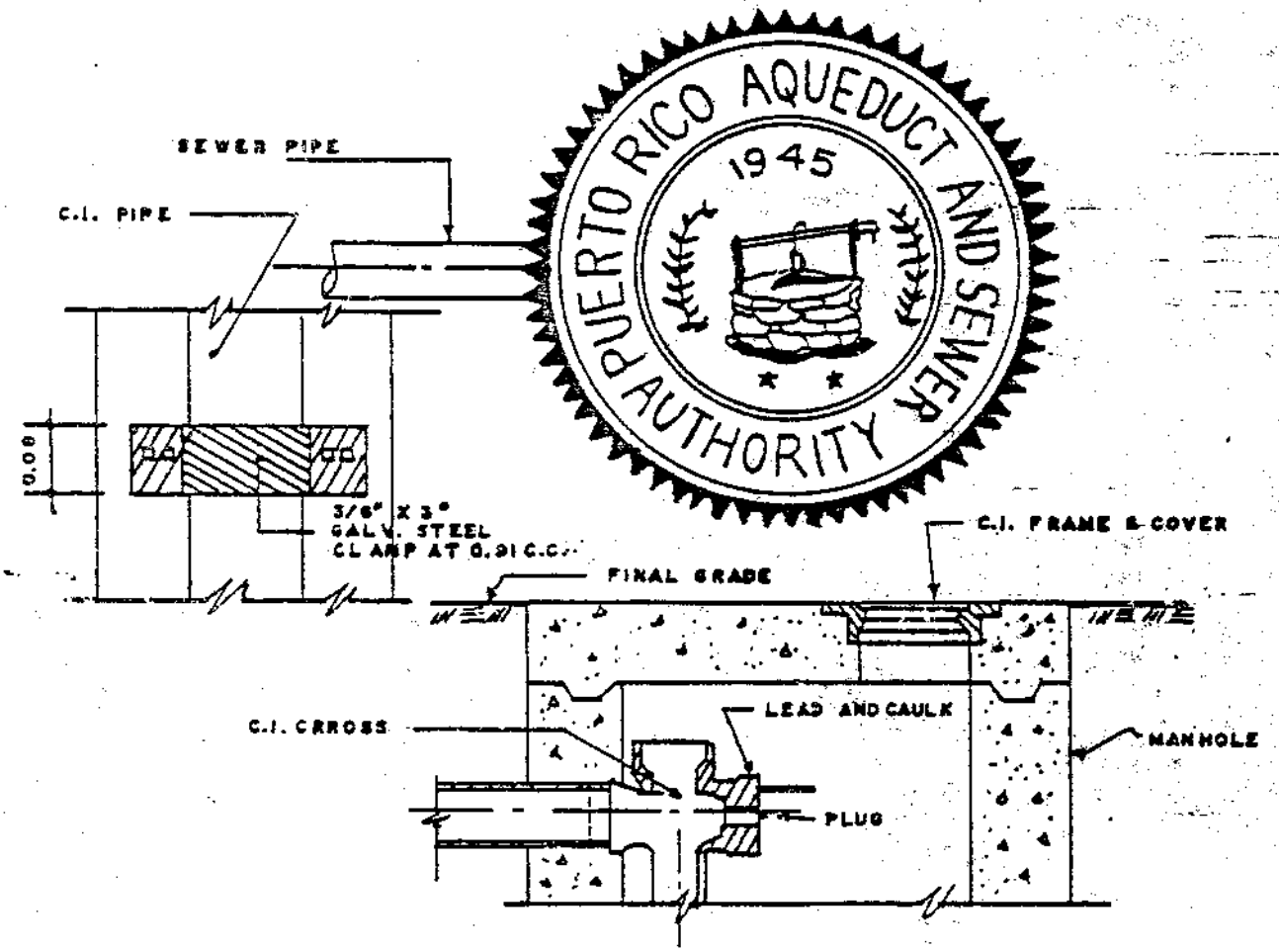
3149

RULES AND REGULATIONS FOR THE DESIGN STANDARDS



PUERTO RICO AQUEDUCT AND SEWER AUTHORITY

PUERTO RICO AQUEDUCT AND SEWER AUTHORITY

No. 3149
Date: September 13, 1984 10:20
Approved: Carlos S. Quirós
Secretary of State
By: Assistant Secretary of State

RESOLUTION NUMBER 1127

WHEREAS: The Puerto Rico Aqueduct and Sewer Authority was created in order to provide and help provide the inhabitants of Puerto Rico an adecuate water and sanitary sewer service and any other service or incidental facilities concerning to the same (22 L.P.R.A., Section 144);

WHEREAS: The Puerto Rico Aqueduct and Sewer Authority is empowered to promulgate rules and regulations concerning the use and conservation of water, the disposal of waste waters, the care, conservation and protection of the facilities used or to be used for the supply, distribution, consumption or use of water and disposal of waste waters in order to comply with the purposes for which the Puerto Rico Aqueduct and Sewer Authority was created (32 L.P.R.A., Section 152);

WHEREAS: In the year 1974 the Rules and Regulations for Designing were approved, which actually regulates the designing for Sanitary Sewer Systems and the Water Supply Systems;

WHEREAS: A committee was appointed to perform a revision to such rules and regulations and to adapt them for today's technical and professional needs;

WHEREAS: After having complied with all the law requirements including public hearings and submitted to the Executive Director, Eng. Carlos A. Mulero, who approved the same;

NOW, THEREFORE BE IT RESOLVED: By this Governing Board and in compliance with Law Number 163 of May 3rd., 1949 to RATIFY THE APPROVAL OF THE RULES AND REGULATIONS FOR DESIGNING, which shall be in effect as soon as it is complied by filing the same at the Department of State. The Rules and Regulations for Designing in force are hereby revoke and repeal.

I, JULIO A. NOLLA AMADO
Secretary of the Governing Board
of the Puerto Rico Aqueduct and
Sewer Authority, DO HEREBY CERTIFY,
the above is a true and exact copy
of the Resolution approved by the
Board during their meeting held on
June 26, 1984.

No. 3149
Date: September 13, 1984 10:20 A-K
Approved: Carlos S. Quirós
Secretary of State
By: Assistant Secretary of State

*** INTRODUCTION ***

The Puerto Rico Aqueduct and Sewer Authority in its desire to offer a better service to its customers and to lessen its operation and maintenance problems, prepared what at the time entitled "House Connection Standards" and considered this as its first attempt to prepare a manual that in the future would be called "Operation Manual and Design Standards". This "House Connection Rules" advised that from time to time, when new ideas, new methods appear, the necessary revisions should be made.

By the year 1957, its name was changed to "Design Standard Manual", and in 1974, the Authority was compelled to revise its standards. Now, the Authority, recognizes that due to the new water quality standards, new programs, raising costs of equipment, chemical products, operation and maintenance programs, must deal with the revision of its design standards aiming at the uniformity of its structures, services, operation and maintenance programs, etc.

In addition the Authority for its revision, held public hearings, consulted customers, updated safety requirements, incorporating them into the "Rules of Design Standards".

Today I am very pleased to submit to you the Rules that will govern the Design of Aqueduct and Sewer Systems in Puerto Rico and that will come into effect today.

To all entities both governmental and private, fellow engineers, businessmen and to all that in one way or another assisted us in preparing this rules of design standards, our gratitude.

CARLOS A. MULERO
EXECUTIVE DIRECTOR

December 19, 1983

F O R E W O R D

The purpose of this Rules of Design Standards is to establish the needed requirements and the proper procedure for the development and approval of design projects for Sanitary Sewer Systems and/or Water Supply Systems. These Standards are not expected to cover each and everyone of the submitted cases, and they may be subjected to particular conditions.

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CHAPTER I

REQUIREMENTS FOR THE SUBMITTAL OF PLANS

This chapter comprises the requirements applicable to the submittal of plans, from the Preliminary Consultation to the Final Plans for each type of project, including Trailer Houses.

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CHAPTER I

REQUIREMENTS FOR THE PRESENTATION OF PLANS

1.01 Types of Projects

1.01.01 Private and public urbanizations, simple lot divisions, urban renewal projects, and any other public housing project where water and/or sewer facilitiesare provided to be connected to the systems of the Authority or to be transferred to it for its operation.

1.01.02 Apartment, condominiums or office buildings with more than three units and trailer houses.

1.01.03 Hotels, hospitals, medical centers, industrial buildings, institutional buildings, commercial, educational, recreational, sports centers, gasoline station.

1.01.04 Any other project not included in the above clauses, which requires a water connection 4" in diameter or larger.

1.02 Preliminary Consultation

Prior to submitting the preliminary plans, a written consultation is required from the proposer or designer, regarding water and sewer facilities available in the area where the project is to be located, with evidence of the submittal of the project plans to the Planning Board, Permit and Regulations Administration, and/or other agencies (E.Q.B., U.S. Army Corps of Engineers, Department of Natural Resources, Health Department, and Transportation and Public Works Authority). The consultation also shall include a site plan and a general description of the project.

1.03 Preliminary Plans

After obtaining the approval of the permits and requirements aforementioned and submitting evidence of such approvals, the proposer shall submit two (2) advance copies of the proposed project plans, including the information specified in Sections 1.04.01 to 1.04.06 for revision and recommendations by the Authority.

1.04 Final Plans

1.04.01 Once the recommendations and approval by the Authority regarding the preliminary plans are obtainded and incorporated, the project planner shall submit two (2) copies for revision and final approval, then two (2) copies, (one in Mylar (0.005) for the Authority and one in sepia to be returned to the project planner, after the approval seal of the Authority is stamped) and six (6) copies of the final plans of the project. Copy of these documents shall be forwarded to the Permits and Regulations Administration.

1.04.02 The horizontal projections shall indicate the following; project site, topography, project limits, adjacent property owners, north, scale, elevation contours at intervals no greater than one (1) meter, road and nearest kilometric marker, streets and other nearby accesses, bench marks within the project limits, referred to one of the U.S. Coast and Geodetic survey and clearly identified in the plans. All dimensions and contours, except pipe sizes and fittings, pump suction and discharge, valves and other accessories related with piping will be indicated in the metric system and in parenthesis its equivalent in the English system.

1.04.03 Horizontal projections indicating the proposed water distribution system and sewer system. In cases of lot divisions or urbanization; numbered lots must be indicated, as well as existing and proposed roads or access. Also, the various elements and details of the water and sewer systems to be installed in the project.

1.04.04 Longitudinal profiles showing the elevations of the roads, streets, as well as the existing and proposed sewers related with the project, survey points, partial distances between manholes, station points, slopes and dimension of the sewers. The manholes shall have the same numbers, invert and top elevations as shown on the site plans. Also all existing sanitary and storm sewers, aqueduct,

gas or any other piping, cable or structure that would cross the water or sewer piping of the proposed project. Aqueduct projects shall include hydraulic profiles of the piping between pumping stations and distribution tank and between tanks and points of maximum or minimum pressure in the distribution system.

In sanitary sewer projects where pumping stations are included, it will be required to show the hydraulic gradient of the system including velocity.

1.04.05 Submit detailed plans, including typical details related to the proposed project, according to the norms of the Authority, as well as special works, such as, overflows, crossings of ramparts, streams, tunnels, siphons, house connections, culverts, channels, sewers of non-circular sections etc.

1.04.06 In case of works that must be installed in private property, the necessary right of way to be adquired and transferred to the Authority, must be indicated.

The land to be transferred, by the Developer, to the Authority, must be transferred at no cost and with a notarized non-return clause and proof of the Owner's agreement. Right-of-way along the property limits of adjacent lots shall not be permitted and shall be accessible to permit maintenance. For right of way width refer to Section 1.04.15.

1.04.07 The plans must include a minimum space of 5" high and 6" long over the title on the lower right hand corner of each sheet for the seal of approval of the Authority. Full name and address of the owner must appear on the first sheet of the plans.

1.04.08 Each project plans must have a conventional symbols' legend or code.

1.04.09 All plans submitted for approval must be prepared and signed by an engineer duly authorized to practice the profession in Puerto Rico including full name, address, and license number.

1.04.10 The minimum scales for the plan shall be 1:1000; for profiles H= 1:1000, V= 1:1000; for street or road transverse sections 1:1000 except typical sections indicating paving details that will be 1:50. For special details an adequate scale shall be used.

1.04.11 On projects for every kind of building, a site plan of the project must be sumitted indicating its use, number of floors, housing, offices, rooms, beds, students etc. Also, building sections and soil test results must be indicated.

1.04.12 Isometric plans or water and plumbing installations of the buildings comprised in the project must be submitted.

1.04.13 Plans for urbanizations shall include a scaled sheet showing all structures comprised in both aqueduct or sewer projects.

1.04.14 The lots for the location of structures, such as pumping stations and distribution tanks that are part of the project, must be indicated in the plans, including compass bearings and length of property lines, area, name of existing adjacent property owners, topography, existing and proposed ways of communication, nearest kilometric marker, existing and proposed access, etc. The lot shall be large enough to allow easy access to the structures, providing paved concrete walks around them, no less than two (2) meters wide. Every lot for pumping stations shall be concrete paved. Restriction to adjacent properties will be required, such as setback around the structures where no other structure will be built. The setback for sewage pumping stations will be 15 meters. For wastewater treatment plants see Chapter 6 Section 6.02. The access road shall be no less than four (4) meters wide with one (1) meter wide shoulder on each side.

1.04.15 The necessary rights-of-way for the installation of water pipes or sewers on private property will be indicated on the plans, having a width as follows:

a) three (3) meters for water pipes up to or twelve (12) inches diameter.

b) four (4) meters for water pipes up to or 18" diameter.

c) for water pipes twenty (20) inches to sixty six (66) inches in diameter, the width shall be six (6) meters.

d) three (3) meter wide for sewer pipes up to twenty-four (24) inches diameter,

e) for sewer with a larger diameter the Authority will determine the width of the right of way, and

f) four meter wide for common right of ways of up to twelve (12) inches for water pipe and sewers up to twenty-four (24) inches in diameter.

