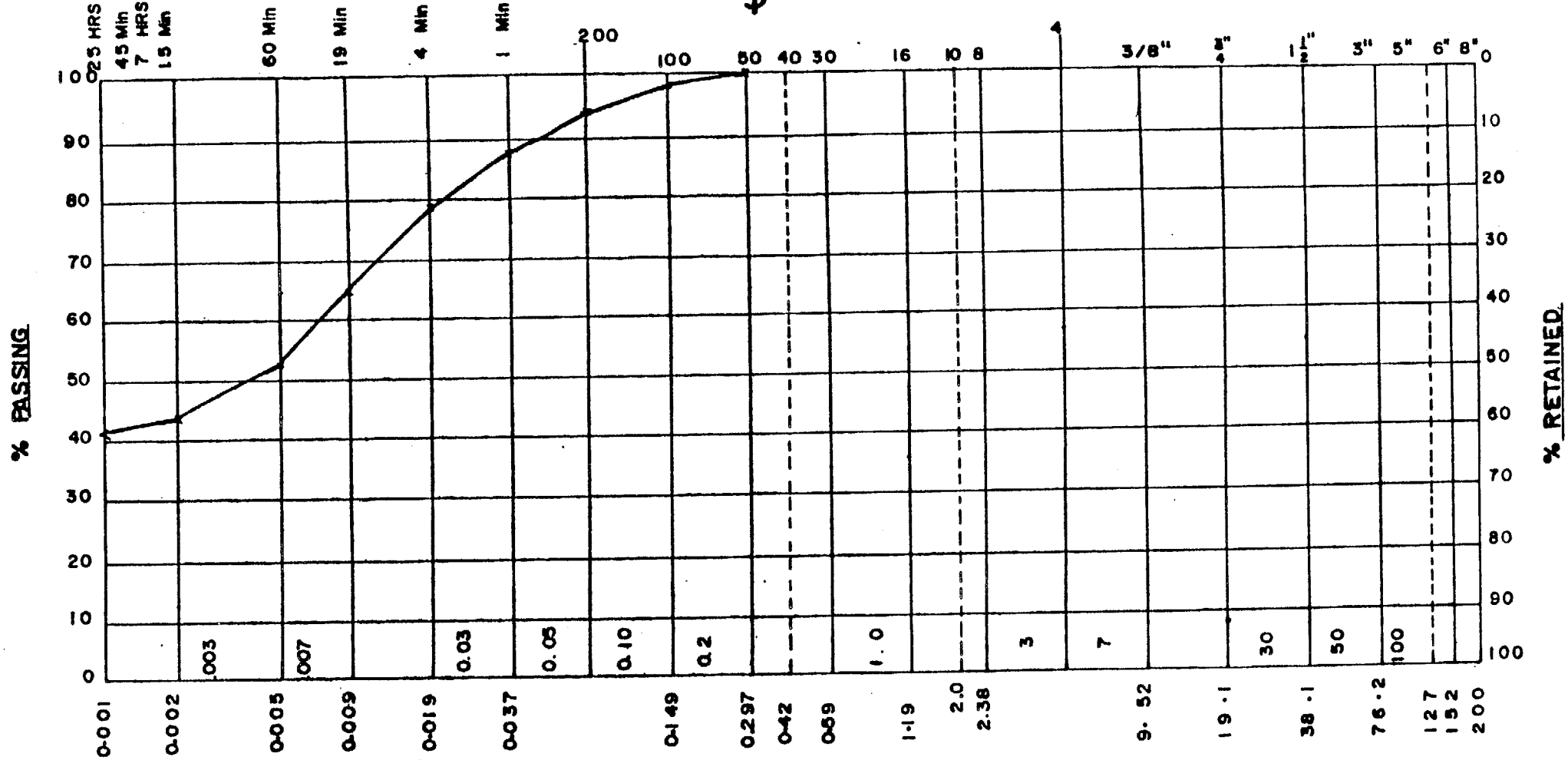
PROJECT _____

GEO. RESEARCH

SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH 11				13.93

REMARKS _____

PROJECT _____

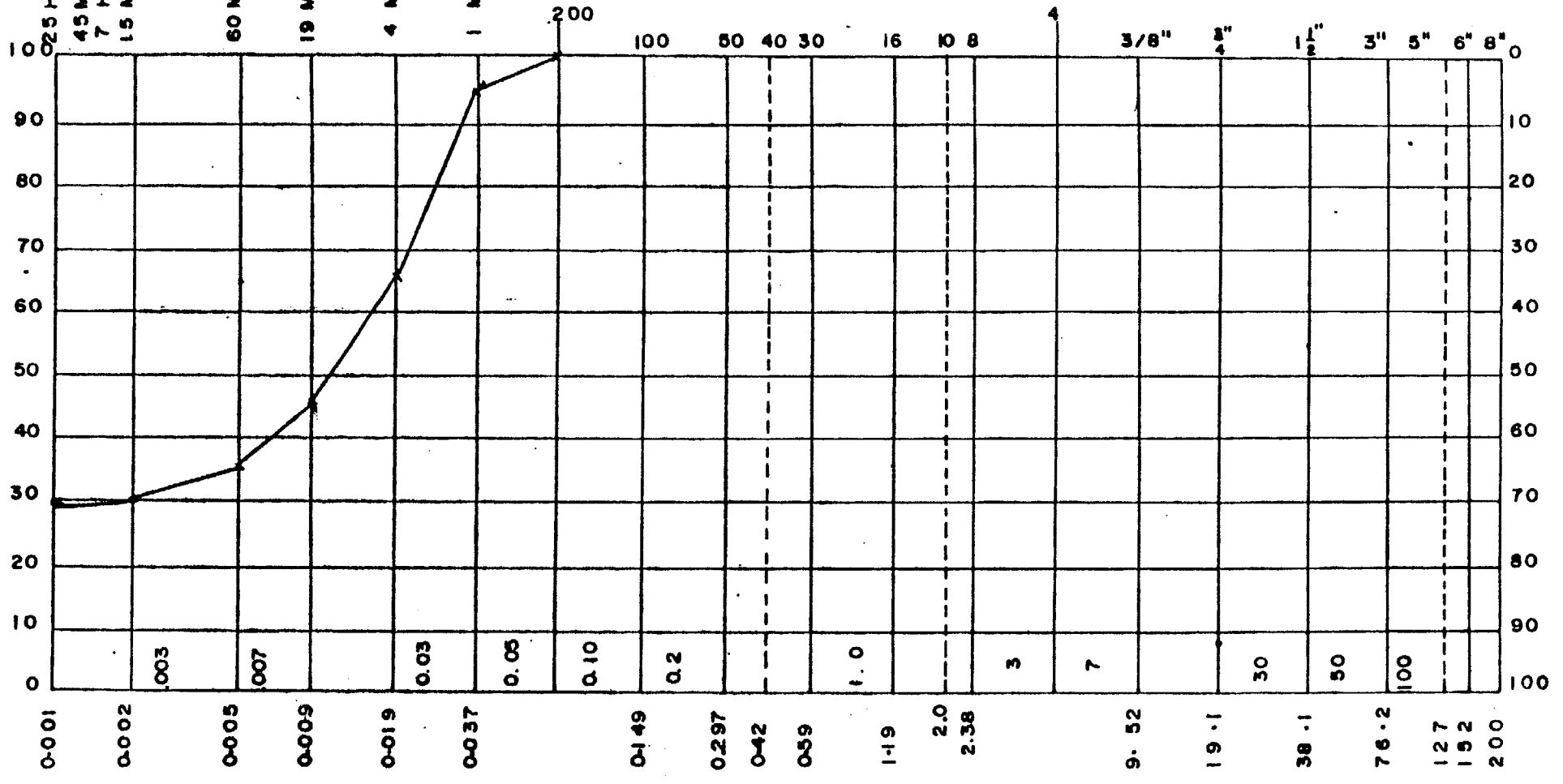
DATE _____

SAMPLE No _____

GEO. RESEARCH

HYDROMETER ANALYSIS

SIEVE ANALYSIS

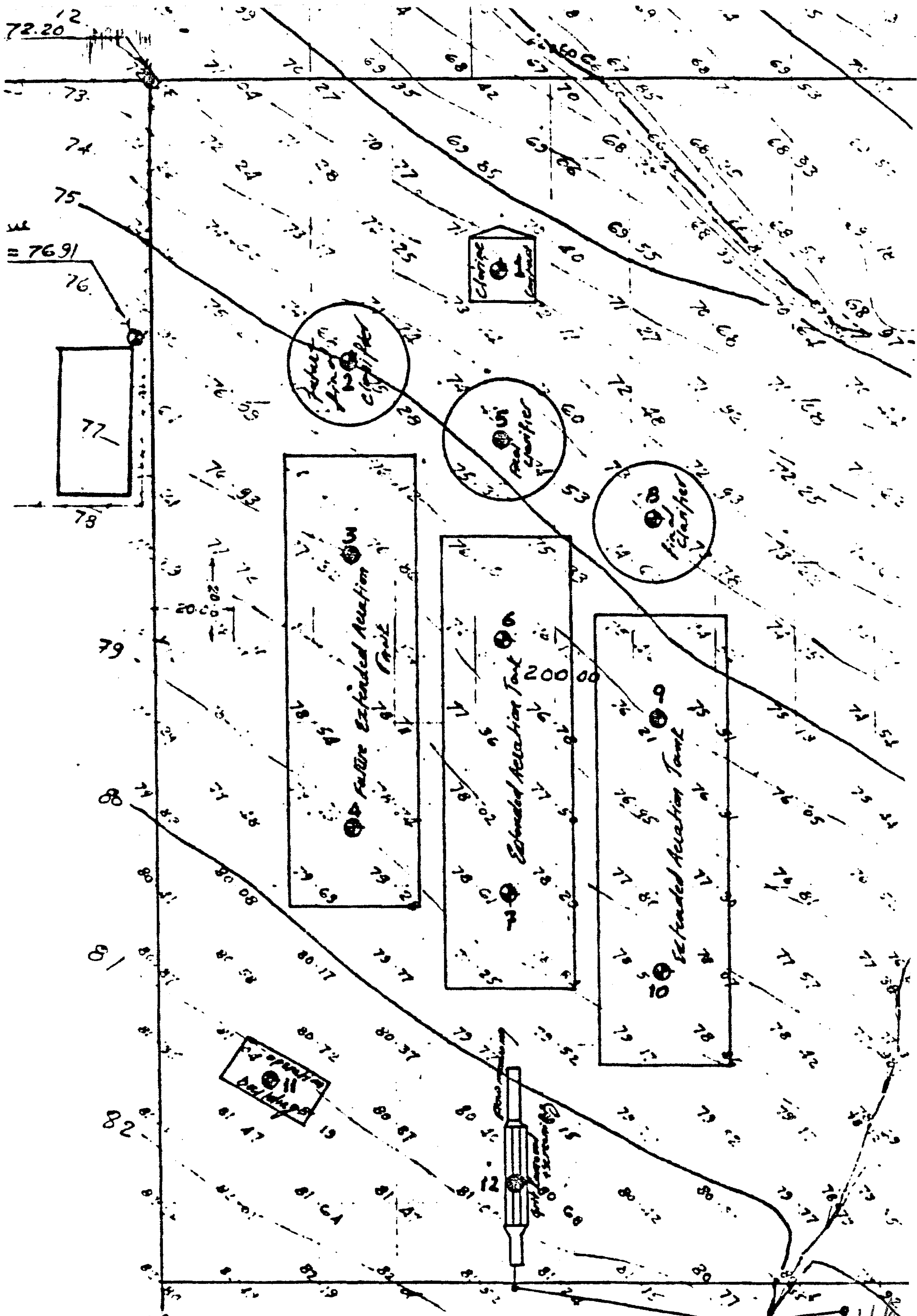


0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH 12 4.50 m	-	-	69.88	30.12

REMARKS _____


72.20
= 7691
Future Extended Aeration Tank
Extended Aeration Tank
Extended Aeration Tank
200.00
20.00
Final Clarifier

ADDITIONAL
SITE INVESTIGATION
OF
THE WASTE WATER TREATMENT PLANT
IRBID

TOUKAN & SAKET
Geo. Research & Foundation
Engineering Office

TOUKAN & SAKET
Geo Research & Foundation
Engineering Office

Drilling , Sampling , Testing
Engineering Geology , Foundations
& Geomechanics

كتب طوقان والساكت
اسات الهندسية الجيولوجية والأساسات

تثقيب ، اخذ عينات ، تحليل ،
مسح هندسي جيولوجي ، دراسة
اساسات وميكانيكا الصخور والتربة

10.1.1982

Additional

Site Investigation of the Waste Water Treatment Plant.

Irbid

Introduction:

Upon the request of Messrs Sigma and Weston International, additional subsoil investigation has been carrie out at the proposed site and at locations representing the construction area.

The investigation was carried out by performing 8 additional boreholes drilled at the study area to de of 10.0 m each. Ten percolation tests were also performed at locations determined by the consultant.

Scope of Work:

The purpose of this study was to determine the grou nd conditions at the site, in order to provide full informations about the materials and provide informations to the Engineer which could assist him in the design of prop and safe foundation.

Laboratory tests were performed on representative samples obtained.

ص.ب ٩٢٦٨٩٧ - تلفون ٦٢٤٠٥ - برقياً : طيار - تلكس : ٢١٥٤٢ طوقــان جو - عمان - الأردن
P.O. ... 92..7 - Telephone ..2405 - Cable - TAYYA.. - Telex - 21542 Toukan Jo - Amman - Jordan

Method of Investigation:

All drilling, sampling and testing were performed in accordance with the ASTM standards.

The subsurface was explored by using CME rig advanced by rotary drilling allowing the performance of standared penetration tests. Representative samples were obtained during the drilling operation and were placed in tight plastic bags for description.

Standard penetration tests were carried out in accordance with the ASTM standards and the results were recorded on the borehole logs at depths to which they refer.

The standard penetration tests were executed with the standard sampling spoon driven by dropping a 140 lb weight hammer with a 30 inches fall height. The 2 inches diameter spoon, lowered to the bottom of the borehole and penetrated about 6 inches into the marl or into any soft material.

The "N" value is the number of blows required to produce one foot of penetration.

In defining the density of the material, very soft material was considered to have standard penetration values less than two blows per foot, soft, between 2 and 4 blows per

foot, and stiff material between 8 and 15 blows per foot, very stiff between 15 and 30 blows per foot,hard material more than 30 blows per foot.

Field Work.

Drilling:

The location of boreholes were chosen so as to represent the construction area and provide as much informations as possible.

A total of 8 boreholes were drilled. The location of the drilled boreholes is shown on the attached plan

The depth to which boreholes were drilled was 10. meters each. No water table was observed during the dr: ling operations.

In addition 10 auger holes were drilled for perco lation tests. The location of the holes is shown on the attached plan.

Sampling:

Continuous samples of the drilled material were taken at regular depth interval of 0.5 meters and at lithological changes of the strata. The samples were labelled, described and logged.

Insitu Testing:

In order to obtain an estimate of the density insitu, standard penetration tests were performed.

The standard penetration tests results indicate that the material is firm to hard (SPT ranges between 6 and 30 blows per foot).

Geo-Mechanics:

The drilling results indicate that the area is covered by a mantle of mediterranian soils composed of sandy silty clay. The thickness of this soil ranges between 1.50m and 4.0 meters.

This material is classified as CL and CH type according to the Unfied Soil Classification System. The CH material has the following engineering properties:

- Sandy silty clay of medium to high plasticity.
- Impervious when compacted.
- Of poor shearing strength.
- Of poor workability as construction material.
- It is considered poor as foundation material particularly when subjected to water.

The CL type material has almost simillar properties but lower plasticity and has higher percentage of sand and silt size fractions.

The mediterranian soils (overburden) is underlain by marl. The called marl in this report is carbonaceous silty clay (rock flour).This fine grained. very soft when wet and has a moderate to low dry strength. The strength of this material is dependent on the percentage of clay size fractions.

The marl "ML" type has the following engineering properties:

- Silty clay, rock flour.
- Semi pervious to impervious when compacted.
- Of poor to fair shear strength when compacted.
- Of low to medium plasticity.
- It is considered poor as foundation material.

In order to find out the engineering properties of the existing material within the study area, the following tests were performed on representative samples obtained:

- Natural moisture content.
- Grainsize analysis.
- Atterberg limits.
- Unconfined compression tests.
- Triaxial compression test.
- Compaction tests.

  - The moisture content of the tested samples show a range between 8% and 30.5% .
  - The grainsize analysis show that the material is composed of sand ranges between 5.9% and 26.8% , silt, ranges between 25.5% and 58.50% and clay, range between 35.6% and 50.1% .
  - The atterberg limits tests results show that the liquid limit ranges between 33.8 and 53.5 with a

Plasticity index in the ranges between 8.5 and 28.8.

- The unconfined compressive strength of the tested samples show a range between 0.5 kg/cm2 and 1.85 kg/cm2.
- The undrained triaxial tests performed on two samples obtained show that the cohesion is ranging between 0.60 kg/cm2. and 0.70 kg/cm2 with a friction angle ranging between 2 and 3 degrees.
- The compaction tests performed on representative samples obtained that the maximum dry density is ranging between 1.45 gr/cm3 and 1.7 gr/cm3 on optimum moisture content between 15.5% and 26%.
- In addition ten percolation tests were performed in auger boreholes drilled at location representing the study area. Tests show that the following results:

Test No:	Time(min)	Percolated Water Volume (Lose of Water)(Litres)
Test 1	15	40
	15	2
	15	1
	60	0.7
3.0m	24 hr	1.0
Test 2	15	25
	15	1
	15	1
	60	0.5
1.5m	24 hr	2
Test 3	15	35
	15	20
	15	1
	60	0.2
3.0m	24 hr	3
Test 4	15	47
	15	25
	15	3
	60	0.75
	24 hr	1

Test No	Time (min)	Lose of Water Percolated Water Volume (LT)
Test 5	15	60
	15	15.5
	15	3.5
	60	0
3.0m	24 hr	1
Test 6	15	40
	15	16.7
	15	7.5
	60	1
3.Cm	24 hr	2
Test 7	15	65.5
	15	12.5
	15	3.0
	60	2.5
	24 hr	3
Test 8	15	40
	15	3.5
	15	0.5
	60	0.5
1.5m	24 hr	0.5
Test 9	15	43.5
	15	10.5
	15	2.0
	60	1.0
1.5m	24 hr	0.75
Test 10	15	47.5
	15	20.5
	15	10.0
	60	4.0
3.0m	24 hr	4.0

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675

The tests show that most of the percolated water is mainly the absorbed water by the dry soil. After the first hour, the amount of water percolation is very low.

As a result of the percolation tests the material could be considered effecively impermeable.

Conclusions and Recommendations:

As a result of this study and tests the following conclusion could be summarized:

- The drilling results show that the material within the study area is uniform interms of lithology and non-uniform interms of density.
- The area is covered by a mantle of overburden, medi- terranean, soil composed of brown sandy silty clay ranges in thickness between 1.5 and 5.0 m.
- The overburden is underlain by firm to hard marl, moist to saturated at few locations.
- No water table was observed in the drilled boreholes.

Owing to non-uniformity of material within the study area, the following bearing capacities are suggested fo: each structure:

Borehole No	Foundation Depth and Recommendation	Bearing Capacity (kg/cm2)
102	468.5m	1.40
108	476m	1.4
109	478m (Refill 0.5m coarse grained granular material compacted to a maximum dry density) + drainage.	
110	476m	1.60
111	477m (Refill o.5m coarse grained granular material to be compacted to a maximum dry density to heavy vibratory rollar).	1.0
112	478.5	1.60
113	473	1.60
A (Additional)	466	1.60

The suggested bearing capacities were based on the weakest material encountered in the boreholes, the lowest SPT results obtained, the shear strength parameters, and assuming that the area is fully drained.

- The weakest material was encountered in boreholes 109 and 111 where soft marl thickness more than five meters. This soft material was also encountered in borehole No 2 of the previous investigation. It seems that those boreholes are located in an old gulley subjected to water accumnlation causing saturation of material.

In order to have a safe, stable foundation at the location of those boreholes, it is recommended to sacrify 1.5 meters below the proposed foundation level. The 1.5m weak material should be replaced by coarse grained granular material and compacted in 12 inch layers to a maximum dry density by means of heavy vibratory roller; a minimum of 20 tons is recommended. Further check of the density before and after compaction is important.

- The material at the proposed foundation level of all structures should be compacted by a heavy roller, aminimum of eight passes in an attempt to density the soft zones within the construction areas. By means of this compaction a uniformity of material interms of density would be achieved.

- Back fill material should be compacted by heavy vibratory to 95% maximum dry density and should not be placed in layers greater than 12 inches. Fill material should be a well graded, sand and gravel mixed with the existing mediterranean soil 50/50 to improve the engineering properties. The mediterranean soils should not be used as foundation or fill for support of structures and pavements. Fill and compaction density and moisture control should be provided through field and laboratory supervision.
- A drainage trench surrounding the construction area should be excavated, filled with filter material, and sloped to drain the water off the area. The material surrounding all the structures should be compacted and the area paved to prevent any percolation of rainwater into the foundation material. Side walks surrounding the buildings should also be wide enough to prevent direct percolation of rainwater into the foundation material.

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Unconfined and Triaxial Compression Tests

Results

Sample NO & Depth	Unconfined Compressive Strength (Kg/cm²)	Triaxial Compression Tests C(kg/cm2)	ϕ
BH 102 3.0m	1.35		
BH 102 4.5m	1.45		
BH 108 4.0m	1.30		
BH 108 5.5m	1.85		
BH 109 1.5m	0.40		
BH 109 3.0m	0.60		
BH 109 4.5m	0.75		
BH 110 3.0m	1.40	0.60	2
BH 110 4.5m	1.65		
BH 111 2.0m	0.50		
BH 111 3.5m	0.65		
BH 111 5.0m	0.80		
BH 112 3.0m	1.65	0.70	3
BH 112 4.5m	1.80		
BH 113 3.0m	1.40		
BH 113 4.5m	1.55		

Summary of Tests Results

Sample No & Depth	Grainsize analysis				Atterberg limits			Moist. Content (%)
	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL	PL	PI	
BH 108 2.50m	7.7	26.8	25.5	40.0	39.60	23.6	16.0	10.5
BH 108 5.00m	-	9.80	42.60	47.60	33.8	25.3	8.5	8.0
BH 109 1.50m	-	13.6	41.50	44.90	48.8	24.2	24.6	36.5
BH 109 3.0m	-	7.3	53.8	38.90	41.30	23.5	17.8	24.0
BH 110 1.8m	8.8	24.50	30.90	35.80	36.8	24.8	12.0	22.0
BH 110 3.50m	-	13.4	40.90	45.70	56.10	28.10	28.0	30.5
BH 111 2.00m	-	13.3	38.60	48.10	52.60	23.8	28.8	26.0
BH 111 4.00m	-	5.90	58.5	35.60	39.10	29.10	10.0	29.0
BH 112 1.50m	-	7.2	42.7	50.10	53.5	26.5	27.0	16.0
BH 112 4.00m	-	12.30	47.90	39.80	38.9	27.9	11.0	19.5
BH 113 3.0m	-	8.90	42.5	48.6	40.0	30.5	9.5	18.0