1.04.16 For the project final approval a report must be submitted including the stratigraphical profiles and localization of the soil test and recomendation of the foundation of the structures. Stratigraphical profile of this soil test must be shown in the project plans. The report should be certified by a Soil Engineer. The Authority may require additional tests, such as:

a) compaction tests to determine settling,

b) triaxial tests to establish resistance to cutting or digging,

c) test trench to verify construction methods,

d) pumping test to determine the coefficient of permeability to use in the design of the drainage system,

e) seismic refraction test, jointly with the borings, to obtain geological information data.

f) establish the number, depth and spacing of the borings. In the case of treatment plants, the dimensions and depth of the structure should be considered.

1.05 Trailer Housing

1.05.01 Trailer housing is a recent type of development and sufficient experience is not yet available to establish design standards. Requirements approved by the Authority shall be applied.

a- Summer trailer housing

b- Residential trailer housing

1.05.02 Up to this date the only regulation pursuant to Trailer Houses has been established by the Planning Board in its Resolution No. J.P. 229. This Resolution aims to promote projects of this type in an orderly and planned manner for the enjoyment of these facilities under healthfulness, comfortable and safety conditions. Said Resolution entails the following criteria:

Definition of Trailer Houses' Recreational Projects

Will be understood as trailer houses' recreational project, that which comprises a lot with minimum facilities, oriented toward the local tourism, to provide two or more parking spaces for compact housing units, with all or part of the ordinary facilities of a house, permanently assembled over a chassis that can be towed by another vehicle, or can move on its own it does not excludes the combination of trailer houses with cottages and/or tents for short term stays, in trailer houses' projects.

Location

1- Projects within or adjacent to an area of environmental, natural and cultural importance will need the endorsement of the Department of Natural Resources.

2- The minimum drinking water infrastructure with adequate capacity according to the rules of the Puerto Rico Aqueduct and Sewer Authority must exist. If there are no sanitary facilities, central septic tanks or any other system will be used.

3- Its location will be at:

a) 30 meters measured from the exterior river bed of every river, channel and brook.

b) 200 meters measured from P.R.A.S.A.'s acquisition limit on every reservoir for the supply of drinking water.

4- Projects proposed to be on lands adjacent to residential areas, urbanizations, rural communities, etc., must observe a buffer zone planted with trees, free of every activity, of 20 meters.

Special Controls

1- The segregation or division into lots or spaces for trailer houses in recreational projects will not be allowed.

2- The trailer houses will no be allowed to be used as permanent housing units.

1.05.03 In compliance, with the Planning Board's Resolution No. 229 this Authority states that:

1- Only one connection of size corresponding to the number of trailer houses at a rate of 200 gallons per day per trailer house, will be allowed.

2- Only one connection to be discharged into a tank or cistern will be allowed and the distribution will be at the owner or administrator's expenses.

3- There will be no segretation, nor installation of individual connections.

4- The distribution system to be used will be designed by a qualified, licensed engineer and it will have to be approved by the Aqueduct and Sewer Authority.

1.06.02 The particular attention of the Designer is directed to the fact that the water and wastewater facilities and all appurtenances shall be designed and constructed to withstand, in addition to normally occuring stresses, the stress resulting from earthquake and hurricane forces.

All designs shall comply with applicable requirements of the Building Regulations of the Puerto Rico Planning Board and of the Uniform Building Code, latest editions.

1.06.03 The designer shall submit the design data and design calculations of the Process, Structural, Electrical, Mechanical, Architectural or any other matter deemed necesarry for the revision and approval of plans submitted to this Authority.

CHAPTER II

GENERAL STANDARDS FOR THE DESIGN OF AQUEDUCT SYSTEM

This chapter includes the daily consumption for different uses such as domestic, industrial, commercial, etc., both urban and rural. Norms for buildings requiring tanks and pumping systems to satisfy the minimum water pressure required, factors to be considered in the design for maximum hourly demand and for 25 years future demand. Water sources of supply are regulated for quality and quantity. General conditions are established for the pumping of raw water and clear water in the distribution system, type and capacity of pumps, and general norms for distribution systems.

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CHAPTER II

GENERAL STANDARDS FOR DESIGN OF AQUEDUCT SYSTEMS

2.01 Domestic Use

2.01.01 Private housing projects - 1514 liters (400 gallons) per day per housing unit.

2.01.02 Public housing projects, renewal projects and other public-communal projects-1135 liters (300 gallons) per day per housing unit.

2.01.03 Rural housing projects - 946 liters (250 gallons) per day per housing unit.

2.02 Other Uses

2.02.01 Light Industry (Consumption for personal use only). Shall be determined based on 1325 liters (350 gallons) of water daily per 93.0 square meters (1000 square feet) of floor space or 37,850 liters (10,000 gallons) daily per each "cuerda" of land assigned for construction of industrial buildings.

2.02.02 Heavy Industry. (Consumption includes human needs and industrial process). The consumption for human need will be the same as in the preceding clause. The owner or the sponsor of the project shall summit the necessary information on the quantities of water to be used for the industrial process.

2.02.03 Commercial Buildings

The consumption will be determined based on 1135 liters (300 gallons) daily per each 93.0 square meters (1000 square feet) of floor space or 26300 liters (7000 gallons) daily per "cuerda" of land assigned for construction of commercial buildings.

2.02.04 Office Buildings

Will be computed based on 1,135 liters (300 gallons) daily per each 93.0 square meter (1000 square feet) of floor space.

2.02.05. Apartment and Condominium Buildings.
1515 liters (400 gallons) daily per apartment.

2.02.06. Hotels (with all services and facilities) - 2650 liters (700 gallons) per room per day

Deductions for Services or Facilities not provided

Laundry ----------378 liters (100 gallons) per room per day
Beach ----------378 liters (100 gallons) per room per day
Food Service ----------378 liters (100 gallons) per room per day
Swimming pool----------189 liters (50 gallons) per room per day

2.02.07. Hospitals and Medical Centers.
1325 liters (350 gallons) per bed per day.

2.02.08. Schools.
114 liters (30 gallons) per student per day.

2.03 Additional Requirements

In those cases where water services can not be provided by gravity, to the buildings mentioned on clauses 2.02.04 and 2.02.07, the following additional requirements must be considered:

2.03.01. A tank must be provided for water storage with a minimum capacity equivalent to half the daily average total consumption of the building, plus an adequate reserve, that in no case shall be less than 11,560 liters (300 gallons) to used in case of fire. The fire protection system should be designed in accordance with the regulations of the Planning Board, the Administration of Permits and Regulations and the Fire Department.

2.03.02. The water service connection must be sized to fill the water storage tank in eight (8) hours.

2.03.03. A pump system must be used, with a capacity equal to the maximum instant consumption of the building, but never less than 11340 liters per second (50 gallons per minute). At least two (2) units shall be provided with capacity to supply maximum instant

consumption each one, which will funtion alternately or simultaneously if necessary.
In apartment buildings, hospitals, or other institutions that provide emergency services, an emergency power generating plant, will be provided, with capacity to run one of the pumps.

2.03.04 The minimum residual pressure, at the top floor level, shall not be less than 1.05 kgs/square cen. (15 lbs/sq. inch.).

2.03.05 For apartment buildings and condominiums see Chapter IX.

2.04 General Standards for Rural Aqueduct Systems Design Guide.

2.04.01 Average domestic water consumption shall be determined based on 190 liters (50 gallons) per capita. Population shall be computed based on five (5) persons per family or living unit. The average domestic consumption will be estimated based on 190 liters (50 gallons) daily per person, plus 114 liters (30 gallons) per student, if schools exist.
If industrial developments, urbanizations, public housing or a possibility of them exist, their consumption must be considered in addition to the rural system consumption and computed according to the norms of the Authority.

2.04.02 The rural aqueducts systems shall be designed with capacity to supply the estimated demand in the next twenty five (25) years, considering a population growth of 25% the actual population, thus the daily future consumption shall be computed by multiplying the actual daily consumption by 1.25. Hourly future maximum demand to be determined by multiplying future demand by 2.25. To calculate the loss due to friction in cast iron pipe use coefficient C-100.

2.04.03 The minimum capacity of the source of supply should be sufficient to provide the demand for the next twenty five (25) years. If not possible the project should include the study of sources to be used in the future.

2.04.04 The water to be used should be chemical and bacteriological satisfactory for human consumption.

When chlorine treatment alone does not guarantee this conditon, additional treatment and chemical use should be considered.

2.04.05 The dams for rural aqueduct systems, and when so permitted by the supply source, should be small dams, approximately 1.5 meters high to facilitate the water intake and storage for a period of time. The dams shall be constructed of reinforced concrete and preferably on rock ground. At the intake structure, two (2) racks should be installed, one at the intake made of steel rods 1.27 centimeter (1/2 inch) in diameter and spaced 5.08 to 10.2 centimeter (1/2 to 2 inches) and another in the interior made of wire mesh gauge number 10, spaced about one centimeter (3/8 inch). A gate, not less than 41 centimeters (16 inch) diameter, shall be provided for drainage and cleaning.

2.05 Pump Stations

2.05.01 When not technically possible or economically feasible to provide a gravity water supply system and/or distribution system, a pumping system as included in clauses 2.05.02 and 2.05.03 will be provided.
Selected pumps should be of the minimum size necessary to supply the daily future flow operating sixteen (16) hours daily and most convenient with regard to efficiency. Two (2) units of equal capacity should be provided, maintaining one in reserve for emergencies and/or maintenance facilities.
All pumping stations shall be provided with pressure gauges to measure pump suction and discharge pressure and automatic graphic pressure recorder of seven (7) days duration. They most be protected by a 1.83 m. (6 feet) high galvanized chain link fence with 3 strands of barbed wire on top, along the property line of the lot with a four (4) meters gate. See Fig. No. 1.
A paved road for access to the pumping stations, not less than four (4) meters wide with one meter shoulders at each side. In case of concrete pavement, construction joints 5.49 meters (18 feet) apart should be provided.

Final grading of the access road will have a minimum elevation of 0.60 meters above maximum flood level. All pumping equipment should at least be duplicated for emergencies, except in particular cases of small projects using a deep well as a supply source. To estimate losses due to friction a coefficient of C= 100 must be used.

2.05.02 Distribution Pump Stations

Distribution pumping stations must have concrete houses of adequate size. The possibility of eliminating the pump house should be consider, subject to previous consultation and approval of the Authority. The space inside the house should permit the easy arrangement and installation of the equipment and accessories so that operation and maintenance can be accomplished with confort. To facilitate the removal of vertical type pumps for replacing or to repair, a one square meter opening should be provided, above each pump, with a watertight lid with hinges and lock. In case of horizontal pumps with motors larger than 15 H.P., an I beam with hoist, must be provided. An automatic starting generator, should be provided for emergencies in case of electric power failure.

2.05.03 Raw Water Pumping Stations

The raw water intake pumping stations shall consist of a catch basin with a minimum capacity equal to eight (8) hours daily average consumption which will be supplied from a river, stream, or a deep well, etc. Means of measuring the flow should be provided. Pumps and electrical controls up to 30 H.P. can be installed outdoors and for those over 40 H.P. a control house should be built. When installed outdoors the control box shall be water-tight (NEMA III)and a Diesel driven generator for emergencies shall be provided, with adequate delay relay to operate automatically in case of electric power failure. An automatic transfer switch shall be provided. Generators shall be housed in a concrete structure. The structures and equipment shall be arranged according to typical details of the Authority.

When the water supply is a river, stream, etc., the catch basin shall be design to include bar screens, weir, drains, and intake dam. In this case a filtering plant is required according to requirements of the Authority depending on each particular case. In this type of installation two pumps well type, will be required, each with a capacity equal to the maximum filtering flow of the plant in 24 hours. See Fig. No. 29 and 29A.

The maximum yield of the well should be 1.67 times greater than the flow to be provided. Concrete housing for the chlorination equipment and electric power generator, shall be provided. The well shall be constructed as follows:

a. Should be tested for plumbness and alignment. Any deviation or bend which might affect the installation or operation of the pump, should constitute basis for rejection.

b. The diameter of the final casing shall depend on the flow required, but never less than 10 inches.

c. The final casing pipe thickness will be determined by the Authority, depending on the diameter and the depth of the well, but shall not be less than 0.23 inches thick.

d. New smooth type steel pipe shall be used for the casing and not less than 15.3 meters (50 feet) deep and seal with cement mortar to eliminate possible contamination of the water.

e. The contractor shall submit to the Authority a tabulation of the well, as constructed, indicating the depth of the different formations penetrated, the pipe installed, the grouting depths, water static levels, water veins founded and any other information that might be usefull to the project history.

f. The contractor shall perform a 48 hours yield test after well construction, supervised by personnel of the Authority. All equipment needed for the test, including the pump, shall be furnished by the contractor.

A suction well must be provided with a minimum water reserve of eight (8) hours, based on the average pump capacity and the connection sized for the capacity of the pit for 24 hours.

2.05.05 Centrifugal Pumps

Every booster pump for water supply purposes must be a centrifugal type pump (horizontal or vertical, simple or multiple stage, turbine well type or with submergible motor), and determined according to the specifications of flow and head on each case.

When pumps of the vertical barrel type are used, they should have the suction and discharge flanges at the same elevation.

In general, these pumps will be bronze fitted, body will be gray iron with a high percentage of steel. The housing impeller wearring and lubrication rings will be of bronze, the shaft shall be of stainless steel (304N) and mounted in adequate ball bearing when required. The pump will be provided with blow off valves, cooling interconnections packing box glands or mechanical seals as required by the Authority.

The horizontal pumps will be driven by electric motors, by means of direct or flexible coupling, mounted on a common base of cast iron or welded steel, subject to the approval of the Authority. When the coupling is flexible, a coupling guard will be provided.

The motor will be horizontal or vertical according to the type and speed of the pumps. They will be induction type, with class B insulation, three phase, 60 cycles and 230 to 460 volts. The Authority has the option, in cases of synchronous motors larger than 150 H.P., to authorize voltage of 4160 volts. The motors and their installation shall meet all the latest requirements of the National Electric Code and the P.R. Electric Power Authority.

When designing the electrical system, consideration should be given to use the most economic power rates.

Pumping equipment electrical control panel shall consist of the following accesories:

a) Automatic type, general circuit breaker of adequate capacity for the total load to be connected.

b) Control for each unit with its magnetic starter, according to the capacity of the motor, preceded by the automatic circuit breaker. For motors larger than 40 H.P. the starter will be of the reduced voltage autotransformer type, with overload protection.

c) Relays for protection against power failure, drop in voltage or phase failure, reversal or unbalance, should be provided connected to the input buss bars of the control panel and electrically protected by a current limitting fuse block at the input of the equipment (C.L.F.). Spare fuses should be provided for emergency use. This device should normally maintain a couple of contacts closed.

d) An electrical control system by means of an exposed, concealed, pneumatic, radio or electric signal device that would be sensitive to the variations of water level in the tank or system, should be provided, to operate automatically the pumping units, using electrodes at the pump suction sump pit to prevent pumping while dry. In case of booster pumps installed in the pipe line a time retarder switch, shall be provided due to the electrodes short margin of operation.

e) Every pump shall be provided with an autographic pressure recorder of seven (7) days duration of a well known and accepted make, electrically operated and will be connected to the system by valves, snubbers and flexible coupling at the pump suction and discharge ends.

Each pump shall be provided with adequate gate valves and flexible couplings in the suction and at the discharged of the same. In addition a pressure sustaining and check valve will be installed at the discharge, prior to the gate valve. All this accessories of adequates size in accordance with the pumping capacity and the velocity recommended in the design. All these fittings & connection shall be flanged connections.

All check valves shall be of the silent type, or any other combined type for pumps of large capacity, as determine by the Authority. See Fig. No. 23 and 24.

f) Other necessary accessories, such as selector switch for manual or automatic operation or for circuit breaker interruptor.

2.05.06 Turbine Type Pumps for Deep Wells

Turbine or centrifugal vertical type pumps for deep wells shall folow the requirements and recommendations of the National Association of Vertical Turbine Pumps Manufactures and the Standards of the Hydraulic Institute with the following conditions:

a) The motor will be open drip-proof weather protected NEMA I of a hollow shaft for a maximum speed of 1750 r.p.m., 3 phase, 60 cycles 230 to 460 volts and couple directly to the base of the pump discharge.

b) The discharge columns shall be of oil lubrication type, and no larger than 3.05 meters (10 feet) and of adequate diameter, according to the capacity and conditions of the system. Total length of the column and the diameter of its components shall be indicated in the plans.

c) The pumping element must be of the multiple type with scroll cases made of cast iron,properly enamaled or other equivalent material, bronze closed type impellers, and stainless steel column. Provided with the corresponding suction pipe of adequate size and galvanized conical screen.

In addition, the necessary equipment to determine the pumping level at any desired moment and an automatic switch for low level.

The pump discharge shall be provided with a flexible rubber gasket coupling, check valve, a gate valve, a flow control valve, smooth nosed sampling tap, a pressure releif valve according to the pumping pressure gauge at the discharge end of the pump and an air release valve of adequate capacity before the check

valve or at the base of the pump.

In addition, in the pump discharge line, after the check valve and before the "T" cleanout a turbine or venturi type meter to measure the flow across the pump shall be installed according to manufacturer instructions. See Fig. No. 23.

A chlorination system shall be installed consisting of hyperchlorinator and solution tank for pump capacities up to 350 g.p.m. and a gas chlorinator of adequate capacity for pumping stations with pump capacities greater than 350 g.p.m., with all necessary equipment.

All electrical equipment and material shall conform to the existing norms and regulations of the National Electric Code and to the Puerto Rico Electric Power Authority.

2.06 Reserve Tanks

2.06.01 Capacity

a) The capacity of the tanks or deposits for reserve for rural systems will be estimated using the following formula:

$V = N\ (250) + (250 \times 60 \times 4)$

where V= Volume or capacity of the tank in gallons.
N= Number of families

b) For urban systems the capacity will be estimated by the following formula:

$V = N\ (400) + (250 \times 60 \times 4)$

where V= Volume or capacity of the tank in gallons.
N= Number of families

2.06.02 General Tank Requirements

a) The location of the tank should be such that produces uniform pressures in the distribution system. In case that the topography does not

permit the construction of the tank on the ground, the construction of an elevated tank will be permitted. Where, due to special conditions, the construction of a concrete elevated tank would be too costly, the construction of reserve tank made of steel or other acceptable material will be permitted.

These tanks must be cathodically protected. However, the construction of such tanks will not be permitted at coastal areas, where the same would be exposed to the effects of sodium nitrates. Prefabricated pre-stress concrete tanks will be accepted subject to previous approval of the Authority.

b) The elevation of the bottom of the tank should be such that maintains, at the highest point of the system, the minimum pressure required as specified in clause 2.06.01.

c) Emergency overflow piping connected to a natural trench or to a storm sewer, shall be provided. Internal overflow pipe should be of the same or greater diameter as the diamter of the inlet pipe. On the outside of the structure the overflow pipe diameter should be the same used in the hydraulic gradient calculations.
Cast iron or ductile cast iron pipe shall be used for exposed pipe lines.

d) A plot will be provided according to the size of the tank, leaving a 3 meter strip around its perimeter. In urban areas the plots shall be concrete paved with paved access and of an area that will permit the addition of another tank.

e) The minimum distance from the perimeter of the base of the elevated tank to the nearest structure will be the same as the height at the top of the tank plus 3 meters.

f) An automatic control to prevent spills and an overflow shall be provided.

2.07 Distribution System

2.07.01 Minimum Pressure Required

The minimum pressure required in the distribution system will be 2.1 kg/sq. cm (30 lbs/sq inch) at the level of the sidewalk curb at the highest point of the system, based on the design maximum hourly consumption.

2.07.02 Capacity of Main Piping

The main piping shall be design to carry from the reserve or storage tanks to the distribution system, a minimum of 2.25 times the average normal consumption plus the reserve for fire or average consumption plus 60,000 GPD (4 hours fire reserve) whichever is greater. The maximum velocity permitted in piping systems flowing by gravity will be 1.22 meters/second (4 feet/second) and in forced mains 2.44 meters/second (8 feet/second).

2.07.03 Pipe Types

Piping for main lines and distribution systems, except in cases approved by the Authority, will be of cast iron or Ductile iron 150 type, with cement lining, P.V.C. or reinforced concrete.

a) Cast Iron and Ductile Iron Pipe

The cast iron pipe, pit cast, size 30" or larger will adjust to specifications ANSI A-21.2 The cast iron pipes centrifugally cast in molds, will meet specifications ANSI A-21.6 (AWWA C-106) or ANSI A-21.8 (AWWA C-108). In addition the ends of the mechanical joints shall conform to specification ANSI A-21.11 (AWWA C-111). Pipes of 2" diameter will adjust to specification CIPRA 8-57.
Ductile iron pipe shall conform to specification A-21-51 (AWWA C-151) and ANSI A-21-51A (AWWA C-151a). Specifications in force, latest revision, shall be applied.

1. Accesories

Accesories with bell and spigot ends in sizes 4" to 12" shall conform to specification ANSI 21.10 (AWWA C-110) and in sizes larger than 12" to specification AWWA C-100. All 90° curves shall conform to AWWA C-100.

All accesories with mechanical joint ends in sizes 4" to 12" shall conform to specification ANSI 21.10 (AWWA C-110), ANSI A-21.11 (AWWA C-111), CIPRA 2.54, 3.5 and 6.54.

Accesories with flanged ends shall conform to specification ANSI B-16.1, class 125.

2. Connections and Coupling Materials

Pipes and accesories in sizes 6" or larger will have push-on mechanical joints.

In crossings under river bed; permanent structures which obstruct their easy removal and replacement, or in installations on road bridges, the use of mechanical joint pipe and accesories shall be required.

3. Pressure Connections

In pipe and accesories with pressure connections the joints shall conform to specification ANSI A21.11 (AWWA C-111). The gasket and the lubricant for the joints shall conform to specification ANSI A21.11.

4. Mechanical Joints

Dimensional and material requirements for pipe ends, pipe caps, screws, lock nuts, joints shall conform with specification ANSI A21.11 (AWWA C-111).

5. Concrete Pipe

Reinforced concrete pipe shall conform to specification AWWA C-300. Prestressed concrete pipe shall meet requirements of specification

AWWA C-301 of latest revision. Both will be designed for the following minimum conditions.

Pressure Calibration....10.5kg./cm^2 (150 lbs/ sq. inch).
Soil Cover.....1.83 meters (6 feet)
Hydraulic Ram.....40% x Pressure Calibration
Accidental Load.....ASSHO H-20

To all concrete pipe, a bituminous layer shall be applied, to seal the interior surface according to specification ANSI A21.4.

The use of concrete pipe will be subject to the approval of the Authority.

All accesories shall be subject to the same requirements as the concrete pipe and the same type of cement should be used.

All joints and coupling material will be subject to the approval of the Authority.

2.07.04 Piping Installation

In General water piping will be installed in streets and roads, avoiding private areas leading to rights-of-way. Installing them at the most convenient side of the public roads, at a depth of not less than 0.75 meters (measured from ground surface to the upper part of the pipe) and a minimum distance of 1.50 meters to the side-walk curb.
On roads with no sidewalk curb or concrete gutter, the 1.50 meter limit can be reduce to 1.00 meter from the edge of the shoulder, subject to the approval of the Authority.
In all installations where plastic pipe is used a detectable metal or plastic tape shall be placed above all the length of the pipe to permit locating the pipe.

a. Crossings

Water mains crossing sewers, above or under or running at a distance less than 1.52 meters

(5.0 feet) shall be laid above the sewer providing a vertical distance of 0.30 meters (1 foot) between the outside of the water main and the outside of the sewer. When crossing at a distance less than 0.30 meter (one foot), or even greater, a concrete foundation shall be provided to the water main to prevent transmitting its weight to the sewer pipe. See Fig. No 43.

b. Parallel Installations

Water mains shall be laid at least 3.05 meters (10 feet) horizontally from any existing or proposed sewer. The distance shall be measured edge to edge. This distance may be less if the water main is installed in a separate trench or on an undisturbed earth shelf located on one side of the sewer at such and elevation that the bottom of the water main is at least 0.46 meters (18 inches) above the top of the sewer, subject to the approval of the Authority. See Fig. No. 43. No crossing or contact between a water pipe and a sanitary or storm sewer manhole will be permitted.

2.07.05 Accesories

In the distribution system the following accesories shall be provided:

a. Valves to isolate the circuits which divide the distribution system. Each circuit shall include four (4) blocks of houses. Valves shall adjust to the specifications of the American Water Works Association (AWWA C-500 71, latest revision) and will be for at least a working pressure of 150 pounds. Valves will open to the left.

b. Drainage valves will be installed in the lower places of the distribution system. The diameter of the drainage valves and piping shall not be less than 4 inches and sufficient to drain the water that flows to the drainage area in a maximum time of two (2) hours. Drainage sizes shall not be less than one half (1/2) the diameter in piping up to 8" diameter and one third (1/3) in piping up to 24" diameter. In piping of larger that 36" diameter, the size of the drainage shall be one fourth (1/4) the diameter of the pipe.

c. Dead ends in the pipe systems will not be permitted. At the ends, after the last house connection, a tapped plug or cap shall be placed. In cases where probability of future development exist, a valve shall be installed before the plug or cap. See Fig. No. 8 and 9.

d. Fire hydrants shall be Puerto Rico type according with the design adopted by the Authority. See Fig. No. 20.

Each fire hydrant shall be provided with an auxiliary valve and a four (4) inch diameter pipe connection when the diameter of the piping to be connected is 4"; and 6" diameter connection when the main is 6" or larger in diameter. The fire hydrants will be located preferably close to street instersections at a distance not less than four (4) meters (13 feet) from the corner of the sidewalks and in such a way that will not interfere with the driveways and yards of residences.

Shall be connected to the piping of larger diameter in the vicinity of the hydrant location. In straight lenghthes the maximum spacing between hydrants shall be 150 meters. In curved spaces the maximum distance shall be the same, measured on a line parallel to the center line of the street or road. Hydrants shall be located in the planting strip between curb and sidewalk. If no planting strip exists it shall be located at not less than one meter from the property line. See Fig. 20.

2.07.06 House Connections

The water service will be provided by house connections or water taps from the distribution mains according to the following:

a. Water service connections will be at least 1/2" in diameter, located in the front and at the center of each plot, its end will be at 0.25 meters (10 inches) from the sidewalk finished surface and will consist of a corporation cock, flexible type "K" copper piping, adapter, straight line jokes provided with a stopcock that permits the installation of a lock and cast iron meter box, all in accordance with the specification and requirements of the Authority. (See Fig. No. 11 and 12. Instead of the straight line joke and the cast iron box, a meter jokebox of a model and specifications accepted by the Authority, may be installed.

The box will be installed in the planting strip, 0.15 meters (6 inches) from the exterior edge of the sidewalk (facing the street) and 0.15 meter (6 inches) thick concrete slab as shown of Figure No. 12. Copper piping from the meter box to a length of 0.30 meters (1 foot) inside the property limit, passing under the sidewalk provided with a brass stop valve. The Authority will determine and approve the adequate size of the house connection and the meter according to the water service to be provided on each case.

b. The following table shows the maximum size house connections allowed in centrifugal cast iron, Class 150. Larger connections than the specified in this, will be done with type F-4339 Double Strap Service Clamp from James B. Clow & Sons, Inc., or approved equal.