Compaction Tests Results

Sample No	Compaction Test Max.Dry Density (gr/cm3)	Optimum Moisture Content (%)
1	1.45	24.5
2	1.65	52.5
3	1.61	26.0
4	1.70	15.5
5	1.49	26.5

TOUKAN & SAKET
GEO - RESEARCH

BOREHOLE LOG DATA SHEET

PROJECT : Waste water treatment Irbid	TYPE & SIZE OF DRILLING
BOREHOLE NO. : 102	DATE :

DEPTH (M)	LOG	DESCRIPTION	REC. (%)	RQD. (%)	SPT (N) 10 20 30 40 50
1		Gravelly sandy silty clay with cobbles.			
2		Sandy silty clay, gravels and marl.			
3					
4		Marl, brownish yellowish, very			
5		stiff to hard.			
6					
7					
8		Marl, yellowish , hard.			
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					

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TOUKAN & SAKET
GEO - RESEARCH

BOREHOLE LOG DATA SHEET

PROJECT : Waste water Treatment Irbid	TYPE & SIZE OF DRILLING
BOREHOLE NO. : 108	DATE :

DEPTH (M)	LOG	DESCRIPTION	REC. (%)	RQD. (%)	SPT (N) 10 20 30 40 50
1 -		Sandy silty clay with gravels			
2 -		Gravelly sandy silty clay and marl			
3 -					
4 -					
5 -		Marl, light brown, very stiff to hard.			
6 -					
7 -		Marl, yellowish, very stiff to hard.			
8 -					
9 -					
10 -					
11 -					
12 -					
13 -					
14 -					
15 -					
16 -					
17 -					
18 -					
19 -					
20 -					
21 -					
22 -					

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TOUKAN & SAKET
GEO - RESEARCH

BOREHOLE LOG DATA SHEET

PROJECT : Waste water treatment Irbid	TYPE & SIZE OF DRILLING
BOREHOLE NO. : 109	DATE :

DEPTH (M)	LOG	DESCRIPTION	REC. (%)	RQD. (%)	SPT (N) 10 20 30 40 50
1		Dark brown, organic, sandy silty clay.			
2		Light brown, sandy silty clay.			
3					
4		Marl, semi saturated, firm.			
5					
6					
7		Marl, yellowish, very stiff to hard.			
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					

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TOUKAN & SAKET
GEO - RESEARCH

BOREHOLE LOG DATA SHEET

PROJECT : Waste Water Treatment Irbid	TYPE & SIZE OF DRILLING
BOREHOLE NO. : 110	DATE :

DEPTH (M)	LOG	DESCRIPTION	REC. (%)	RQD. (%)	SPT (N) 10 20 30 40 5
1		Sandy silty clay, dark brown.			
2		Gravelly sandy silty clay.			
3					
4		Marl, light brown, very stiff, moist.			
5					
6					
7		Marl, yellowish, very stiff to hard.			
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					

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TOUKAN & SAKET
GEO - RESEARCH

BOREHOLE LOG DATA SHEET

PROJECT : Waste Water Treatment Irbid	TYPE & SIZE OF DRILLING
BOREHOLE NO. : 111	DATE :

DEPTH (M)	LOG	DESCRIPTION	REC. (%)	RQD. (%)	SPT (N) 10 20 30 40 50
1		Sandy silty clay, dark brown.			
2 - 6		Marl yellowish light brownish, firm to stiff, moist to saturated			
7 - 10		Marl, yellowish, stiff to very stiff moist.			
11 - 21					
22					

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689

TOUKAN & SAKET
GEO - RESEARCH

BOREHOLE LOG DATA SHEET

PROJECT : Waste water treatment Irbid	TYPE & SIZE OF DRILLING
BOREHOLE NO. : 112	DATE :

DEPTH (M)	LOG	DESCRIPTION	REC. (%)	RQD. (%)	SPT (N) 10 20 30 40 5
1 -		Dark brown, organic, sandy silty clay.			
2 -		Brownish-yellowish sandy silty clay.			
3 -					
4 -		Marl, very stiff to hard, moist.			
5 -					
6 -					
7 -					
8 -					
9 -					
10 -					
11 -					
12 -					
13 -					
14 -					
15 -					
16 -					
17 -					
18 -					
19 -					
20 -					
21 -					
22 -					

TOUKAN & SAKET
GEO - RESEARCH

BOREHOLE LOG DATA SHEET

PROJECT : Waste Water Treatment Irbid	TYPE & SIZE OF DRILLING
BOREHOLE NO. : 113	DATE :

DEPTH (M)	LOG	DESCRIPTION	REC. (%)	RQD. (%)	SPT (N) 10 20 30 40 50
1		Sandy silty clay, dark brown.			
2		Sandy silty clay, light brown, stiff.			
3					
4		Marl, light brown, very stiff.			
5					
6					
7		Marl, yellowish, very stiff to hard.			
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					

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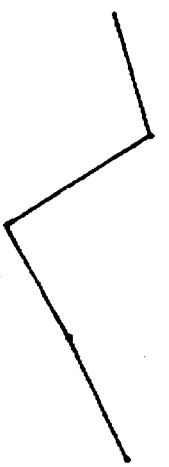
TOUKAN & SAKET
GEO - RESEARCH

BOREHOLE LOG DATA SHEET

PROJECT :	TYPE & SIZE OF DRILLING
BOREHOLE NO. : A (additional)	DATE :

DEPTH (M)	LOG	DESCRIPTION	REC. (%)	RQD. (%)	SPT (N) 10 20 30 40 50
1 -					
2 -		Sandy silty clay, hard, brown, stiff.			
3 -					
4 -		Sandy silty clay some marl, light brown, very stiff.			
5 -					
6 -		Marl, light brown, yellowish.			
7 -					
8 -		Marl, yellowish, very stiff to hard.			
9 -					
10 -					
11 -					
12 -					
13 -					
14 -					
15 -					
16 -					
17 -					
18 -					
19 -					
20 -					
21 -					
22 -					



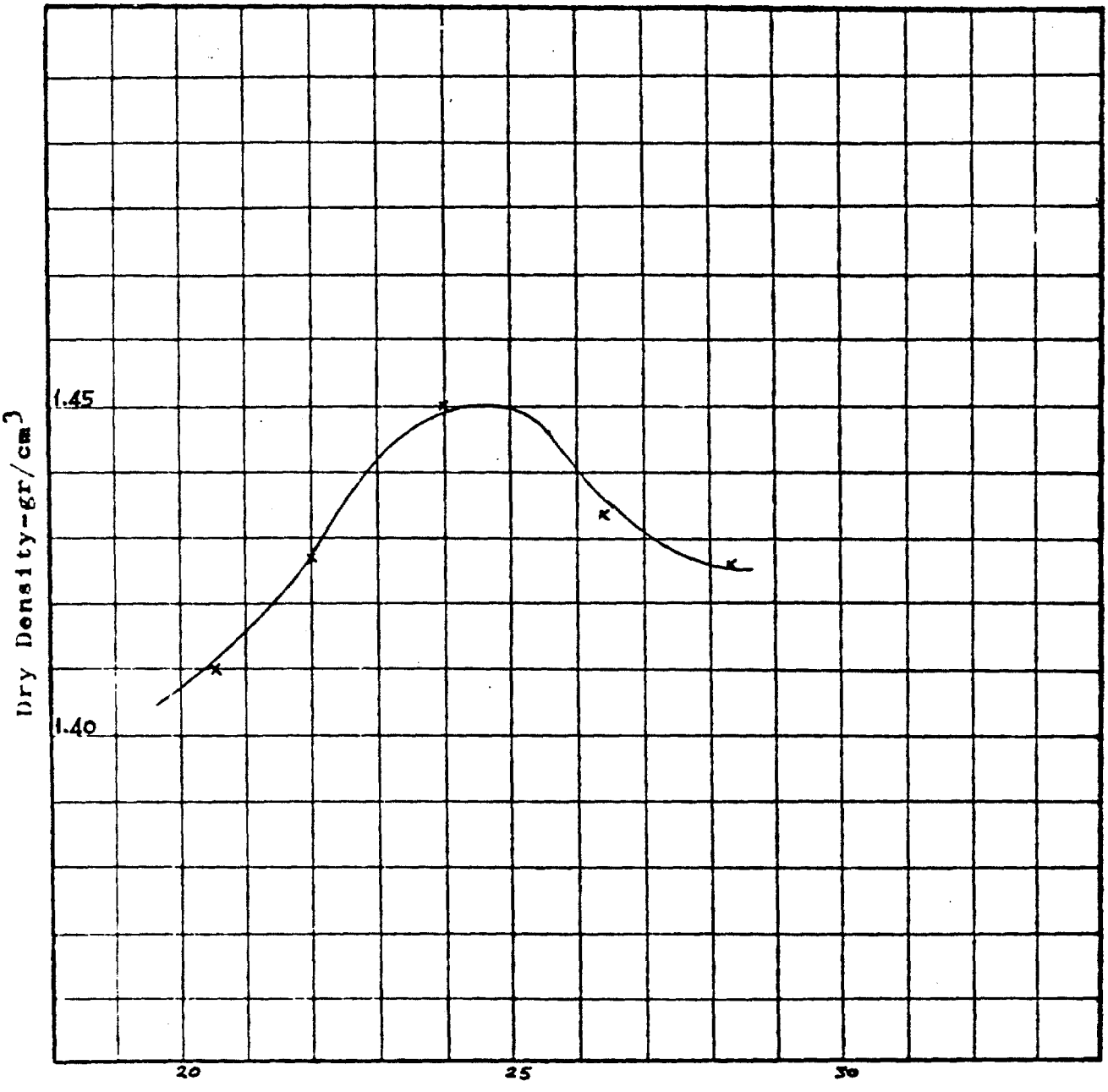
69

Geo-Research

Standard Proctor Compaction Test

Sample No.: 1

Project: Waste Water Treatment plant - Erbil



Max. Dry Density = 1.45 gr/cm³ Moisture Content(%)