Piping Size (inches)	4	6	8	10	12	16	20	24
Water Connection Size (inches)	3/4	1	1	1-1/2	2	2	4	4

In 2" diameter, connections will be done using one strap only.

c. Water connections to service piping larger than 2" diameter will be made with tapping valve and sleeve of the type approved by the Authority. In out of service piping the water connection will be made with a tee and gate valve of the type and class approved by the Authority.

d. The installation of 2" or larger water meters will include special fittings such as niples, valves.

corporation cocks, concrete meter box, cast iron lid to protect meter as indicated in typical detailed figures #13and 14.

2.07.07 Other Dispositions

In special cases in which the project includes other units not covered by this norms, such as dikes, filtration plants, intake lines, etc., the Authority should be consulted in relation to the norms to be used in the design.

2.07.08 Concrete Painting

The interior walls of the pumping stations will be painted in beige color. The exterior walls will be painted ceiling blue. Special paint for concrete of a quality accepted by the Authority will be used. A primer coat and two coats of paint shall be applied.

CHAPTER III

WATER FILTER PLANTS

In this chapter before covering standards related to the title subject, we had covered other areas included in the design of a water supply system, since they are considered exceedingly necessary as an approach to a Water Filter Plant design such as:

a) Supply sources

b) Collection and transportation works

Refering to supply sources we have tried, in the case of surface water, to include; hydrological information, flow, safe yield, description of the watershed, etc., and in the case of underground sources, its advantages, the geological formation through which the source is to be developed, a summary of the exploration, etc., the Engineer would notice that these phases precede the standards for treatment that begins in Section 3.10, page III-27, which, to the best of our knowledge, covers a wide range in the field of surface water treatment, and future designs shall be evaluated by these Design standards.

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CHAPTER III

WATER FILTER PLANTS

3.01 A system for supplying or providing water consist of the following basic parts:

a- Sources of water supply

b- Structures for its collection and transportation from the source to the treatment works

c- Water treatment structures

d- Distribution system

The water supplied should meet two basic conditions:

a- Should be free of risks or dangers to the health or life of the consumers.

b- Should consider all costs and the system should be operated at a reasonable cost.

At times this conditions may be conflicting, but both factors must be taken in consideration. To satisfy the first, the water should be free of pathogenic micro-organisms, substances that are health toxic or noxious, which is an essential and indispensable condition. To fulfil the second, the water characteristics must be such that do not cause any damage to the distribution system, the industries or the domestic economy, and can be obtained without having to incur in an exceptionally expensive treatment process, consuming great quantities of electric power.

3.01.01 General

All permits necessary for the location of the plant should be obtained from all agencies such as the Planning Board, Health Department, the U.S. Army Corps of Engineers, Enviromental Quality Board, Department of Permits and Regulations, Department of Natural Resources and others; before applying for approval to the Aqueduct and Sewer Authority.

Permits for construction, for waste discharge, for crossing of water courses, etc. must be required from the pertinent federal, state, or local agencies.

Preliminary plans and the engineer's report should be submitted for review prior to the preparation of final plans.

No approval for construction can be issued until final, complete, detailed plans and specifications have been submitted to the Authority and found to be satisfactory, The documents submitted for formal approval shall include at least

a- a summary of the basis of design,

b- operation requirements, where applicable,

c- general layout,

d- detail plans,

e- specifications,

f- cost estimates

3.01.02 Sources of Water Supply

The Engineer's report shall describe the proposed source or sources of water supply to be developed, the reasons for their selection, and provide the following information:

A- Surface Water Sources

Including:

a- hydrological data, stream flow and weather records,

b- safe yield, including all factors that may affect it,

c- maximum flood level, together with approval for safety features of the spillway and dam from the appropiate authorities,

d- description of the watershed, noting any existing or potential sources of contamination which may affect water quality.

e- summarized quality of the raw water with special reference to fluctuations in quality, changing metereological conditions, etc.

B- Ground Water Sources

Including:

a- sites considered,

b- selected side advantages,

c- elevations with respect to surroundings,

d- probable character of formations through which the source is to be developed,

e- geologic conditions affecting the site,

f- summary of source exploration, test well depth, and methods of construction; placement of liners or screen; test pumping rates and their duration; water levels and specific yield; water quality,

g- sources of possible contamination such as sewers and sewerage facilities, landfills, waste disposal wells, etc.

3.01.03 Proposed Treatment Processes

Summarize and establish the adequacy of proposed processes and unit parameters for the treatment of the specific water under consideration. Alternative methods of water treatment and chemical use should be considered as a means of reducing waste handling and disposal problems. Pilot studies may be required.

3.01.04 Waste Disposal

Discuss the various wastes from the water treatment plant, their volume, proposed treatment and points of discharge, considering Public Federal, Law 95-217 Rev.

3.01.05 Automation

Provide supporting data justifying automatic equipment, including the servicing and operator training. Manual override must be provided for any automatic controls.

3.01.06 Project Sites

Including:

a) discussion of the various sites considered and advantages of the recommended ones,

b) the proximity of residences, industries, and other establishments.

c) any potential source of pollution that may influence the quality of the supply or interfere with the effective operation of the water works system, such as sewage absorption systems, septic tanks, privies, cesspools, sink holes, sanitary landfills, refuse and garbage dumps, etc.

d) plant location

1. the plant should be located as near as possible to present and future developments to be service,

2. with easy access

3. plot of sufficient area available for expansion and addition of facilities.

3.01.07 Influent and Effluent Quality

The characterists of the influent shall determined the modes and degree of treatment to be applied and should be based on the standards for water quality.

3.02 General Design Considerations

3.02.01 General

The design of a water supply system or treatment process comprises a broad area. Application of this part is dependent upon the type of system or process involved.

3.02.02 Plant Layout

The design shall consider

a) funtional aspects of the plant layout,

b) provisions for future plant expansions,

c) provisions for expansion of the plant waste treatment and disposal facilities,

d) access roads,

e) site grading,

f) site drainage,

g) walks,

h) driveways,

i) chemical delivery

3.02.03 Building Layout

Design shall provide for

a) adequate ventilation,

b) adequate lighting

c) mechanical ventilation, if necessary,

d) adequate drainage,

e) dehumidification equipment, if necessary,

f) accessibility of equipment for operation, serving, and removal,

g) flexibility of operation,

h) operator safety,

i) convenience of operation

j) chemical storage and feed equipment in a separate room to reduce hazards and dust problems.

3.02.04 Location of Structures

The appropiate regulating authority must be consulted regarding any structure which may impede normal or flood stream flows because of its location.

3.02.05 Electrical Controls

Main switch gear electrical controls shall be located above ground level.

3.02.06 Stand-by Power

Standby power may be required by the Authority so that the plant operations may continue during power outage.

3.02.07 Shop Space and Storage

Adequate facilities for shop space and storage should be include, consistent with the designed facilities.

3.02.08 Laboratory Equipment

Laboratory facilities and equipment shall be compatible with the raw water source, intended use of the treatment plant and the complexity of the treatment process involved.

3.02.09 Testing Equipment

Testing equipment provided shall be adequate for the purpose intended and recognized procedures must be utilized

3.02.10 Physical Facilities

Adequate ventilation, adequate lighting,

sufficient bench space, storage room, laboratory sink, and auxiliary facilities shall be provided. Air conditioning may be necessary.

3.02.11 Monitoring Equipment

Water treatment plants with a capacity of 1.89 mld (0.5 mgd) or more should be provided with continuous monitoring equipment (including recorders) to monitor water being discharged to the distribution system as follows:

a) plants treating surfaces water and plants using lime for softening should have the capability to monitor and record turbidity and free chlorine residual,

b) plants treating ground water using iron removal and/or ion exchange softening should be capable of monitoring and recording free chlorine residual.

3.02.12 Sample Taps

Sample taps shall be provided so that water samples can be obtained from each water source and from appropiate locations in each operation of treatment. Taps shall be consistent with sampling needs and shall not be of the petcock type. Taps used for obtaining samples for bacteriological analysis shall be of the smooth-nosed type without interior or exterior threads and shall not be of the mixing type, and shall not have a screen, aerator, or other such appurtenance.

3.02.13 Facility Water Supply

Water supply service line for the facility and the plant finished water sample tap shall be supplied from a source of finished water at a point where all chemicals have been thoroughly mixed.

3.02.14 Wall Sleeves

To facilitate future uses whenever pipes pass through walls of concrete structures, consideration

shall be given to providing extra wall sleeves built into the structure.

3.02.15 Piping Color Code

To facilitate identification of piping in plants and pumping stations it is recommended that the following color scheme be used:

Water Lines

Raw	Olive green
Settled or Clarified	Aqua Blue
Finished or Potable	Dark Blue

Chemical Lines

Alum	Orange
Ammonia	White
Carbon Slurry	Red
Chlorine (Gas or Solution)	Yellow
Fluoride	Light Yellow with Red Band
Lime Slurry	Light Green
Potassium Permanganate	Violet
Sulfur Dioxide	Light Green with Yellow Band

Waste Lines

Backwash Waste	Light Brown
Sludge	Dark Brown
Sewer (Sanitary, Other)	Dark Gray

Other

Compressed Air	Dark Green
Gas	Black
Other Lines	Light Gray

In cases where two colors do not have sufficient contrast to easily differentiate between them, a six-inch band of contrasting color should be painted on one of the pipes at approximately 76 cm. (30 inches) intervals.

The name of the gas or liquid should also be painted on the pipe. In some cases it may be advantageous to paint arrows indicating the direction of flow.

3.02.16 Disinfection

All pipes, tanks, wells, and equipment that can convey or store potable water shall be disinfected in accordance with AWWA procedures. The procedure shall be outlined in the plans and specifications, including the disinfectant dosage, contact time, and method of testing the results of the procedure.

3.02.17 Manuals and Parts Lists

A part list and parts order form, and an operation and maintenance manuals shall be supplied to all water works as part of every unit installed in the facility.

3.02.18 Operation Instruction

Provisions shall be made for operator instruction at the start-up of a plant or a pumping station.

3.02.19 Other Considerations

Consideration must be given to the design requirements of other federal state and local agencies for items such as special designs for the handicapped, plumbing and electrical codes, etc.

3.03 Source Development

3.03.01 General

In selecting the source of water to be developed, the designing engineer must prove to the satisfaction of the Authority that an adequate quantity of water will be available, and that the water which is to be delivered to the consumers will meet the current reqirements of the authorities with respect to microbiological, physical, chemical and radiological qualities. Each water supply should take its water from the best available source which is economically reasonable and technically possible.

3.03.02 Surface Water

A surface water source includes all tributary streams and drainage basins, natural lakes and artificial reservoirs or impoundments above the point of water supply intake.

3.03.03 Quantity

The quantity of water at the source shall

a) be adequate to meet the projected water demand of the service area as determined by calculations based on the extreme drought of record,

b) provide a reasonable surplus for anticipated growth,

c) be adequate to compensate for all losses such as silting, evaporation, seepage, etc.

3.03.04 Quality

A sanitary survey and study shall be made of all the factors, both natural and man made, which will affect the quality. Such survey and study shall include but not be limited to:

a) determined possible future uses of impoundments and reservoirs,

b) determined the degree of control of watershed,

c) assessing the degree of hazard to the supply by accidental spillage of materials that may be toxic harmful or detrimental to treatment process

d) obtaining samples over a sufficient period of time to assess the microbiological, physical, chemical and radiological characteristics of the water,

e) assessing the capability of the proposed treatment process to reduce contaminants to applicable standards.

3.03.05 Structures

1. Design of Intake Structures shall provide for:

   a) withdrawal of water from more than one level if quality varies with depth,

b) separate facilities for release of less desirable water held in storage,

c) inspection manholes every 300 meters for pipe sizes large enough to permit visual inspection,

d) occasional cleaning of the inlet line,

e) adequate protection against rupture,

f) parts located above the bottom of the stream, lake, or impoundment, but at a sufficient depths to be kept submerged at low water levels,

g) where shore wells are not provided, a diversion device capable of keeping large quantities of fish or debris form entering an intake structure.

2. Shore Wells

Shall:

a) have motors and electrical controls located above grade, and protected from flooding as required by the Authority,

b) be accessible,

c) be designed to prevent flotation,

d) be equipped with removable or traveling screens before the pump suction well,

e) provide for application of chlorine or other chemicals in the raw water transmission main if necessary for quality control,

f) have intake valves and provisions for back-flushing or cleaning by a mechanical device and testing for leaks, where practical,

g) provide for withstanding surges where necessary.

3. An Upground Reservoir

Is a facility into which water is pumped during periods of good quality and high stream flow for future release to treatment facilities. Upground reservoirs shall be constructed to assure that:

a) the water quality is protected, by controlling the runoff into the reservoir,

b) dikes are protected against wind action and erosion and structurally sound,

c) intake structures and devices meet requirements of Section 3.03.05,

d) influent flow point is separated from the point of withdrawal,

e) provide separate pipes for influent to and effluent from the reservoir.

3.04 Ground Water

A ground water source includes all water obtained from dug, drilled, bored wells, and infiltration lines.

3.04.01 Quantity

The total developed ground water source capacity shall equal or exceed the design maximum future day demand with the largest producing well out of service. A minimum of two (2) sources of ground water shall be developed.

3.04.02 Auxiliary Power

a) When power failure would result in interruption of the minimum essential service sufficient power shall be provided to meet average day demand by means of:

1. connection to at least two independent power sources, or

2. portable or in-place auxiliary power.

b) When automatic pre-lubrication of pump bearings is necessary, and an auxiliary power supply is provided, the pre-lubrication line shall be provided with a by-pass, with valve, around the automatic control.

3.04.03 Microbiological Quality

a) Disinfection of every new, modified or re-conditioned ground water source;

1. should be provided after completion of work if a period of time, to be determined by the Authority, elapses prior to test pumping or placement of permanent pumping equipment, and

2. shall be provided after placement of permanent pumping equipment.

b) After disinfection, one or more water samples shall be submitted to a laboratory satisfactory to the Authority for microbiological analysis and results submitted to the Authority before the well is place into service.

3.04.04 Physical and Chemical Quality

a) Every new, modified or reconditioned ground water source shall be examined for applicable physical and chemical characteristics by tests of a representative sample in a laboratory approved by the Authority with the results submitted to the Authority.

b) Samples shall be collected at the conclusion of the test pumping procedure and examined as soon as practical or at the earliest opportunity in the required period of time.

c) The Authority may require field determination of physical and chemical constituents or special sampling procedure.

3.04.05 Radiological Quality

Every new, modified or recondition ground water source shall be examined for radiological acitivity

as required by the Authority by tests of a representative sample in an approved laboratory, with results reported to the Authority.

3.05 Location

3.05.01 Well Location

The Authority and other pertinent agencies shall be consulted prior to design and construction regarding a proposed well location since its location may be affected by potential sources of contaminations and other ground water developments.

3.05.02 Continued Protection

Continued protection of the well site from potential sources of contamination shall be provided either through ownership, zoning, easements, leasing, rigth-of-way or other means acceptable to the Authority. Fencing of the site will be required by the Authority.

3.06 Testing and Records

3.06.01 Yield and Drawdown Tests

a) Yield and drawdown tests shall be performed on every production well after construction or subsequent treatment and prior to placement of the permanent pump.

b) The test methods should be clearly indicated in the specifications.

c) Shall have a test pump capacity, at maximum anticipated drawdown, at least 1.5 times the quantity anticipated.

d) Provide for a continous pumping test for at least 48 hours or until stabilized drawdown has continued for at least six hours when test pumped at 1.5 times the design pumping rate.

e) Shall provide the following information:

1. test pump capacity-head characteristics,

2- static water level

3- depth of test pump setting, and

4- time of starting and ending each cycle, which consist of a time period where a balance between production and drawdown level is stablished, which could last for days.

f) Provide recordings and graphic evaluation at one hour intervals or less, as may be required by the Authority, of the following:

1- capacity and pumping rate characteristics,

2- pumping water level,

3- drawdown, and

4- water recovery rate and levels.

3.06.02 Plumbness and Alignment Requirements

a) Every well shall be tested for plumbness alignment in accordance with the Authority and AWWA standards.

b) The test method and allowable tolerance shall be clearly stated in the specifications.

c) The Engineer may accept the well even though it fails to meet the requirements of plumbness and alignment if it does not interferes with the installation or operation of the pump or uniform placement of grout.

3.06.03 Geological Data

a) Shall be determined from samples collected 1.52 meters (5.0 feet) and at each pronounced change in formation.

b) Shall be recorded and submitted to the Authority.

c) Shall be supplemented with information on accurate record of drillhole diameters and

depths, assembled order of size and lenght of casings and liners, grouting depths, formation penetrated, water levels.

3.07 General Well Construction

3.07.01 Minimum Protected Depths

Drilled wells minimum protected depths shall provide watertight construction to such depth as required by the Authority, to:

a) exclude contamination

b) seal off formations that are, or maybe, contaminated or yield undesirable water

3.07.02 Temporary Steel Casing

Temporary steel casing used for construction shall be capable of withstanding the structural load imposed during its installation and removal.

3.07.03 Permanent Steel Casing Pipe

Shall

a) be new pipe meeting ASTM or API specifications for water construction,

b) have minimum weights and thickness indicated in Table I,

c) have additional thickness and weight if minimum thickness is not considered sufficient to assure reasonable life expectancy of a well,

d) be capable of withstanding forces to which it is subjected,

e) have full circunferential welds or threaded coupling joints.

TABLE I

STEEL PIPE*

SIZE	DIAMETER (INCHES) EXTERIOR	DIAMETER (INCHES) INTERIOR	THICKNESS (INCHES)	WEIGHT PER FOOT (POUNDS) PLAIN ENDS (CALCULATED)	WEIGHT PER FOOT (POUNDS) WITH THREADS Y COUPLINGS (NOMINAL)
10 id	10.750	10.020	0.365	40.48	41.85
12	12.750	12.000	0.375	49.56	51.15
14 od	14.000	13.250	0.375	54.57	57.00
16	16.000	15.250	0.375	62.58	
18	18.000	17.250	0.375	70.59	
20	20.000	19.250	0.375	78.60	
22	22.000	21.000	0.500	114.81	
24	24.000	23.000	0.500	125.49	
26	26.000	25.000	0.500	136.17	
28	28.000	27.000	0.500	146.85	
30	30.000	29.000	0.500	157.53	
32	32.000	31.000	0.500	168.21	
34	34.000	33.000	0.500	178.89	
36	36.000	35.000	0.500	189.57	

* Abstracted from AWWA standard for Deep Wells, AWWA A-100.
id, Interior Diameter
od, Exterior Diameter

3.07.04 Nonferrous Casing Materials

a) Prior to submission of plans and specifications, approval of the use of any nonferrous material as well casing, shall be subject to special determination by the Authority.

b) Nonferrous material proposed as well casing must be resistant to the corrosiveness of the water and to the stress to which it will be subjected during installation, grouting and operation.

c) The material used for packing shall be such that will not impart taste, odor, toxic substance or bacterial contamination to the well water.

3.07.05 Screens

Shall

a) be constructed of materials resistant to damage by chemical action of ground water or cleaning operations,

b) have size of openings based on sieve analysis of formation and/or gravel pack materials,

c) have sufficient diameter to provide adequate specific capacity and aperture for a low entrance velocity. Usually the entrance velocity should not exceed 0.1 feet per second.

d) shall be installed so the pumping water level remains above the screen under all operating conditions,

e) be designed and installed, where applicable, to permit removal or replacement without adversely affecting watertight construction of the well.

3.07.06 Grouting Requirements

All permanent well casing, except driven Schedule 40 steel casing with the approval of the Authority, shall be surrounded by a minimum of 1 1/2 inches of grout to the depth required by the Authority. All temporary construction casings should be removed, but shall be withdraw at least five feet to insure grout contact with the native formation.

a) Neat Cement Grout

1. For 1 1/2 inches openings, cement conforming to ASTM Standar C-150 and water, with not more than six gallons per sack of cement, must be used

2. Fluidity may be increased by using additives, subject to the approval of the Authority.

b) Concrete Grout

1. For openings larger than 1 1/2 inches, equal parts of cement conforming to ATSM Standard C-150, and sand, with not more than six gallons of water per sack of cement, may be used

2. Gravel not larger than one-half inch in size may be added where an annular opening larger than four inches is available.

c) Clay Seal

Where an annular opening greater than six inches is available a clay seal of clean local clay mixed with at least 10 percent swelling bentonite may be used subject to approval by the Authority.

d) Application

1. To permit a minimum of 1 1/2 inches of grout around permanent casings, including couplings, sufficient annular opening should be provided.

2. Prior to grouting bentonite or similar materials, may be added to the annular

opening, in the manner indicated for grouting.

3. When the annular opening is less than 10 cm. (four inches), grout shall be applied under pressure by means of a grout pump from the bottom of the annular opening upward in one continuos operation until the annular opening is filled.

4. When concrete grout is used and the annular opening is 10 cm. (four inches)or more and less than 30.5 meters (100 feet) in depth, the grout may be placed by gravity through a grout pipe installed at the bottom of the annular opening in one continuous operation until the annular opening is filled.

5. If the annular opening exceeds 15 cm. (6 inches), less than 30.5 meters (100 feet) in depth, and a clay seal is used, it may be placed by gravity.

6. The work on the well shall be discontinued once the cement grouting is applied, until the cement or concrete grout has properly set.

e) The casing must be provided with sufficient guides welded to the casing to permit unobstructed flow and uniform thickness of the grout.

3.07.07 Upper Terminal Well Construction

a) Ground water sources' permanent casing shall project at least 30 cm. (12 inches) above the pumphouse floor, and at least 46 cm. (18 inches) above final ground surface.

b) The floor surface shall be at least 15 cm (6 in.) above the final ground elevation where a well house is constructed.

c) Sites subject to flooding shall be provided with an earth berm surrounding the casing and terminating at an elevation at least 0.60 meters (2 feet) above the highest known flood elevation, or other suitable protection as determined by the Authority.

d) At sites subject to flooding, the top of the well casing shall terminate at least 1.52 meters (5 feet) above the hightest known flood elevation or as required by the Authority.

3.07.08 Development

a) Every well shall be develop to remove the native silts and clay, drilling mud and/or finer fraction of the gravel pack,

b) Development should continue until the maximum specific capacity is obtained from the completed well.

c) The specification shall include provisions for the method, equipment, chemicals, testing for residual chemicals, and disposal of waste and inhibitors, when chemical conditioning is required.

d) Where blasting procedures may be used, the specifications shall include provisions for blasting and cleaning.

3.07.09 Capping Procedures

a) The preferred method for capping a well is a threaded cap or a welded metal plate,

b) To prevent tampering with the well or entrance of foreign materials, the contractor shall provide protection at all times during the progress of the work.

3.07.10 Well Abandonment

a) Test wells or ground water sources which are not in use shall be sealed by such methods as necessary to restore the controlling geological conditions which existed prior to construction or directed by the Authority.

b) Wells to be abandoned shall :

1. be sealed to prevent undesirable exchange of water from one aquifer to another,

2. preferably be filled with neat cement grout,

3. have fill materials other than cement grout or concrete, disinfected and free of foreign materials, and

4. when filled with concrete or cement grout, these materials will be applied to the well hole through a pipe, tremie or bailer.

5. The Authority may determined not to seal an abandoned well to use it as an observation point for aquifer fluctuations.

3.08 Aquifer Types and Construction Methods Special Conditions

3.08.01 Sand or Gravel Wells

a) If above the water bearing formation, clay or hard pan is encounter, the permanent casing and grout shall extend through such materials.

b) When a sand or gravel aquifer is overlaid only by permeable soils, the permanent casing and grout shall extend to at least 6.10 meters (20 feet) below original or final elevation, whichever is lower.

c) The temporary outer casing, when used, shall be completely withdrawn as grout is applied.

3.08.02 Gravel Pack Wells

a) Gravel pack shall be well rounded particles, 95 per cent sileceous material, that are smooth and uniform, free of foreign material, properly sized, washed and disinfected immediately prior to or during placement.

b) Gravel pack shall be placed in one uniform continuous operation.

c) When used, gravel refill pipes shall be Schedule 40 steel pipe incorporated within the pump foundation and terminated with screwed or welded caps at least 30 centimeters (12 inches) above the pump house floor level or concreted apron.

d) A minimum of 1 1/2 inches of grout shall surround the annular opening when gravel refill pipes are located in the grouted annular opening.

e) Protection from leakage of grout into the gravel pack or screen shall be provided.

f) Inner and outer permanent casings shall meet requirements of Section 3.07.03.

g) Minimum casing and grouted depth shall be approved by the Authority.

3.08.03 Radial Water Collector

a) Locations of all caisson construction joints and porthole assemblies shall be indicated.

b) The caisson shall be reinforced to withstand the forces to which it will be subjected.

c) Radial collectors shall be in areas and depths approved by the Authority.

d) Provisions shall be made to assure that radial collectors are essentially horizontal.

e) A watertight floor shall cover the top of the caisson.

f) All openings in the floor shall be curb and protected from entrance of foreign material.

g) The pump discharge pipe shall not be placed through the caisson walls.

3.08.04 Infiltration Lines

a) Only where geological conditions preclude the possibility of developing an acceptable drilled well, consideration may be given to infiltration lines.

b) The area around infiltration lines shall be under the control of the Authority for an acceptable or required distance.

c) Flow in the lines shall be by gravity to the collecting well.

3.08.05 Dug Wells

a) Dug wells may be considered only if geological conditions preclude the possibility of developing an acceptable drilled well.

b) A watertight cover shall be provided.

c) Protective lining and grouted depth shall be at least a minimum of 3.05 meters (10 feet) below original or final groundelevation, whichever is lower.

d) Openings shall be curb and protected from entrance of foreign material.

e) Pump discharge piping shall not be placed through the well casing or wall.

3.08.06 Limestone or Sandstone Wells

a) The permanent casing shall be firmly seated in increviced or unbroken rock if the depth of the mantle is more that 15.3 meters (50 feet). The Authority shall determined the grouting requirements.

b) Where the depths of mantle is less than 15.3 meters (50 feet), the casing and grout shall be at least 15.3 meters (50 feet) or as determined by the Authority.

3.08.07 Naturally Flowing Wells

a) Flow shall be controlled.

b) Provisions shall be made for permanent casing and grout.

c) Special protective construction may be required by the Authority if erosion of the confining bed appears likely.

3.09 Well Pumps, Discharge Piping and Appurtenances

3.09.01 Line Shaft Pumps

Wells equipped with line shaft pumps shall:

a) have the casing firmly connected to the pump structure or have the casing inserted into a recess extending at least one-half inch into the pump base,

b) have the pump foundation and base designed to prevent water from coming into contact with the joint.

3.09.02 Submersible Pumps

Where a submersible pump is used:

a) The top of the casing shall be effectively sealed against the entrance of water under all conditions of vibration or movement of conductors or cables,

b) The electrical cable shall be firmly attached to the riser pipe at 6.10 meter (20 feet) intervals or less.

3.09.03 Discharge Piping

The discharge piping shall:

a) Be designed so that the friction loss will be as low as possible.

b) When an above-ground discharge is provided, controll valves and appurtenances located above the pump house floor have to be installed.

c) Be protected against the entrance of contamination

d) Be equipped with a check valve, a shutoff valve, a pressure gauge, a means of measuring flow, and a smooth nosed tap located at a point where positive pressure is maintained.

e) Where applicable, be equipped with an air release-vacuum releif valve located upstream from the check valve, with exhaust relieve piping ending in a down turned position at least 46 centimeters (18 inches) above the floor and covered with a 24 mesh corrosion resistance screen.

f) Provide valve to permit test pumping and control of each well.

g) Have all exterior piping, valves and appurtenances protected against physical damage

h) Be properly anchored to prevent movement.

i) Be protected against surge or water hammer

2- Means of pumping to waste shall be provided for the discharge piping, but not directly connected to a sewer.