Optimum Moisture Content = 24.5 %

368

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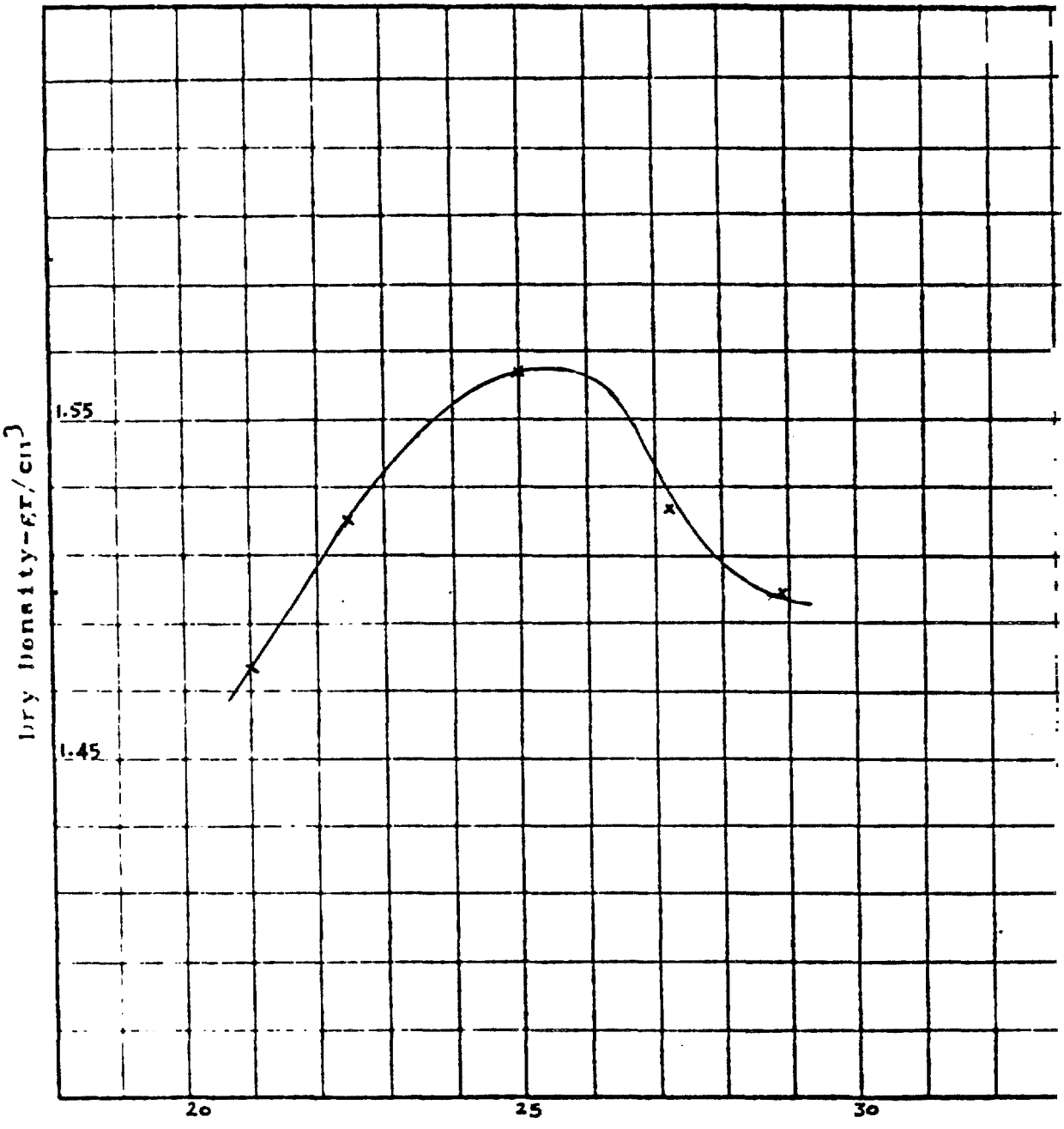
Remarks: The ...

Geo-Research

Standard Proctor Compaction Test

Sample No.: 2 Project:



Max. Dry Density = 1.56 gr/cm^3 Moisture Content(%)

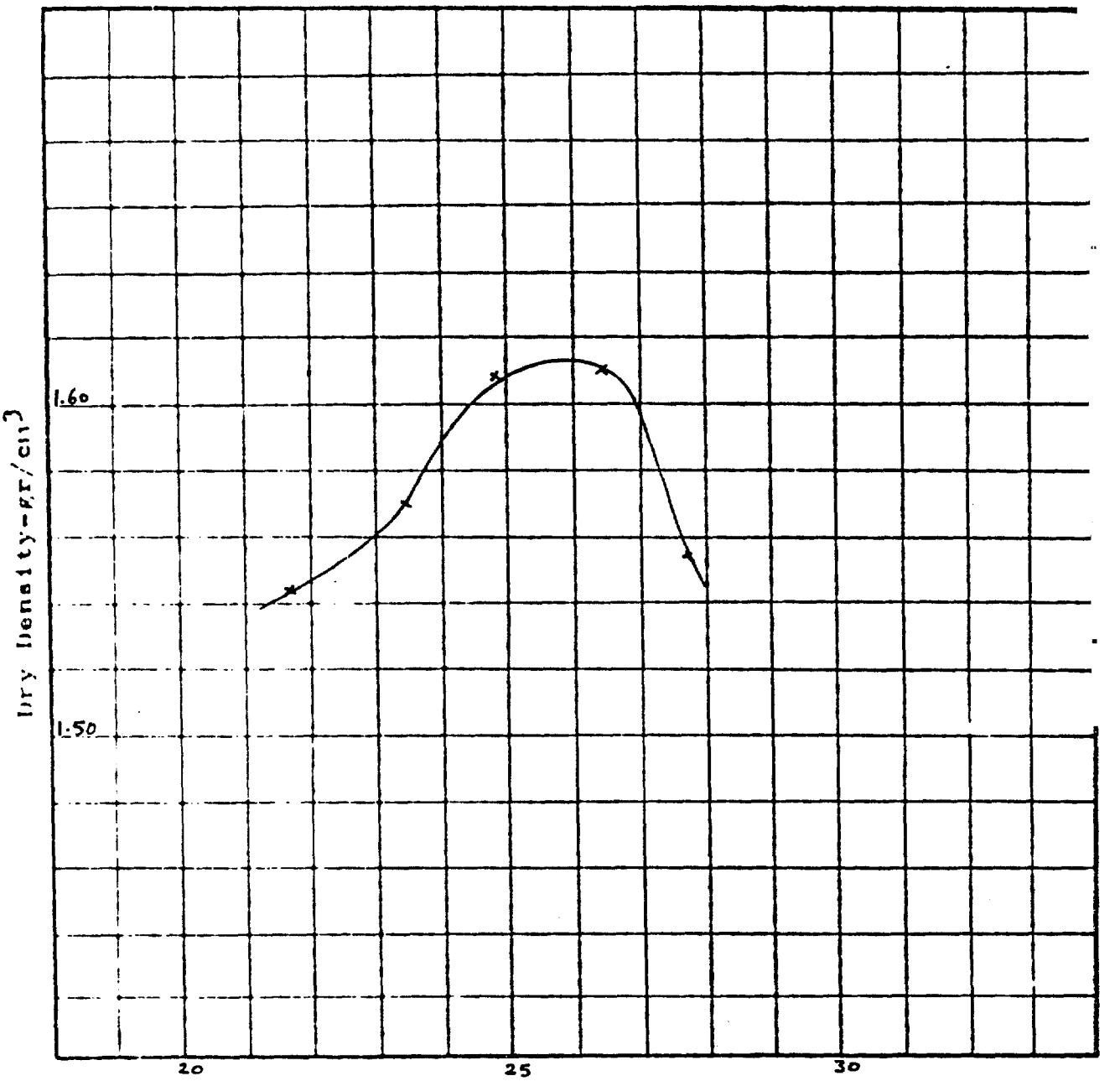
Optimum Moisture Content = 25.5%

Remarks: The sample is light brown sandy silty clay.

Geo-Research

Standard Proctor Compaction Test

Sample No.: 3 Project:



Max. Dry Density = 1.61 gr/cm^3 Moisture Content(%)

Optimum Moisture Content = 26.0 %

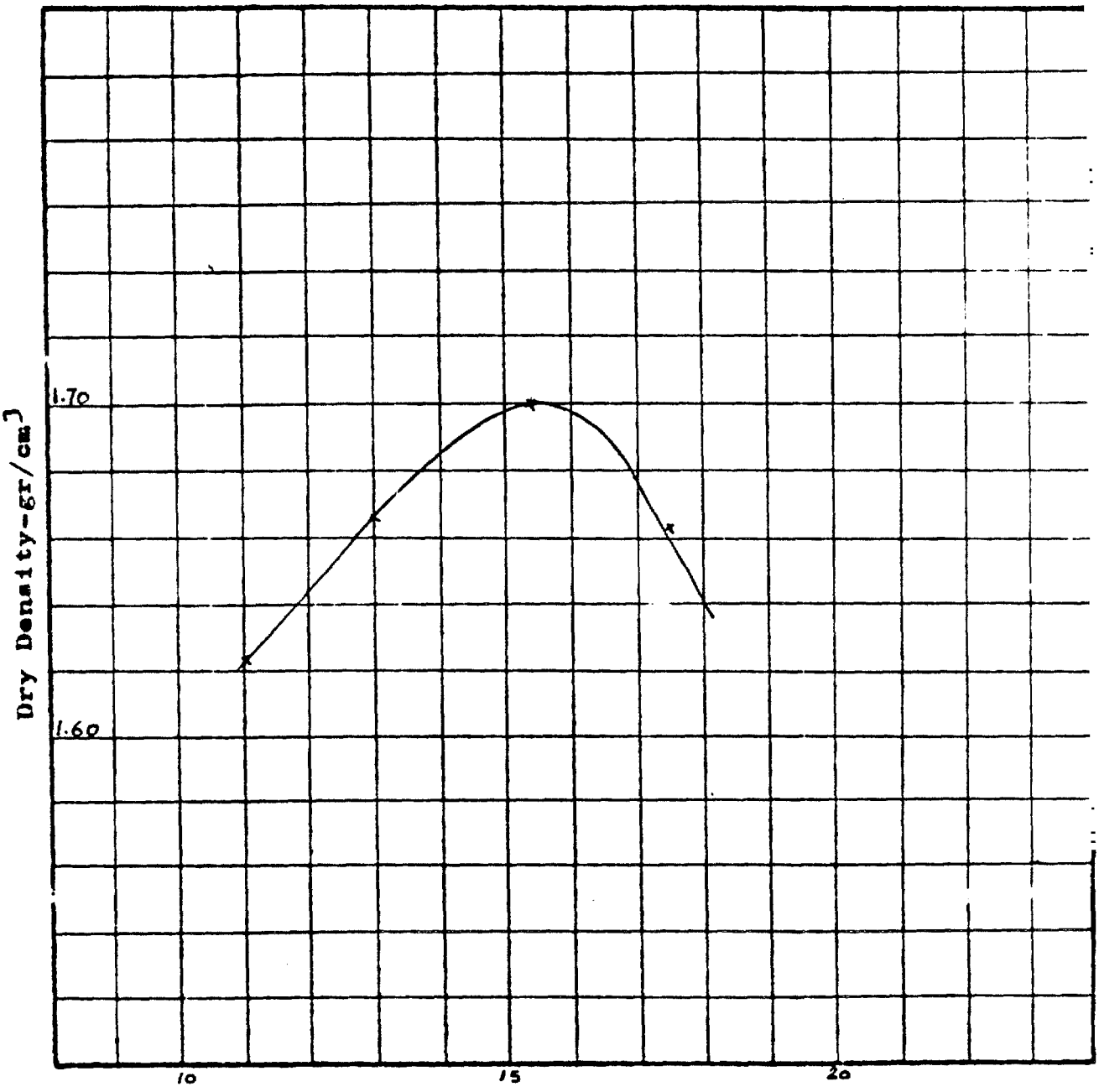
369

Remarks: The sample is light brown sandy silty clay, some fine gr...

Geo-Research

Standard Proctor Compaction Test

Sample No.: 4 Project:



Max. Dry Density = 1.70 gr/cm³ Moisture Content(%)

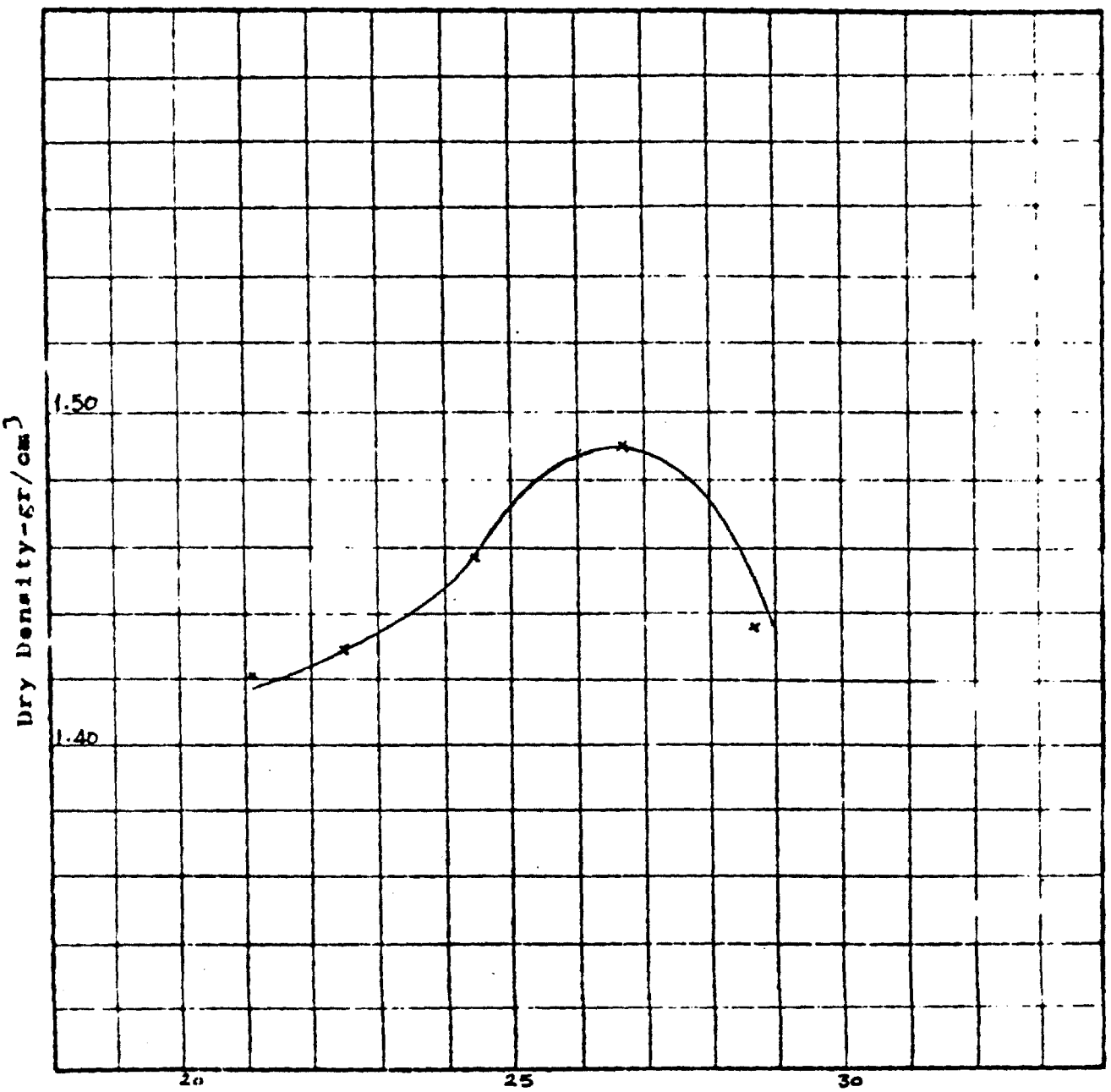
Optimum Moisture Content = 15.5 %

69

Geo-Research

Standard Proctor Compaction Test

Sample No.: 5 Project:



Max. Dry Density = 1.49 gr/cm³ Moisture Content(%)

Optimum Moisture Content = 26.5 % 370

Remarks:

DATE _____

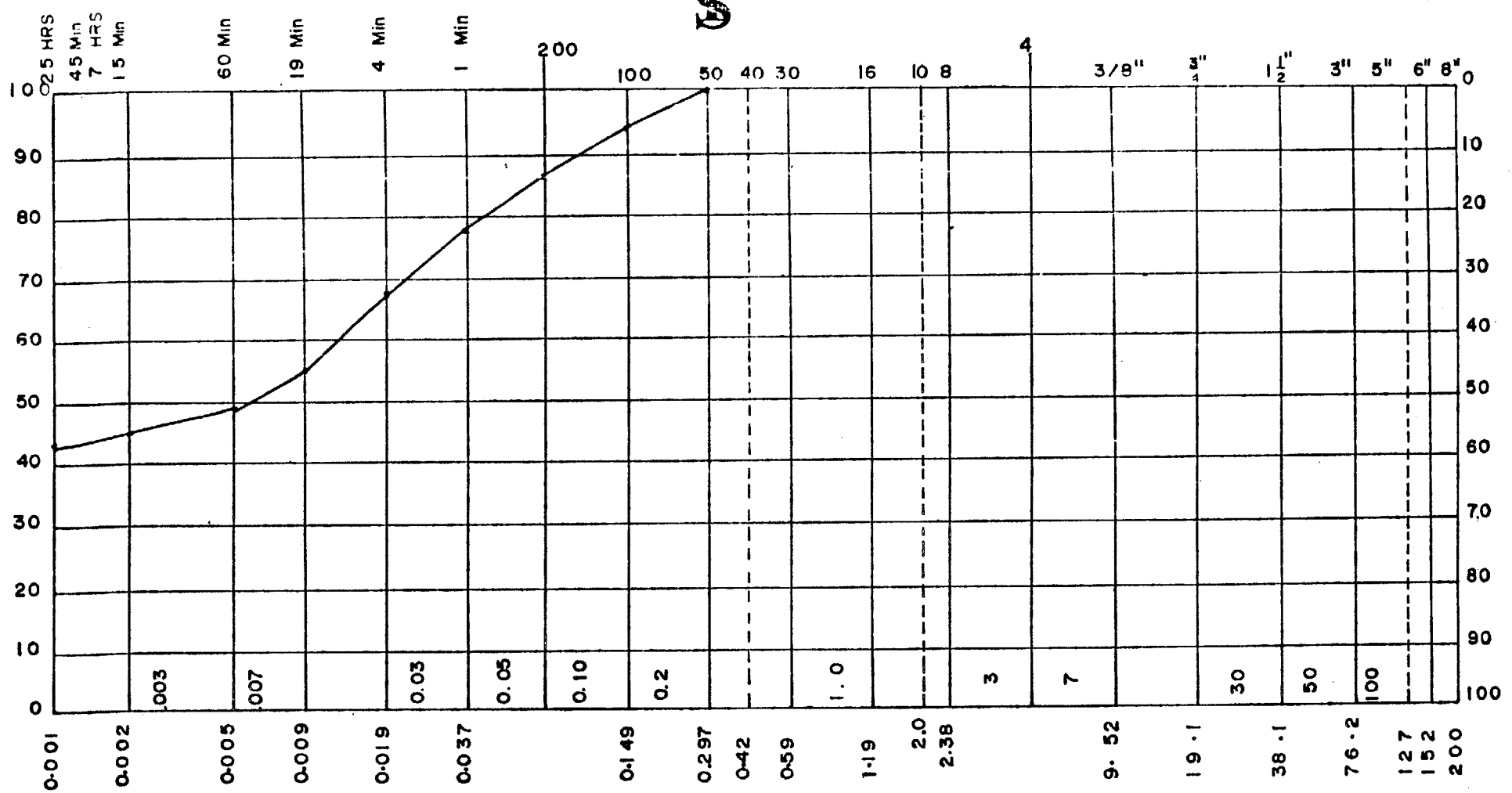
PROJECT _____

SAMPLE No _____

GEO_RESEARCH

HYDROMETER ANALYSIS

SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH01 1.5m	–	13.60	41.50	44.90

REMARKS _____

DATE _____

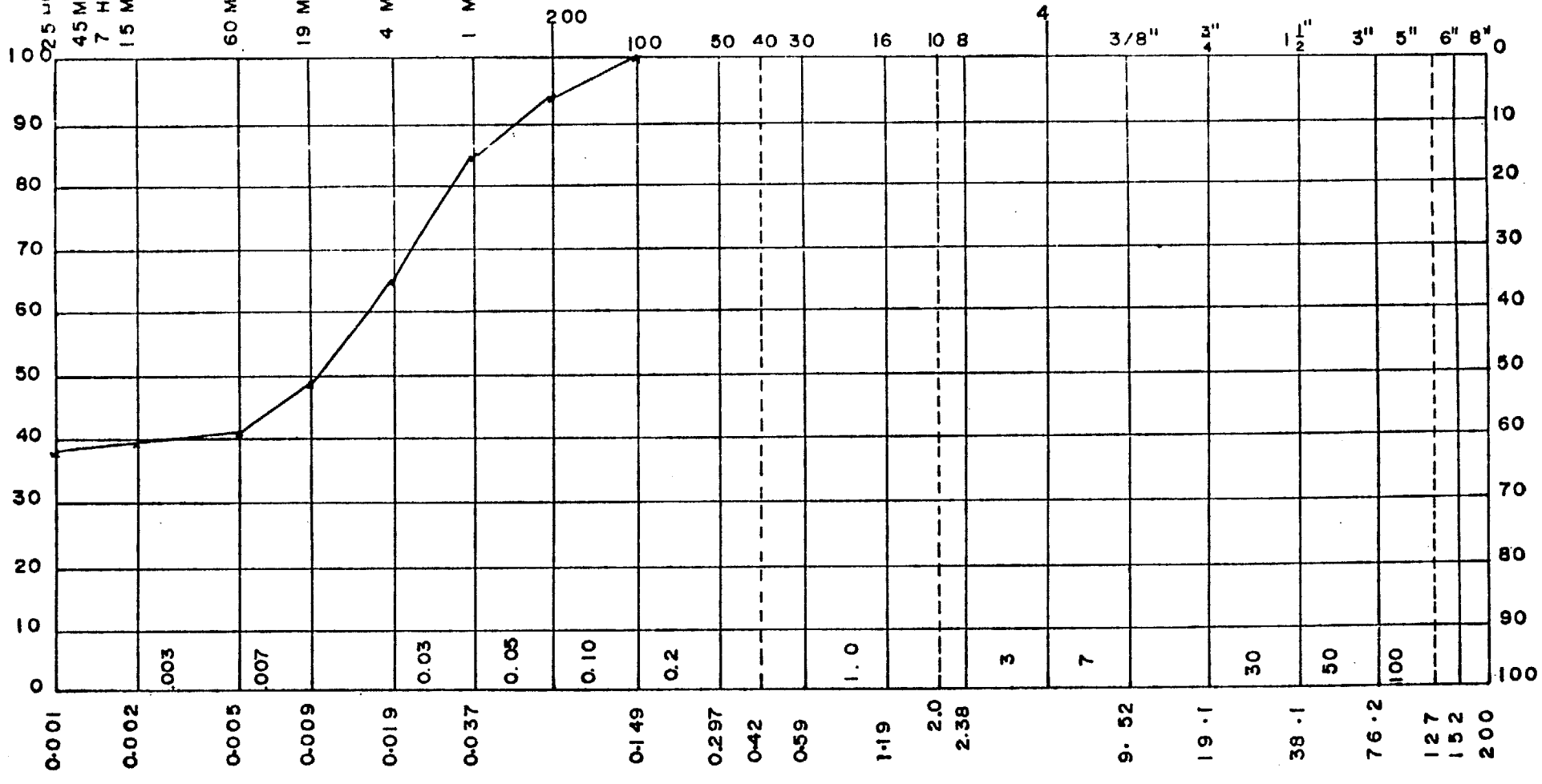
PROJECT _____

GEO. RESEARCH

SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH 99 3.0m	—	7.30	53.80	38.90