3.09.04 Pitless Well Units

a) The Authority must be consulted for approval of specific applications of pitless units.

b) Pitless units shall:

1- Be shop-fabricated from the point of connection with the well casing to the unit cap or cover.

2- Be threaded or welded to the well casing.

3- Be of watertight construction throughout.

4- Be of materials and weight at least equivalent or compatible to the casing

5- Have field connection to the lateral discharge from the pitless unit of thread, flanged or mechanical type.

6- End at least 46 centimeters (18 inches) above final ground elevation or 1.52 meters (5feet) above highest known flood elevation or as the Authority determines.

c) Provisions shall be made in the design for:

1- Access to disinfect the well.

2- An adequate constructed casing vent meeting the requirements of Section 3.09.05.

3- Facilities to measure water levels in the well (See Section 3.09.06)

4- Prevent the entrance of contamination by providing a cover at the upper terminal of the well.

5- A contamination-proof entrance for the eletrical cable

6- Up to and including casing diameters of 30 centimeters (12 inches) have an inside diameter as great as that of the well casing, to facilitate work and repair on the well, pump, or well screen.

7- At least one check valve within the well casing or in compliance with the requirements of the Authority.

d) The shop-assembled unit must be designed for field welding if the connection to the casing is by field weld. The only field welding permitted will be that needed to connect a pitless unit to the casing.

3.09.05 Casing Vent

Provisions shall be made for venting the well casing to the atmosphere. The vent shall end in a down-turned position at or above the top of the casing or pitless unit in a minimum 1 1/2 inch diameter opening covered with a 24 mesh, corrosion resistant screen. The pipe connecting the casing to the vent shall be of adequate size to provide rapid venting of the casing.

3.09.06 Water Level Measurements

a) Provisions shall be made for periodic measurements of water levels in the completed well.

b) Permanent water level measuring equipment installation shall be made using corrosion resistant materials attached firmly to the drop pipe of pump column and in such a manner as to prevent entrance of foreign materials.

3.09.07 Observation Wells

Shall be:

a) Constructed in accordance with the requirements for permanent wells if they are to remain in service after completion of a water supply well.

b) Protected at the upper terminal to preclude entrance of foreign materials.

3.10 Treatment

3.10.01 General

The design of treatment process and devices shall depend on evaluation of the nature and quality of the particular water to be treated and the desired quality of the final product.

3.10.02 Clarification

Plants design for processing surface water shall:

a) For rapid mix, flocculation and sedimentation, a minimum of two units each should be provided.

b) Permit operation of the units either in series or in parallel.

c) Be constructed to permit units to be taken out of service without disrrupting operation, and with drains and pumps sized to allow dewatering in a reasonable period of time.

d) When required by the Authority provide multi-stage treatment facilities.

e) Be able to start manually following shutdown.

3.10.03 Presedimentation

Waters containing high turbidity may require pretreatment, usually sedimentation, either with or without the addition of coagulation chemicals.

a) Basin Design - Basins for presidementation should have hopper bottoms or be equipped with continous mechanical sludge removal apparatus, and provide arrangements for dewatering.

b) Inlet - In coming water shall be dispersed accross the full width of the line of travel as quickly as possible, short-circuiting must be prevented

c) By-pass - Presedimentation basins bypassing provisions shall be included

d) Detention Time - The minimum detention period recommended is three (3) hours; greater detention may be required.

3.10.04 Rapid Mix

Shall mean the rapid dispersion, usually by violent agitation, of chemicals throughout the water to be treated.

a) Equipment - Basins shall be equipped with mechanical mixing devices.

b) Mixing - The detention period should not be less than twenty (20) seconds.

c) Location - The rapid mix and flocculation basins shall be located as close together as possible.

3.10.05 Flocculation

Shall mean the agitation of water at low velocities for long periods of time.

a) Tank Design - Inlet and outlet design shall prevent destruction of floc and short-circuiting. A drain or pumps shall provided to handle dewatering and sludge removal.

b) Detention - The flow-through velocity shall not be less than 15 centimeters (0.5 ft.) nor greater than 30 centimeters (one ft.) per minute with a detention time for floc formation of at least 30 minutes.

c) Equipment - Variable speed drives with the peripheral speed of paddles ranging from 15 to 30 centimeters (0.5 to 1.0 ft.) per second, shall be used to drive the agitators.

d) Piping - Flocculation and sedimentation basins shall be as close together as possible. The velocity of flocculated water through pipes and conduits to settling basins shall not be less than 15 centimeters (0.5 ft) per second nor greater than 30 centimeters (1 ft.) per second. Allowances must be made to minimize turbulence at bends and changes in direction.

e) Other Types - Baffling may be used to provide for flocculation in small plants, only after consultation with the Authority. The design shall be so that the velocities and flows noted above will be maintained.

3.10.06 Sedimentation

Flocculation shall be followed by sedimentation. For effective clarification, the detention time is dependent on a number of factors related to basin design and the nature of the raw water.

a) Detention Time - A minimum of four hours of settling time shall be provided for detention time.

b) Inlet Devices - Inlets shall be design to distribute the water equally and at uniform velocities. Entrance arrangements such as open ports, submerged ports or similar, are required. A baffle should be constructed across

the basins close to the inlet end and should project several feet below the water surface to dissipate inlet velocities and provide uniform flows across the basin.

c) Outlet Devices - Outlet devices shall be designed to maintain velocities suitable for settling in the basin and to minimize short-circuiting. In order to provide a volume above the orifices for storage when there are fluctuations in flow, the use of submerged orifices is recommended.

d) Overflow Rate - The rate of flow over the outlet weir shall not exceed 75,700 liters (20,000 gallons) per day per 30 centimeters (one foot) of weir length. Submerged orifices shall not be lower than 0.91 meters (3 feet) below the flow line with flow rates equivalent to weir loadings, when used as an alternate for overflow weirs.

e) Velocity - The velocity through settling basins shall not exceed 60 centimeters (2.0 ft.) per minute. The basins must be designed to minimize short-circuiting and baffles must be provided as necessary.

f) Overflow - The maximum water level desired on top of the filters will be established by installing an overflow weir (or pipe). It shall discharge with a free fall at a location where the discharge will be noted.

g) Sludge Collection - Mechanical sludge collection equipment should be provided.

h) Drainage - Means for dewatering the basins must be provided. The slope of the basin bottoms toward the drain shall not be less than 30 centimeters (1 foot) in 3.66 meters (12 feet) where mechanical sludge collection equipment is not required.

i) Flushing Lines - Flushing lines or hydrants with 2 1/2" diameter nozzles shall be provided and must be equipped with backflow prevention devices acceptable to the Authority.

j) Access - On the inside walls of basins, permanent ladders or handholds, shall be provided.

Guard rails should be included.

k) Sludge Disposal - Facilities for disposal of sludge (See Section 3.20) are required by the Authority. Provisions shall be made for the operator to observe or sample sludge being withdrawn from the unit.

3.10.07 Solids Contact Unit

When the water charateristics are not variable and flow rates are uniform, combine softening and clarification units are acceptable. Approval of the Authority shall be obtained before such units are considered as clarifiers without softening. Clarifiers should be designed for the maximum uniform rate and should be adjustable to changes in flow which are less than the design rate and for changes in water characteristics. A minimum of two units are required for surface water treatment.

a) Equipment Installation - At the time of installation and inicial operation, supervision by a representative of the manufacturer shall be provided including instruction to the personnel assigned by the Authority.

b) Operating Equipment - The following shall be provided for plant operation:

1. Complete outfit of tools and accessories,

2. necessary laboratory equipment, and

3. adequate piping with suitable sampling taps so located as to permit the collection of samples of water from critical portions of the units.

c) Chemical Feed - Chemical shall be applied at such points and by such means as to insure satisfactory mixing of the chemicals with the water.

d) Mixing - The Authority may require a rapid mix deviced or chamber ahead of the solids contact units to assure proper mixing of the chemicals applied.

Mixing devices employed shall be so constructed as to:

1. provided good mixing of the raw water with previously formed sludge particles, and

2. prevent deposition of solids in the mixing zone.

e) Flocculation - Flocculation equipment shall:

1. be adjustable (speed and/or pitch),

2. provide for coagulation in a separate chamber or baffled zone within the unit, and

3. should provide a flocculation and mixing period of not less than 30 minutes.

f) Sludge Concentrators - In order to obtain a concentrated sludge with the minimum of waste of water, the equipment should provide either internal or external concentrators

g) Sludge Removal - The sludge removal design shall make provisions for

1. sludge pipes to be not less than six (6) inches in diameter and so arranged as to facilitate cleaning,

2. the entrance to sludge withdrawal piping shall prevent clogging,

3. for accessibility, valves shall be located outside the tank,

4. the operator to be able to observe and sample sludge being withdrawn from the unit.

h) Cross-Connections-

1. The Authority will determined the places where the blow-off outlets and drains must terminate and discharge.

2. For potable water lines used to backflush sludge lines, cross-connection control must be included.

i) Detention Period - The raw water characteristics and other local conditions that affect the operation of the unit, should be the basis to establish the detention time. Based on design flow rates, the detention time should be:

1- four hours for suspended solids contact clarifiers and softeners treating surface water, and

2- one hour for the suspended solids contact softeners treating only groundwater.

The Authority may alter the detention time requirements.

j) Suspended Slurry Concentrate - Softening units should be designed so that continous slurry concentrates of one per cent or more, by weight, can be satisfactorily mantained.

k) Water Losses - The design should take into consideration that

1- units shall be provided with suitable controls for sludge withdrawal,

2- total water losses shall not exceed five per cent for clarifiers and three per cent for softners,

3- solid concentration of sludge bled to waste should be three per cent, by weight, for clarifiers and five per cent, by weight for softners.

l) Weirs or Orifices - The units should be equipped with either overflow weirs or orifices constructed so that water at the surface of the unit does not travel over ten feet horizontally to the collection trough.

1- Weirs shall be adjustable, and at least equivalent in length to the tank perimeter

2- Weir loading shall not exceed 38 liters per minute per 30 centimeters (10 gal./min./foot) of weir length for units used for clarifiers and 76 liters per minute per 30 centimeters (20 gal./min./foot) of weir length for units used as softeners.

3- Where orifices are used, the loading per foot of launder should be equivalent to weir loadings.

Either shall produce uniform rising rates over the entire area of the tank.

m) Upflow Rates - Unless supporting data is submitted to the Authority to justify rates exceeding the following, rates shall not exceed

1- 3.8 liters per minute per 929 sq. centimeter (1 gal./min./sq. ft.) of area at the sludge separation line, for units used as clarifiers

2- 6.62 liters per minute per 929 sq. centimeter (1.75 gal./min./ sq. ft.) of area at the slurry separation line, for units used as softeners.

n) Tube Setters - Even though recognized as an alternate method of clarification, sufficient experience is not yet available to establish design standards. Therefore, proposals for tube settler clarification must include pilot plant and/or full scale demostration satisfactory to the Authority prior to the preparation of final plans and specifications for approval.

3.11 Filtration

Upon the discretion of the Authority, the acceptable filters shall include the following types:

a) rapid rate gravity filters, and

b) rapid rate pressure filters.

Water quality data representing a reasonable period of time to characterize the variations in water quality must support the application of any one type. The Authority may require experimental treatment studies to demostrate the applicability of the method of filtration proposed.

3.11.01 Rapid Rate Gravity Filters

a) Pretreatment - When using rapid rate gravity filters, pretreatment is required

b) Number - At least two units must be provided. If only two units are provided, each shall be capable of meeting the plant design capacity (normally the projected maximum daily demand) at the approved filtration rate. When more than two filter units are provided, the filters shall be capable of meeting the plant design capacity at the approved filtration rate with one filter removed from service.

c) Rate of Filtration - Such factors as raw water quality, degree of pretreatment provided, filter media, water quality control parameters, and other factors as required by the Authority, must be considered when determining the rate of filtration. In any case, the filter rate should be proposed and justified by the designing engineer to the satisfaction of the Authority, prior to the preparations of final plans and specifications.

d) <u>Structural Details and Hydraulics</u>

The filter structure shall be so designed as to provide for:

1- vertical walls within the filter,

2- no protrusion of the filter walls into the filter media,

3- head room to permit normal inspection and operation,

4- minimum depth of filter box of 2.59 meters (8.5 feet), except in special cases, which requires the approval of the Authority,

5- minimum water depth over the surface of the filter media of 91 centimeters (3 feet),

6- trapped effluent to prevent backflow of air to the bottom of the filters,

7- prevention of floor drainage to the filter

with a minimum 4 inch curb around the filters,

8. maximum velocity of treated water in pipes and conduits to filters of 60 centimeters (2 feet) per second,

9. cleanouts and straight alignment for influent pipes and conduits where solids loading is heavy or following line-soda softening.