REMARKS _____

DATE _____

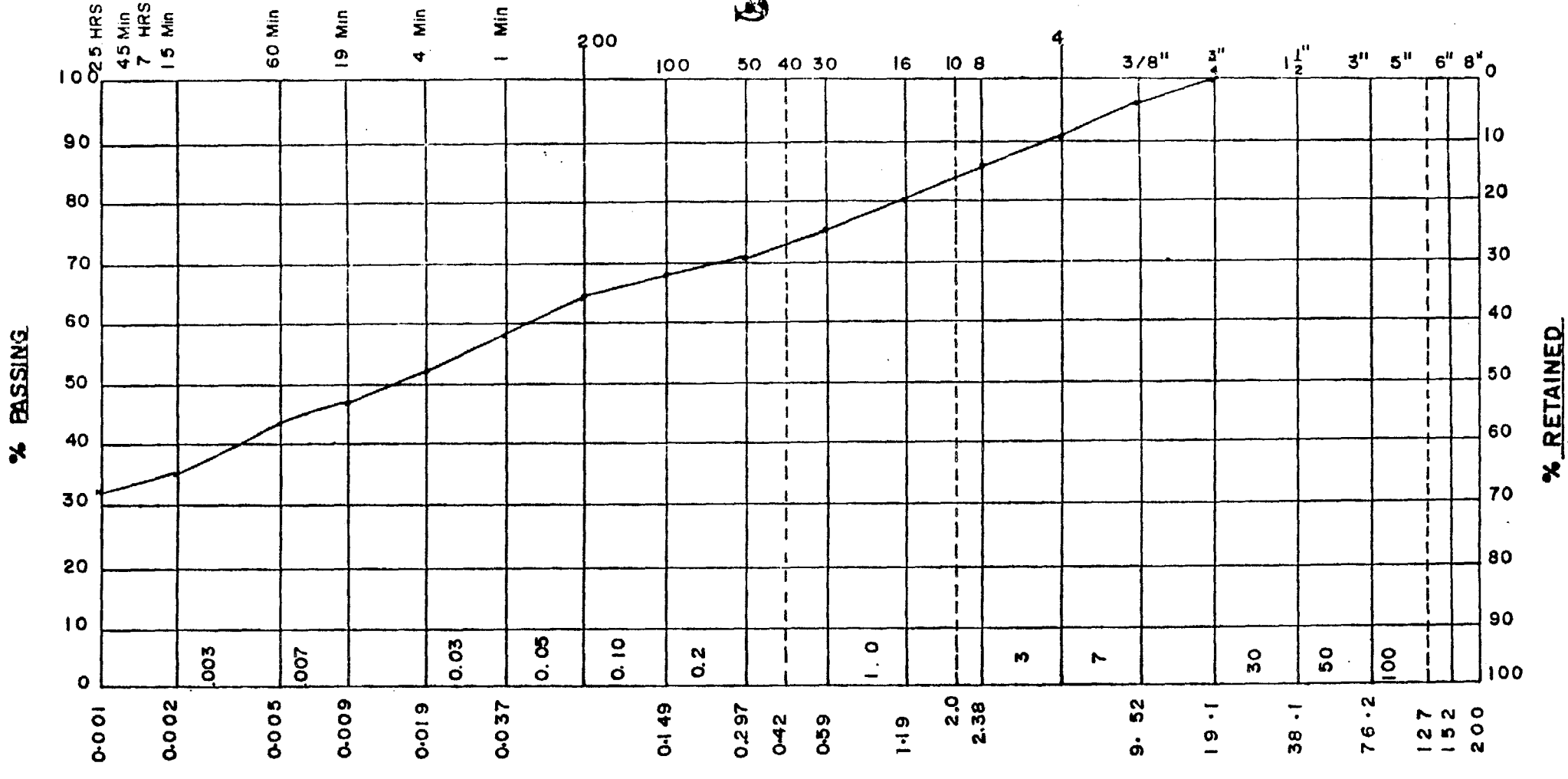
PROJECT _____

GEO_RESEARCH

SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

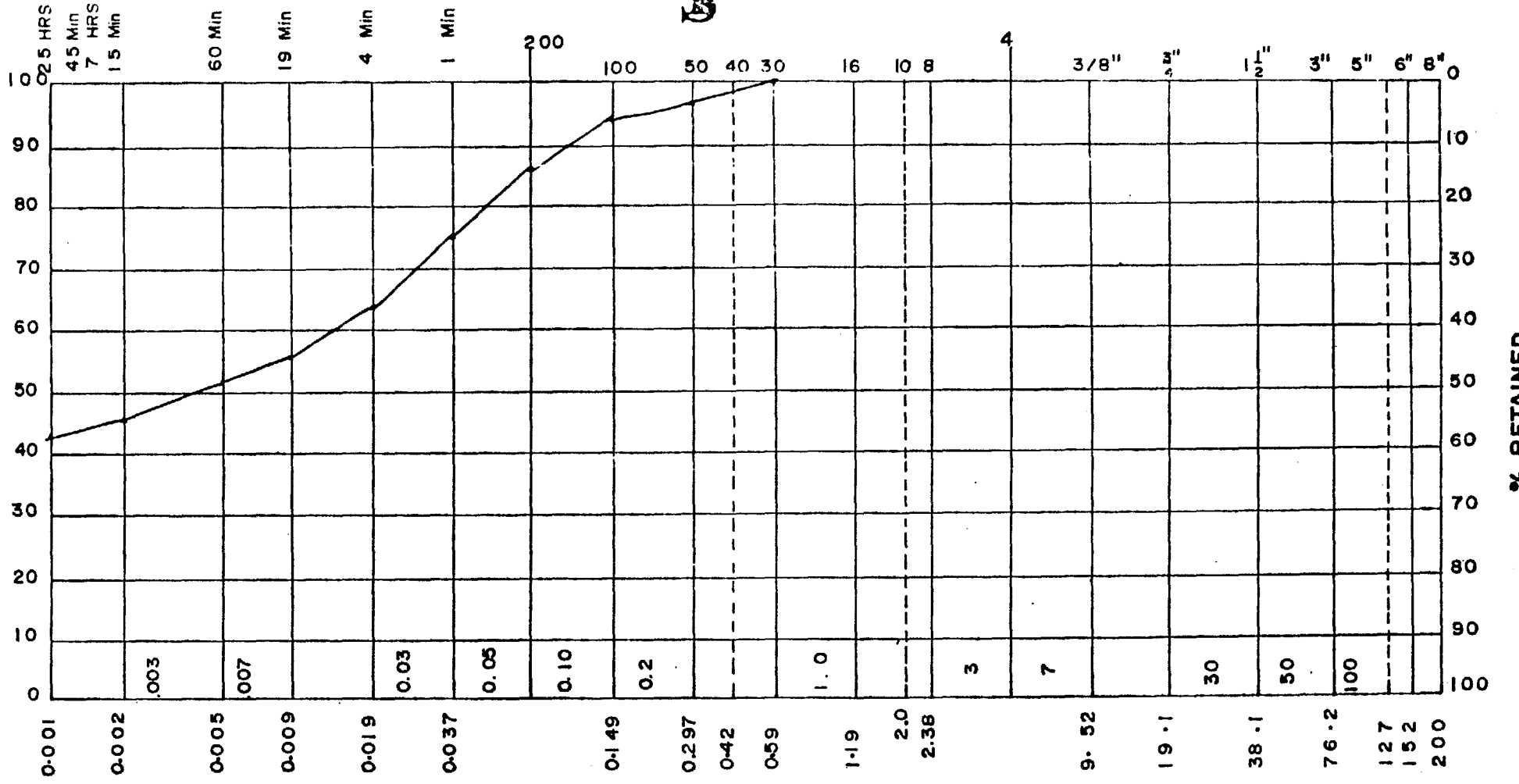
SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH No				
1.	8.80	[illegible]	31.90	35.[illegible]

REMARKS _____

DATE _____

PROJECT _____ GEO. RESEARCH SAMPLE No _____

HYDROMETER ANALYSIS SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH10	—	13.40	40.90	45.70
7.50 m				

REMARKS _____

DATE _____

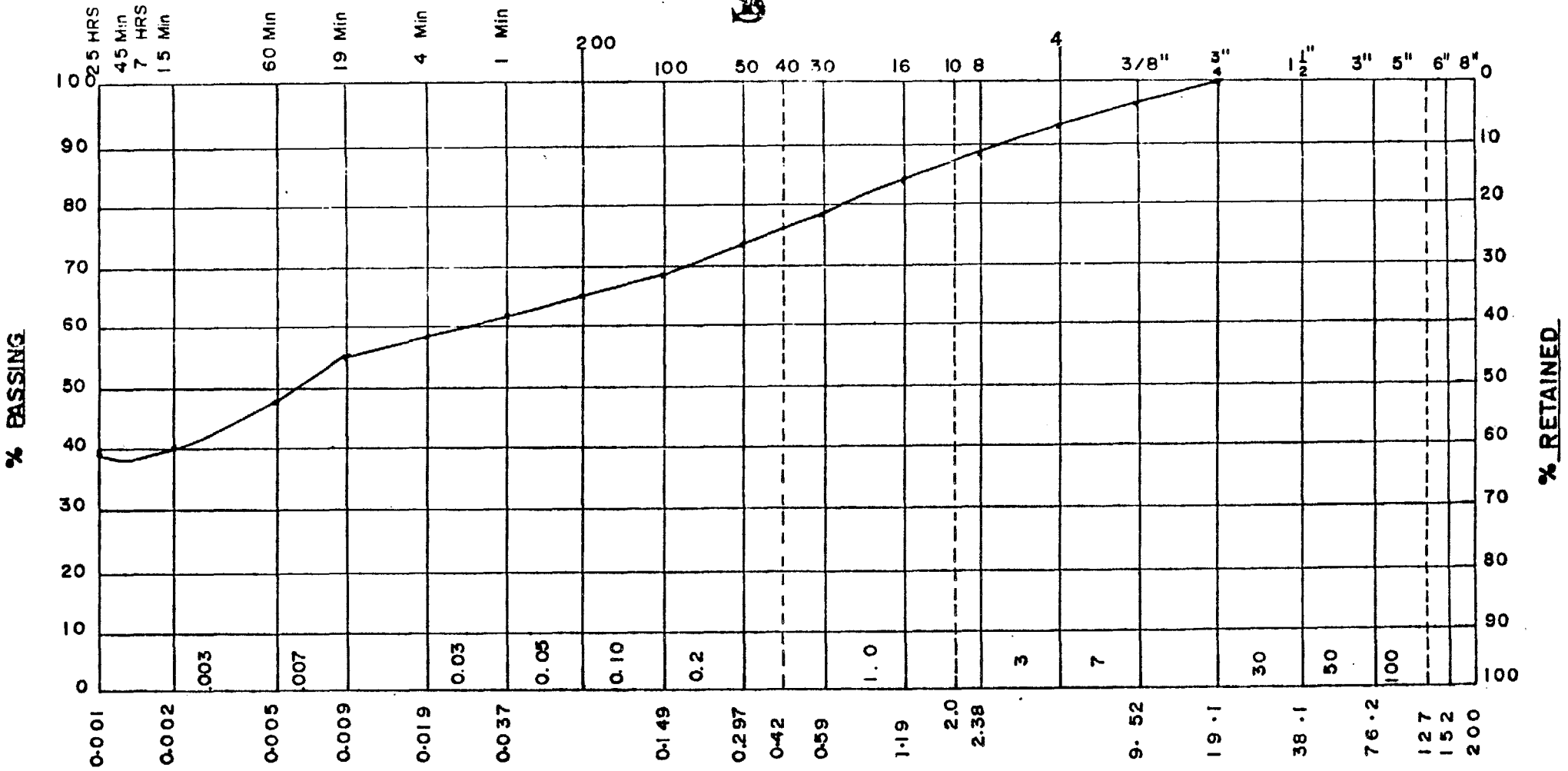
PROJECT _____

GEO_RESEARCH

SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE N	GRAVEL %	SAND%	SILT %	CLAY %
B.H.08	7.70	21.80	25.50	40.0

REMARKS _____

881

DATE _____

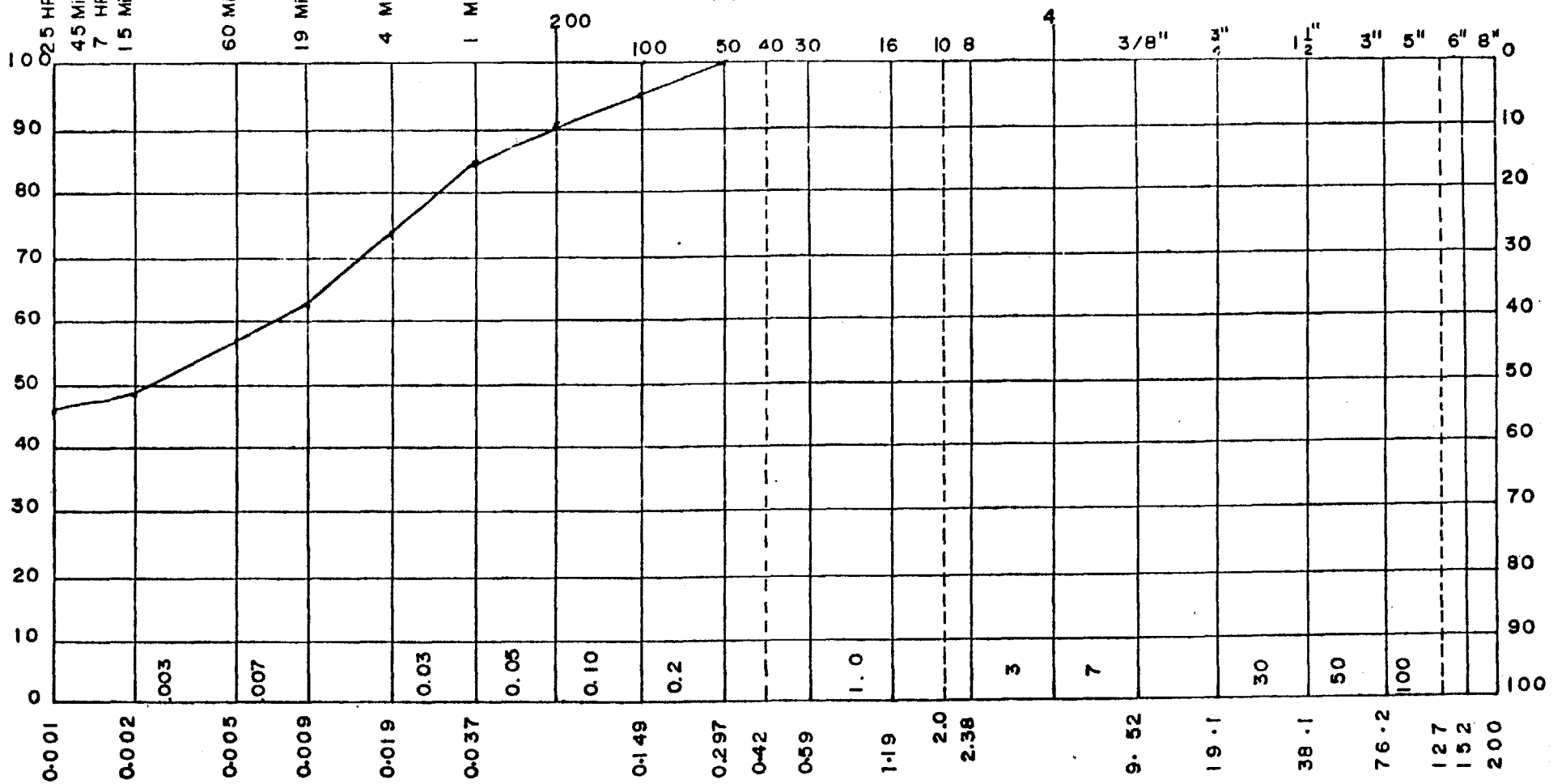
PROJECT _____

GEO. RESEARCH

SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	
		0.074			4.76		

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH#8	—	9.80	42.60	47.60
5.0m				

REMARKS _____

DATE _____

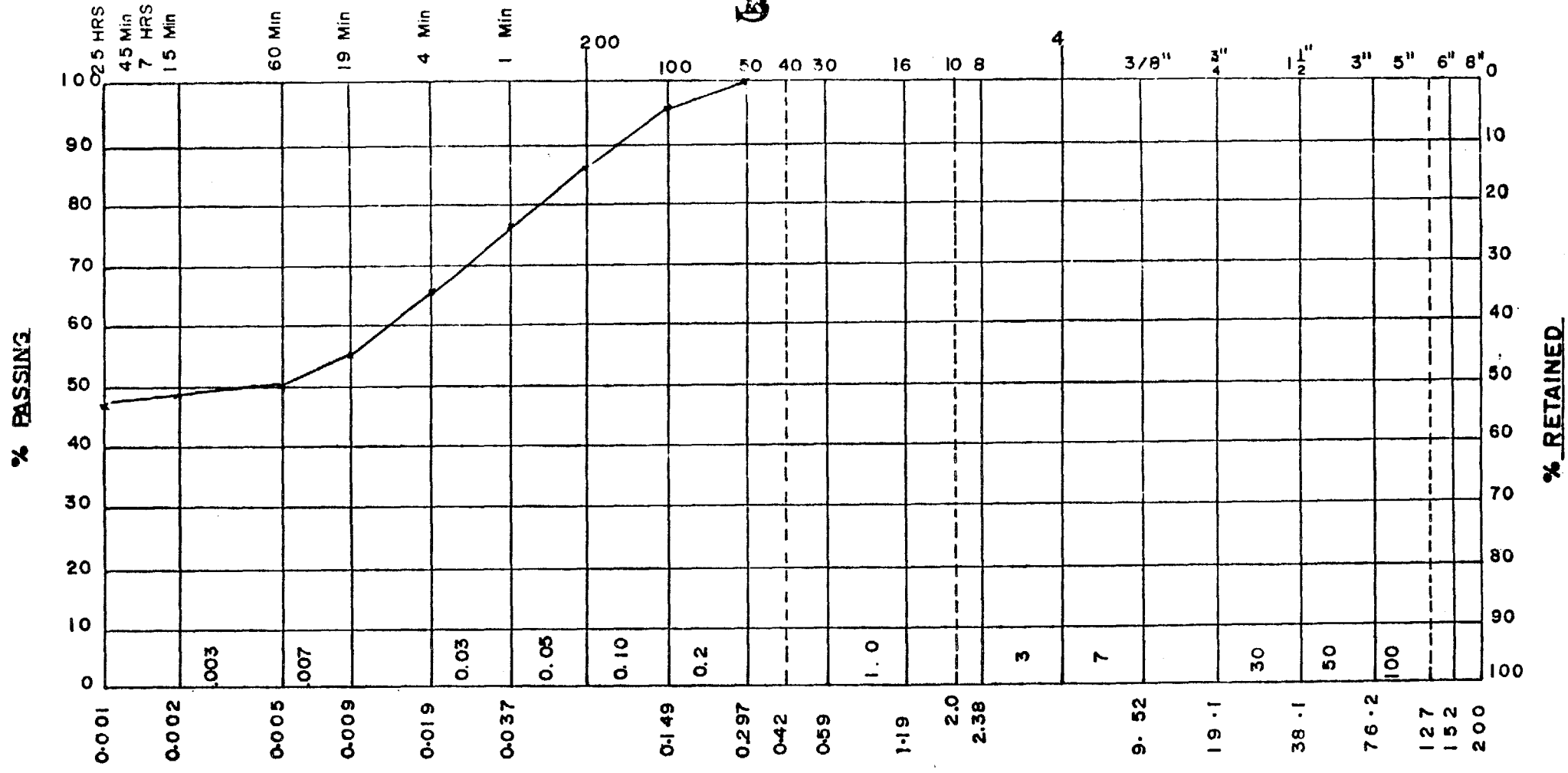
PROJECT _____

GEO. RESEARCH

SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %	REMARKS
BH III					
2	—	17	3		