10. washwater drain capacity to carry maximum flow, and

11. walkways around filters to be not less than 76 centimeters (30 inches) wide.

e) Washwater Troughs

Washwater troughs shall be designed to provide

1. the bottom elevation above the maximum level of expanded media during washing and a 5 centimeters (2 inches) freeboard at the maximum rate of wash,

2. the top edge to be level, and

3. spacing so that each trough serves the same number of square centimeters of filter area and maximum horizontal travel of suspended particles to reach the trough not to exceed 91 centimeters (3 feet).

f) Filtering Media

1. The media shall be clean silica sand or other natural or synthetic media approved by the Authority, having the following characteristics:

a- a total depth of not less than 61 centimeters (24 inches) and generally not more than 76 centimeters (30 inches)

b- an effective size range of the smallest material no grater than 0.45mm. to 0.55mm.

c) an uniformity coefficient of the smallest material not greater than 1.65,

d) 12 inch minimum of media with an effective size range no greater than 0.45 mm to 0.55 mm and specific gravity greater than other filtering materials within the filter,

e) types of filter media:

1. Anthracite - Clean crushed anthracite or a combination of anthracite and other media may be considered on the basis of experimental data specific to the project and shall have:

a- effective size of 0.45 mm - 1.2 mm depending on the intended use (anthracite used alone must meet the specifications of Section 3.11.01, Subsection f)

b- uniformity coefficient of not greater than 1.85 (not greater than 1.65 if use alone)

2. Sand shall have:

a- effective size of 0.45mm to 0.55 mm.,

b- uniformity coeffcient of not greater than 1.65

3. Granular activated carbon - Use of granular activated carbon media may be considered only with the approval of the Authority, and must meet the basic specifications for filter material as given in Section 3.11.01, Subsection f) and

a- provision shall be made for a free chlorine residual in the water following the filters and before distribution,

b- means for periodic treatment of filter material for control of bacterial and other growths must be provided.

4. Other media - Bases on experimental data and operating experience, other media

will be considered.

5. Torpedo - An 8 centimeter (3 inch) layer of torpedo sand should be used as a supporting media for filter sand, and should have

   a- effective size of 0.8 mm to 2mm, and

   b- uniformity coefficient not greater than 1.7

6. Gravel - When gravel is used as supporting media, shall consist of hard, rounded particles and not include flat or elongated particles. The coarsest gravel shall be 6 centimeters (2 1/2 inches) in size when the gravel rests directly on the strainer system, and must extend above the top of the perforated laterals. Four layers of gravel at least shall be provided when used with perforated laterals, in accordance with the following size and depth distribution:

Size*	Depth*
2 1/2 to 1 1/2	5 to 8
1 1/2 to 3/4	3 to 5
3/4 to 1/2	3 to 5
1/2 to 3/16	2 to 3
3/16 to 3/32	2 to 3

*Size and depth in inches

The reduction of gravel depths may be considered upon approval of the Authority.

3.11.02 Filter Bottoms and Strainer Systems

Deviations from these standards may be acceptables for high rate filters. Porous plate bottoms shall not be used where iron or manganese may clog them or with waters softened by lime. Manifold-type collection systems shall be of such design as to

a) minimize loss of head in the manifold and laterals.

b) assure even distribution of washwater and even rate of filtration over the entire area of the filter,

c) provide the ratio of the area of the final openings of the strainer systems to the area of the filter at about 0.003,

d) provide the total cross-sectional area of the laterals at about twice the total area of the final openings,

e) provide the cross-sectional area of the manifold at 1 1/2 to 2 times the total area of the laterals,

3.11.03 Surface Wash or Subsurface Wash

Facilities for surface or subsurface wash are required except for filters used exclusively for iron or manganese removal.

It may be accomplished by a system of fixed nozzels or a revolving-type apparatus. All devices shall be designed with

a) water pressures of at least 3.2 kgs/sq./cm. (45 psi) must be provided,

b) properly installed vacuum breaker or other approved device to prevent back siphonage if connected to the treated water system,

c) rate of flow of 2 gal./min./square foot of filter area with fixed nozzles or 0.5 gal./min./square foot with revolving arms.

3.11.04 Appurtenances

For every filter, the following shall be provided:

1- facilities for influent and effluent sampling,

2- an indicating loss of head gauge with 24 hours recorder,

3- a rate-of-flow meter with recorder for 24 hours,

4- a continuous or rotating cycle turbidity

recording device for surface water treatment plants,

5. manholes providing access to the filter interior at several locations for sampling or pressure sensing.

6. a 1 to 1-1/2 inch pressure hose and storage rack at the operating floor for washing filter walls.

7. provisions for draining the filter with appropriate measures for backflow prevention. (See Section 3.18)

3.11.05 Backwash

Provisions shall be made for washing filters as follows:

a) a minimum of 57 liters (15 gallons) per minute per 929 square centimeter (square foot), consistent with water temperature and specific gravity of the filter media. A rate of 76 liters per minute per 929 sq. cem. (20 gallons per minute per square foot) or a rate necessary to provide for a 50 per cent expansion of the filter bed is recommended. For full depth anthracite or granular activated carbon filters, a reduced rate of 38 liters per minute per 929 sq. centimeters (10 gallons per minute per square foot) may be acceptable,

b) filtered water provided at the required rate by washwater tanks, washwater pump, from the high service main, or a combination of these,

c) duplicate washwater pumps unless other means of obtaining washwater is available,

d) not less than 15 minutes wash of one filter at the design rate of wash,

e) a washwater regulator or valve on the main washwater line to obtain the desired rate of filter wash with the washwater valves on the individual filters open wide,

f) on the main washwater line, a rate-of-flow indicator, preferably with an indicator, located so that it can be easily read by the operator during the washing process,

g) design to prevent rapid changes in backwash water flow.

3.11.06 Miscellaneous

Roof drains shall not discharge into the filters or basins and conduits preceding the filters.

3.12 Rapid Rate Pressure Filters

For iron or manganese removal the use of rapid rate pressure filters may be considered. Pressure filters shall not be used in the filtration of polluted waters or following lime-soda softening.

3.12.01 General

Minimum criteria relative to number, rate of filtration, structural details and hydraulics, filter media, etc, provided for rapid rate gravity filter also apply to pressure filters where appropriate

3.12.02 Rate of Filtration

The rate shall not exceed 11.4 liters per minute per 929 sq. cm. (3 gals./min/sq. ft.) of filter area.

3.12.03 Details of Design

The design of the filters shall provide for:

a) on the inlet and outlet pipes of each filter, a loss of head gauge,

b) an easily readable meter or flow indicator on each battery of filters. A flow indicator is recommended for each filter,

c) an arrangement of piping as simple as possible to accomplish filtration and backwashing of

each filter individually,

d) the height of the side wall shall be determinated according to the type of filter and filter media used,

e) the underdrain system to efficiently collect the filtered water and to uniformly distribute the backwash water at a rate not less than 57 liters per minute per 929 square centimeters (15 gal./min./sq.ft) of filter area.

f) backwash flow indicators and controls that are easily readable while operating the control valves,

g) on the highest point of each filter, an air release valve,

h) an accesible manhole to facilitate inspections and repairs,

i) means to observe the wastewater during back-washing,

j) construction to pre ent cross-connection.

3.13 Disinfection

The preferred disinfecting agent is chlorine. Chlorination may be accomplished by means of liquid chlorine, calcium or sodium hypochlorites or chlorine dioxide. Providing reliable application equipment is available and testing procedures for a residual are recognized in "Standards Methods for the Examination of Water and Wasterwater" latest edition, consideration may be given to other disinfecting agents. Disinfection is required at all surface water supplies and at any ground water supplies which are of questionable sanitary quality or where any other treatment is proyided. Continous disinfection is recomended for all water supplies.

3.13.01 Chorination Equipment

a) Type- Solution-feed-gas-type chlorinators or hypochlorite feeders of the positive displace-ment type must be provided. (See Section 3.21).

b) Capacity - The capacity of the chlorinator shall be such that a free chlorine residual of at least 2 milligrams per liter can be attained in the water after contact time of at least 30 minutes when maximum flow rates coincide with anticipated maximum chlorine demands. The equipment shall be of such design that it will operate accurately over the desired feeding range.

c) Standby Equipment - Where chlorination is required for protection of the supply, standby equipment of sufficient capacity shall be available to replace the largest unit during shut-down.

d) Automatic Proportioning - Where the rate of flow or chlorine demand is not reasonably constant, automatic proportioning chlorinators will be required.

3.13.02 Contact Time and Point of Application

Due consideration shall be given to the contact time of the chlorine in water with relation to pH, ammonia, taste-producing substances, temperature, bacterial quality, and other pertinent factors. Chlorine should be applied at a point which will provide the maximum contact time. At plants treating surface water, provisions should be made for applying chlorine to the raw water, filtered water, and water entering the distribution system. At plants treating ground water, provisions should be made for applying chlorine to at least the detention basin inlet and water entering the distribution system. Free residual chlorination is the preferred practice; 30 minutes contact time for ground water and two hours for surface water must be provided. In package plants the chlorine may be apply before or after the filter or at both points preferrably before the filter. The amount of chlorine that should be apply varies with the degree of contamination.

3.13.03 Residual Chlorine

In a potable water distribution system, the residual chlorine should be according to the design and the requirements of the Authority.

3.13.04 Testing Equipment

Chlorine residual test equipment recognized in the latest edition of "Standard Methods for the Examination of Water and Wastewater" shall be provided. All plants with a capacity of 2 mgd or more should be equipped with recording chlorine analyzers monitoring water entering the distribution system. (See Section 3.02.11).

3.13.05 Chlorinator Piping

The chlorinator water supply piping should be designed to prevent contamination of the treated water supplied to the system. At all facilities treating surface waters, pre-and post-chlorination systems must be independent to prevent possible siphoning of partially treated water into the clear well.

3.13.06 Housing

Adequate housing must be provided for the chlorination equipment and for storing the chlorine. (See Section 3.21 and Chapter VIII).

3.13.07 Other Disinfecting Agents

Although disinfecting agents other than chlorine are available, each has usually demostrated short comings when applied to a public water supply. Proposals for use of other than chlorine, disinfecting agent must be approved by the Authority prior to preparation of the final plans and specifications.

3.14 Aeration

Aeration may be used to help remove offensive tastes and odors due to dissolved gases from decomposing organic matter, or to reduce or remove objectionable amounts of

carbon dioxide, hydrogen sulphide, etc., and to introduce oxygen to assist in iron and/or manganese removal.

3.14.01 Natural Draft Aeration

Design shall provide:

a) perforations in the distribution pan 0.48 to 1.3 centimeters (3/16 to 1/2 inch) in diameter, spaced 2.54 to 7.62 centimeters (1 to 3 inches) on centers to maintain a 15 centimeter (6 inch) water depth.

b) for distribution of water uniformly over the top tray,

c) discharge through a series of three or more trays with separation of trays not less than 30 centimeters (12 inches),

d) a rate of loading of 3.8 to 18.9 liters (1 to 5 gals.) per minute for each 929 square centimeter (square foot) of total tray area

e) trays with slotted, heavy wire (1.3 centimeters (1/2 inch) openings) mesh or perforated bottoms,

f) construction of durable material resistant to aggressiveness of the water and dissolved gases,

g) protection from loss of spray water by wind carriage by means of enclosure with louvers sloped to the inside at an angle of approximately 45 degrees,

h) for a 24-mesh screen protection from insects.

3.14.02 Forced or Induce Draft Aeration

Devices shall be design to:

a) include a blower with a weather proof motor in a tight housing and screened enclosure,

b) insure adequate counter current of air through the enclosed aerator column,

c) exhaust air directly to the outside atmosphere,

d) include a down-turned and 24-mesh screened air inlet and outlet,

e) be such that air introduced in the column shall be as free from harmful fumes, dust, and dirt as possible,

f) be such that sections of the aerator can be easily reached or removed for maintenance of the interior or installed in a separate aerator room,

g) provide loading at a rate of 3.8 to 18.9 liters (1 to 5 gals.) per minute for each 929 square centimeter (square foot) of total tray area.

h) insure that the water outlet is adequately sealed to prevent unwarranted loss of air,

i) discharge through a series of five or more trays with separation of trays of not less than 15 centimeters (6 inches),

j) provide distribution of water uniformly over the top tray,

k) be of durable material resistant to the aggressiveness of the water and dissolved gases.

3.14.03 Pressure Aeration

Only if pilot plant study indicates the method is applicable, may pressure aeration be used for oxidation purposes. Filters following pressure aeration must have adequate exhaust devices for release of air. Pressure aeration devices shall be design to:

a) give thorough mixing of compressed air with water being treated,

b) provide screened and filtered air, free of obnoxious fumes, dust, dirt and other contaminants.

3.14.04 Other Methods of Aeration

If applicable to the treatment needs, other methods of aeration may be used. Such methods include but are not restricted to spraying, diffused air, cascades and mechanical aeration. The treatment processes must be design to meet the particular needs of the water to be treated and are subjet to the approval of the Authority.

3.14.05 Protection of Aerators

All aerators except those discharging to lime softening or clarification plants shall be protected from birds and insects.

3.14.06 Disinfectation

Ground water supplies exposed to the atmosphere by aeration must receive chlorination as the minimum additional treatment.

3.14.07 By-pass

All aeration units shall be provided with a by-pass.

3.15 Iron and Manganese Control

As used herein, iron and manganese control, refers solely to treatment processes designed specifically for this purpose. The character of the raw water will determined the treatment processes to be used. The selection of one or more treatment process must meet specific local conditions as determined by engineering investigations, including chemical analysis of representative samples of water to be treated, and receive approval of the Authority. It may be necessary to operate a pilot plant in order to gather all information pertinent to the design. Consideration should be given to adjusting pH of the raw water to optimize the chemical reaction.

3.15.01 Removal by Oxidation, Detention and Filtration

a) Oxidation

May be by aeration, as indicated in Section 3.14, or by chemical oxidation with chlorine or potassium permanganate.

b) Detention

1- Reaction - A minimum detention time of 20 minutes shall be provided following aeration in order to insure that the oxidation reactions are as complete as possible. The minimum detention shall be omitted only where a pilot plant study indicates no need for detention. The detention basin shall be designed as a holding tank with no provisions for sludge collection but with sufficient baffling to prevent short circuits.

2- Sedimentation - Basins for Sedimentation, shall be provided when treating with high iron and/or manganese content, or where chemical coagulation is used to reduce the load of the filters.