DATE _____

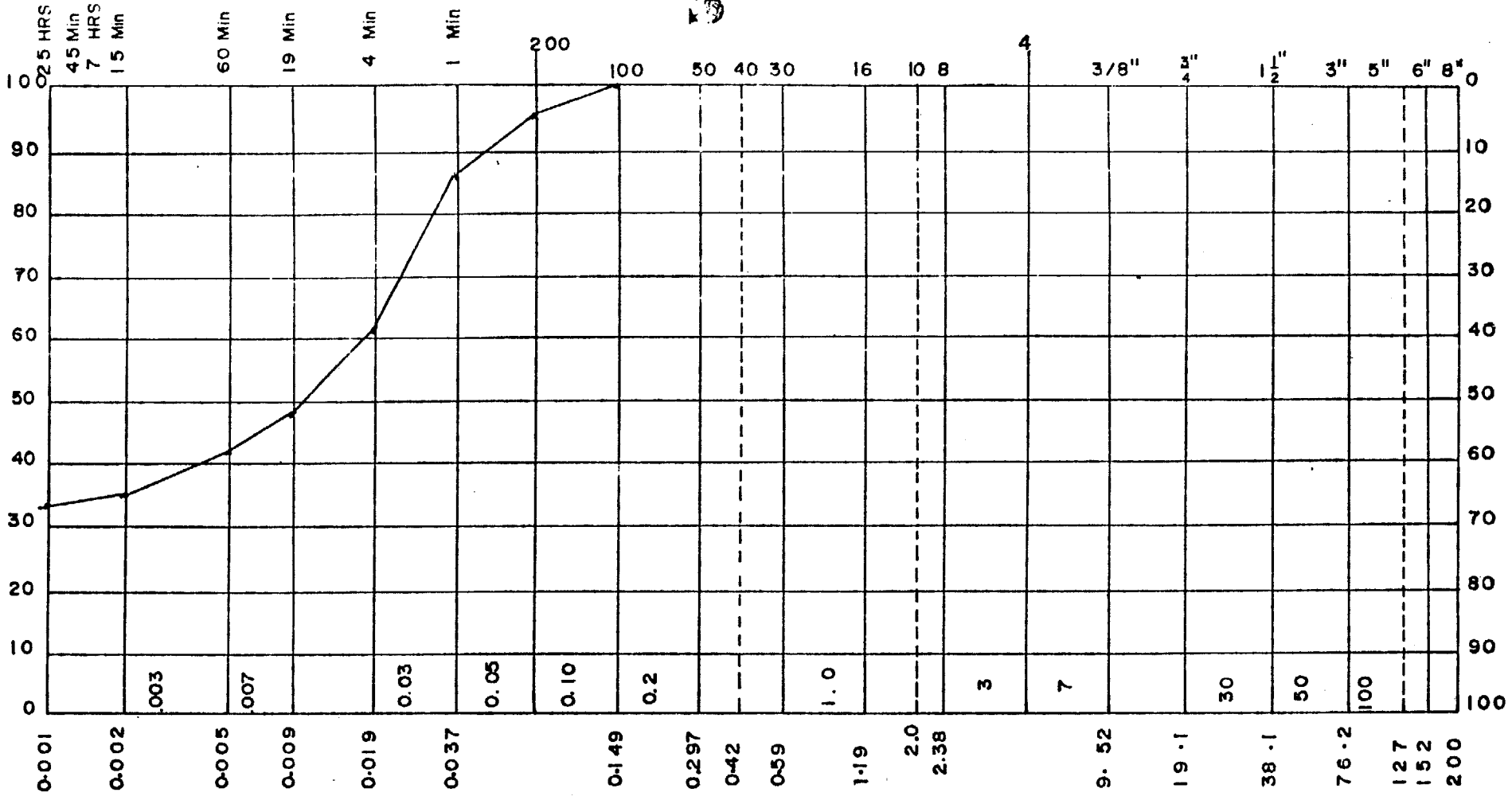
PROJECT _____

GEO. RESEARCH

SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

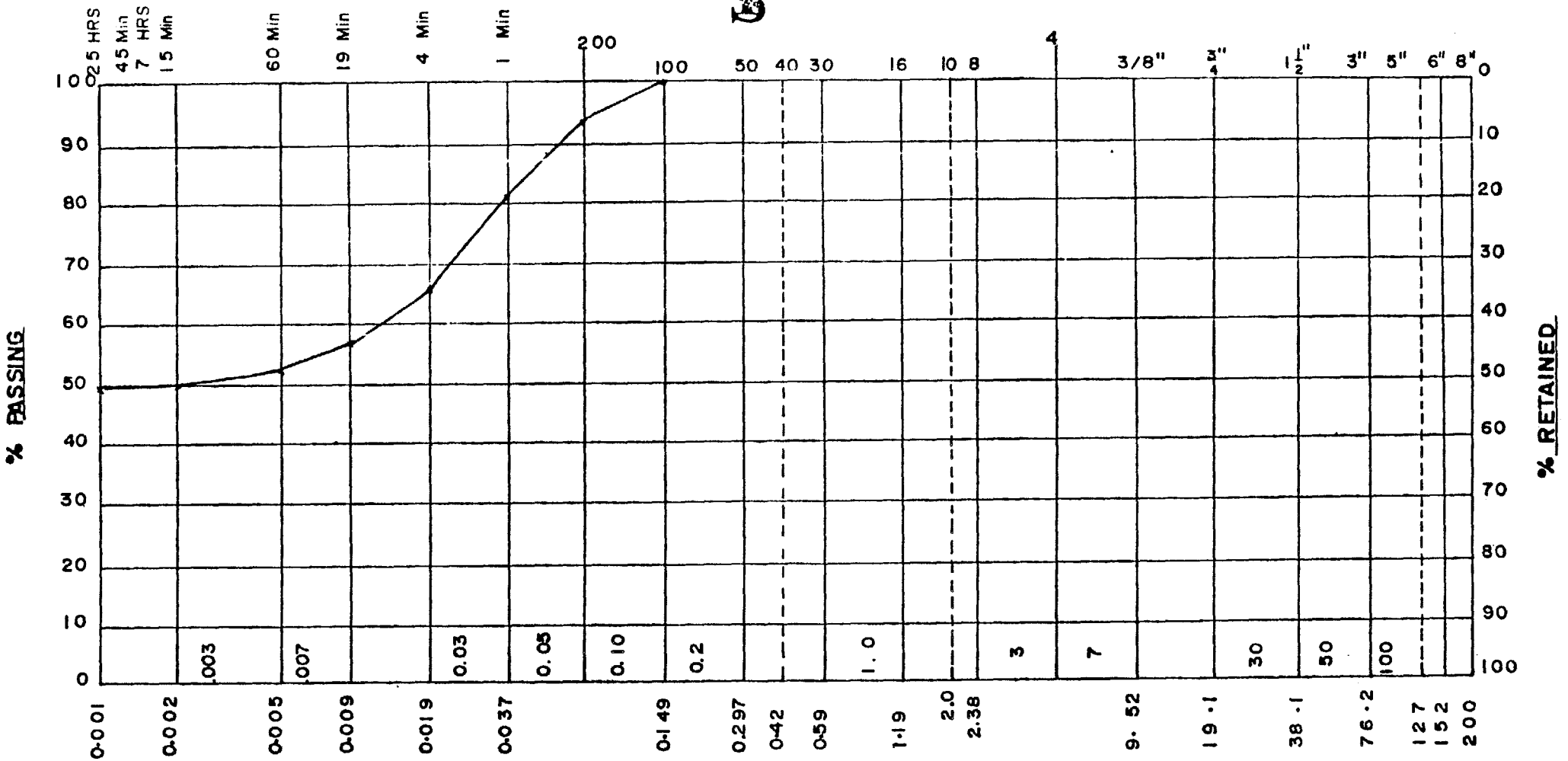
SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH11 4.0m	—	5.90	58.50	35.60

REMARKS _____

DATE _____

PROJECT _____ GEO. RESEARCH SAMPLE No _____

HYDROMETER ANALYSIS SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH12				
	—			

REMARKS _____

PROJECT _____

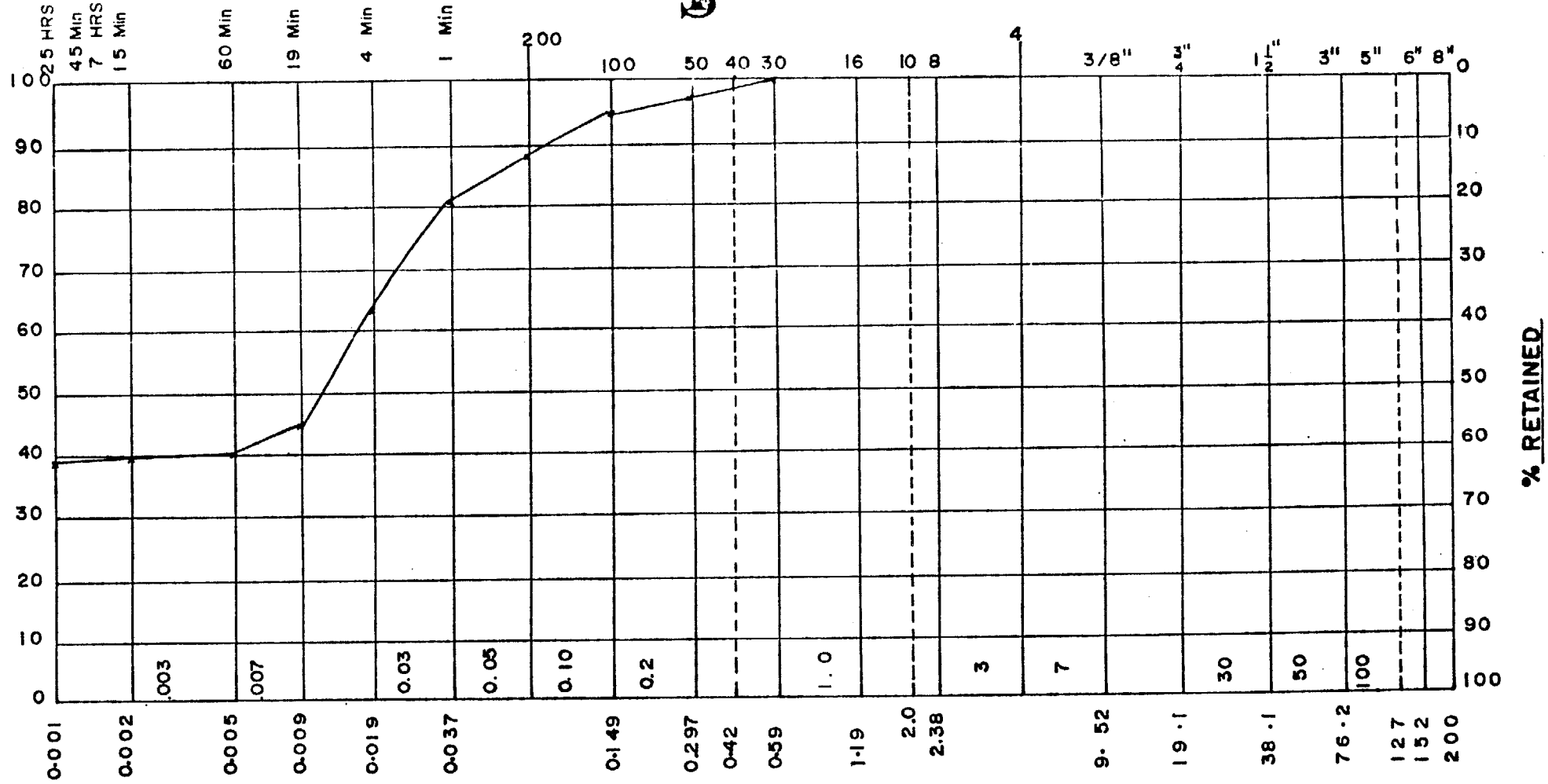
GEO. RESEARCH

DATE _____

SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %
BH12 40m	–	12.30	47.90	39.80

REMARKS _____

DATE _____

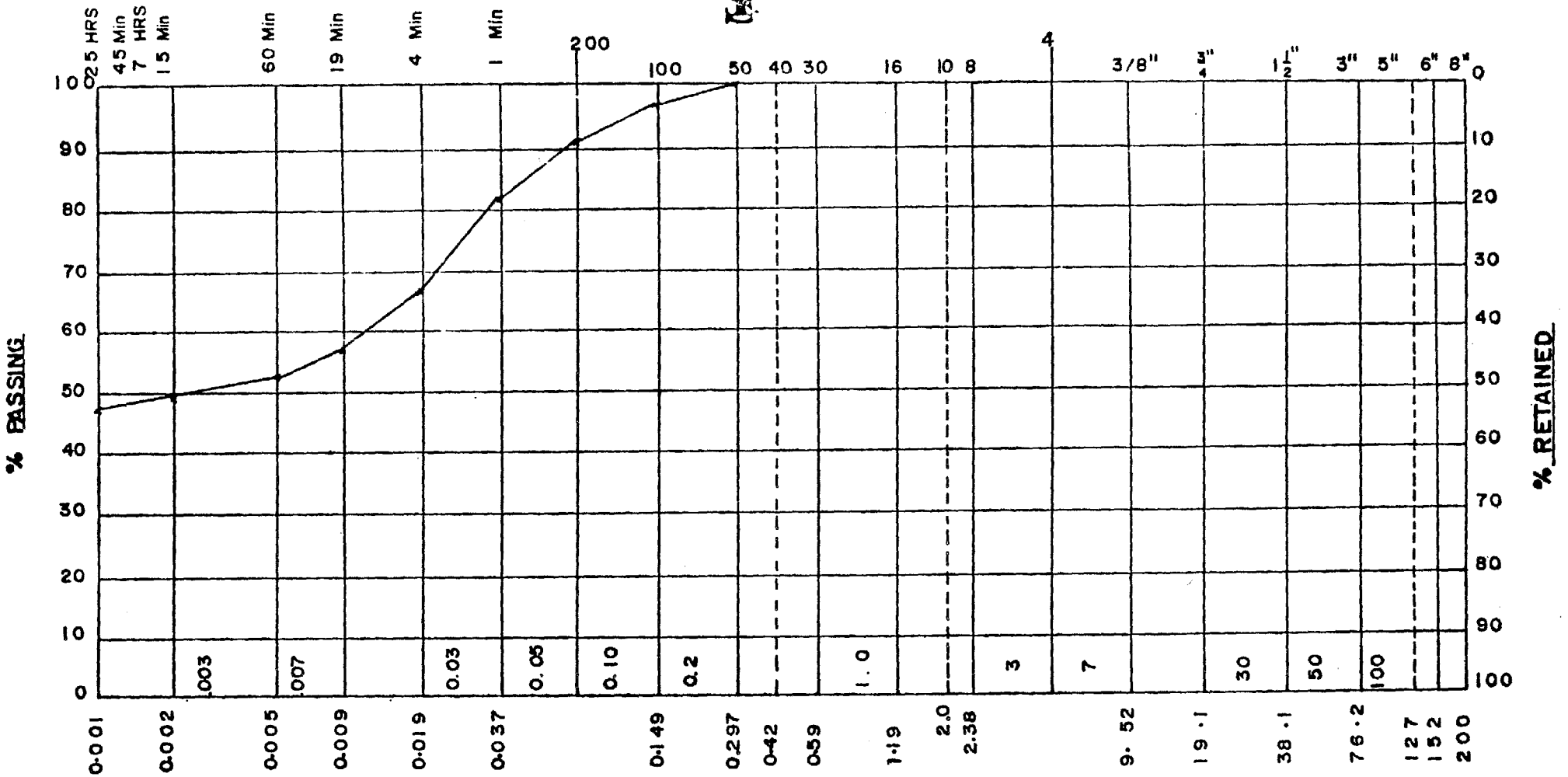
PROJECT _____

GEO. RESEARCH

SAMPLE No _____

HYDROMETER ANALYSIS

SIEVE ANALYSIS



0.074 4.76

CLAY	SILT	SAND			GRAVEL		COBBLES
		FINE	MEDIUM	COARSE	FINE	COARSE	

SAMPLE No	GRAVEL %	SAND %	SILT %	CLAY %	REMARKS
BH13					