3- Filtration - Filters shall be provided and shall conform to Section 3.08

3.15.02 Removal by Lime-Soda Softening Process

See Section 3.10.02

3.15.03 Removal by Manganese Greensand Filtration

This process, consisting of a continous feed of potassium permanganate to the influent of a manganese greensand filter, is more applicable to the removal of manganese than to the removal of iron.

a) Provisions should be made to apply the permanganate as far ahead of the filter as practical and to a point immediately before the filter

b) Other oxidizing agents or processes such as chlorination or aeration may be used before the permanganate feed to reduce the cost of the chemical.

c) Anthracite media cap of at least six inches shall be provided over manganese greensand.

d) Normal filtration rate is 11.3 liters per minute per 929 square centimeters (3 gallons per minute per square foot)

e) Normal wash rate is 30.3 to 37.8 liters per minute per 929 square centimeters (8 to 10 gallons per minute per square foot).

f) Air washing should be provided.

g) Sample taps shall be provided

1- before the application of permanganate,

2- immediately ahead of filtration,

3- at a point between the anthracite media and the manganese greensand,

4- halfway down the manganese greensand,

5- at the filter effluent.

3.15.04 Removal by Ion Exchange

This process of iron and manganese removal should not be used for water containing more than 0.3 milligrams per liter of iron, manganese or combination thereof. This process is not acceptable where either the raw water or wash water contains dissolved oxygen.

3.15.05 Sequestration by Polyphosphates

This process shall not be used when iron, manganese or combination thereof exceeds 1.0 milligrams per liter. The total phosphate applied shall not exceed 10 milligrams per liter as PO_4.

Where phosphate treatment is used, satisfactory chlorine residuals shall be maintained in the distribution system.

a) Feeding equipment shall conform to the requirements of Section 3.20

b) Stock phosphate solution must be kept covered and disinfected by carrying approximately 10 milligrams per liter free chlorine residual.

c) Polyhposphates shall not be applied ahead of iron and manganese removal treatment. The point of application shall be prior to any aeration, oxidation or disinfection if no iron or manganese removal is provided.

d) Phosphate chemicals must be food grade.

3.15.06 Sampling Equipment

For control purposes, smooth-nosed sampling taps shall be provided.

3.15.07 Testing Equipment

All plants shall be provided with testing equipment.

a) The equipment should be capable of accurately measure the iron content to a minimum of 0.1 milligram per liter and the manganese content to a minimum of 0.05 milligram per liter.

b) Appropriate phosphate test equipment shall be provided where polyphosphate sequestration is provided.

3.16 Fluorination

Commercial sodium fluoride, sodium silicofluoride and hydrofluosilicic acid shall conform to the applicable AWWA standards. Other fluoride compounds which may be available must be approved by the Authority. Fluoride application proposed method must be approved prior to preparation of final plans and specifications.

3.16.01 Fluoride Compound Storage

Covered or unopened containers shall be used to store fluoride compounds and should be stored inside a building.

Unsealed storage units for hydrofluosilicic acid should be vented to the atmosphere at a point outside any building.

3.16.02 Chemical Feed Equipment and Methods

In addition to the requirements in Section 3.20, fluoride feed equipment shall meet the following requirements:

a) scales or loss-of-weight recorders shall be provided for dry chemicals feeds,

b) feeders shall be accurate to within five percent of any desired feed rate,

c) to avoid precipitation of fluoride, the fluoride compound should not be added before lime-soda softening and shall not be added before ion exchange softening.

d) the point of application of hydrofluosilicic acid, if into a horizontal pipe, shall be in the lower half of the pipe,

e) a positive displacement pump, having a stroke rate of not less than 20 strokes per minute, shall be used to applied a fluoride solution,

f) adequate anti-siphon devices shall be provided for all fluoride feed lines.

3.16.03 Protective Equipment

At least one pair of rubber gloves, a respirator of a type certified by the Occupational Safety and Health Administration for toxic dusts or acid (as necessary), an apron or other protective clothing and goggles or face mask shall be provided for each operator.

3.16.04 Dust Control

For the transfer of dry fluoride compounds from shipping containers to the storage bins or hoppers in such a way as to minimize the quantity of fluoride dust which may enter the room in which the

equipment is installed, provision must be made. The enclosure shall be provided with an exhaust fan and dust filter which place the hopper under a negative pressure. Air exhausted from fluoride handling equipment shall discharge through a dust filter to the outside atmosphere of the building.

Provisions shall be made for disposing of empty bags, drums or barrels in a manner which will minimize exposure to fluoride dusts. A floor drain should be provided to facilitate the hosing of floors.

3.16.05 Testing Equipment

Equipment shall be provided, subject to the approval of the Authority, for measuring the quantity of fluoride in the water.

3.17 Taste and Odor Control

At all surface water treatment plants, provision shall be made for the addition of taste and odor control chemicals. Such chemicals shall be added sufficiently ahead of other treatment processes to assure adequate contact time for an effective and economical use of chemicals.

3.17.01 Flexibility

So that the operator will have flexibility of operation, equipment that makes several of the control processes available, should be provided at plants treating water that is known to have taste and odor problems.

3.17.02 Chlorination

For the removal of some objectionable odors, chlorination can be used, provided adequate contact time is allowed to complete the chemical reactions involved.

3.17.03 Powdered Activated Carbon

a) Powdered activated carbon may be added prior to coagulation to provide maximum contact time.

Facilities to allow the addition at several points is preferred. Activated carbon should not be applied near the point of chlorine application.

b) The carbon can be added as pre-mixed slurry or by means of a dry-feed machine as long as the carbon is properly wetted

c) Agitation is necessary to keep the carbon from depositing in the slurry storage tank

d) Adequate dust control shall be provided

e) The required rate of feed of carbon in a water treatment plant depends upon the tastes and/or odors involved, but provisions should be made for adding from 0.1 milligrams per liter to at least 40 milligrams per liter.

3.17.04 Granular Activated Carbon Absortion Units

See Section 3.11.01 (f)

3.17.05 Copper Sulfate and other Copper Compounds

Continuous or periodic treatment of water with copper compounds to kill algae or other growths shall be controlled to prevent copper in excess of 1.0 milligrams per liter as copper in the plant effluent or distribution system.

3.17.06 Aeration

See Section 3.14

3.17.07 Other Methods

Only after consultations with and approval by the Authority should the decision be made to use other methods of taste and odor control.

3.18 Waste Handling and Disposal

Provisions shall be made for proper disposal of water treatment plant waste such as sanitary, laboratory, clarification sludge, softening sludge, iron sludge, filter backwash water and brines.

All wastes discharges shall be governed by the pertinent regulatory agencies. The requirements outlined herein must be considered minimum requirements as water pollution control authorities may have more restrictive requirements. When selecting waste disposal facilities, due consideration shall be given to preventing contamination of the water supply.

Alternative methods of water treatment and chemical use should be consider as a means of reducing waste handling and disposal problems.

3.18.01 Sanitary Waste

The sanitary waste from water treatment plants, pumping stations, etc., must receive treatment. Waste from these facilities must be discharged directly to a sanitary sewer system, if feasible, or to any adequate waste treatment facility.

3.18.02 Brine Waste

By controlled discharge to a stream, if adequate dilution flow is available, the waste from ion exchange plants, demineralization plants, etc. may be disposed of. Stream requirements of the regulatory agency will control the rate of discharge. A holding tank of sufficient size to allow the brine to be discharge over a period of 24 hours, should be provided, except when discharging to large waterways. When discharging directly to a sanitary sewer, a holding tank may be required to prevent the overloading of the sewer and/or interference with waste treatment process.
The effects of brine discharge to sewage lagoons may depend on the rate of evaporation from the lagoons.

3.18.03 Alum Sludge

The use of lagoons as a mean to handle the alum sludge should be considered. Lagoon size can be calculated using total chemicals used plus a factor for turbidity. Mechanical concentration may be considered. A pilot plant study is required before

the design of a mechanical dewatering installation. Alum sludge may be discharge to a sanitary sewer, however, approval of this method should be obtained from the Authority before final designs are made. Acid treatment of sludge for alum recovery may be a possible alternative.

Lagoons should be designed to produce an effluent satisfactory to the regulatory agencies and should provide for:

a) free from flooding location

b) if necessary, dikes, deflecting gutters or other means of diverting surface water so that it does not flow into the lagoon,

c) a minimum usable depth of 1.52 meters (five feet),

d) adequate freeboard, 30 cms. (12 inches),

e) adjustable decanting device,

f) effluent sampling point, and

g) adequate safety provisions.

3.18.04 "Red Water" Waste

Plants for removal of iron and manganese can dispose of the filter wash water waste as follows:

a) Sand filters

The following features should be included for sand filters:

1. Regardless of the volume of water to be handled, the total filter area should be no less than 9.29 square meters (100 sq. ft.) Two or more cells are required unless the filter is small enough to be cleaned and return to service in one day:

2. Unless the production filters are washed on a rotating schedule and the flow through the production filters is regulated by true rate of flow controllers, the "red water" filters

shall have sufficient capacity to contain, above the level of the sand, the entire volume of wash water produced by washing all of the production filters in the plant. To properly dispose of the wash water involved, sufficient volume must be provided;

3. Sufficient filter surface area should be provided so that, during any one filtration cycle, no more than 0.60 meters (2feet) of backwash water will accumulate over the sand surface;

4. The filter shall not be subject to flooding by surface runoff or flood waters. Finished grade elevation shall be such as to facilitate maintenance, cleaning and removal of sand as required;

5. The filter media should consist of a minimum of 30 centimeters (12 inches) of sand, 7.6 to 10 centimeters (3 to 4 inches) of supporting small gravel or torpedo sand, and 23 centimeters (9 inches) of gravel in graded layers. All sand and gravel should be washed to remove fines;

6. The effective size of the filter sand should be 0.3 to 0.5 mm and an uniformity coefficient not to exceed 3.5. The use of larger sized sands shall be justified by the designing engineer to the satisfaction of the Authority;

7. An adequate underdrain collection system to permit satisfactory discharge of filtrate, should be provided in the filter;

8. Provision shall be made for the sampling of the filter effluent.

9. Overflow devices from "red water" filters shall not be permitted.

10. "Red Water" filters shall comply with the requirements for common walls which pertain

to the possibility of contamination of finished water when finished water and raw water are stored or conveyed in adjacent compartments. The Authority must be consulted for approval of any arrangement when separate structures are not contemplated.

b) Lagoons

Lagoons shall have the following features:

1- the design volume shall be ten (10) times the total quantity of wash water discharged during any 24 hour period,

2- a minimum usuable depth of 0.91 meters (3feet),

3- lenght four times width, and the width at least three times the depth, as measured at the operating water level,

4- outlet located at the end opposite the inlet,

5- a weir overflow device at the outlet end with weir length equal to or greater than depth,

6- dissipate the velocity at the inlet end.

c) Discharge to Sanitary Sewer

Red water can be discharge to the community sanitary sewer. However, approval of this method must be obtained from the Authority. To prevent overloading the sewers, provision for a holding tank is recommended.

3.18.05 Waste Filter Wash Water

Waste filter wash water from surface water treatment or lime softening plants should have the suspended solids reduced to a level acceptable to the Authority and regulatory agencies before being discharge.

Constructing a holding tank and returning this water to the inlet end of the plant should be contemplated. This tank should be of such a size that it will contain the anticipated volume of waste wash water produced by the plant when operating at design capacity. Plants having two filters should have a holding tank that will contain the total waste wash water from both filters calculated by using a 15 minutes wash at 75.7 liters per minute per 929 square centimeters (20 gallons per minute per square foot). In plants with more filters, the size of the tank will depend on the anticipated hours of operation. A waste filter wash water rate of return of less than 10% of the raw water entering the plant is recommended.

3.19 Chemicals Application

To treat drinking waters, no chemicals shall be applied unless specifically permitted by the Authority.

3.19.01 Plans and Specifications

Plans and specifications shall be submitted for review and approval of the Authority, as provided in Chapter I, and should include

a) descriptions of feed equipment, including minimum and maximum feed limits,

b) location of feeders, piping layout and points of application,

c) facilities for storage and handling,

d) specifications for chemicals to be used,

e) operating and control procedures including proposed application rates, and

f) descriptions of testing equipment and procedures.

3.19.02 Chemical Application

Chemicals shall be applied to the water at such points and by such means as to:

a) assure maximum efficiency of treatment,

b) assure maximum safety to consumer,

c) provide maximum safety to operators,

d) assure maximum mixing of the chemicals with the water,

e) provide maximum flexibility of operation through several points of application, when appropiate, and

f) prevent backflow and back-siphonage between multiple points of feed through common manifolds.

3.19.03 General Equipment Design

Design of general equipment shall be such that:

a) at all times, the feeders shall be able to supply, at an accurate rate, the necessary amounts of chemicals throughout the range of feed,

b) surfaces and chemical-contact materials are resistant to the aggressiveness of the chemical solution,

c) introduce corrosive chemicals in such a manner as to minimize potential for corrosion, and

d) chemicals that are incompatible are not feed, stored or handled together.

3.20 Facilities Design

3.20.01 Number of Feeders

a) Where chemical feed is necessary for the protection of the supply, such as chlorination, coagulation or other essential processes,

1- a minimum of two feeders shall be provided, and

2- to replace the largest unit during shut-downs, a standby unit or a combination of units of sufficient capacity should be available;

3- where a booster pump is required, duplicate equipment should be provided and, when necessary, standby power,

b) For each chemical applied a separate feeder shall be used

c) To replace parts which are subject to wear and damage, spare parts shall be available for all feeders

3.20.02 Control

a) Manually or automatically controlled feeders may be used, with automatic controls being designed so as to allow override by manual controls.

b) Chemical feed rates shall be proportional to flow.

c) In order to determine chemical feed rates, means to measure water flow must be provided.

d) Provisions shall be made for measuring the quantities of chemical used.

e) Weighing scales

1- shall be provided to weigh cylinders, at all plants utilizing chlorine gas,

2- may be required for fluoride solution feed,

3- shall be provided for volumetric dry chemical feeders, and

4- should be accurate to measure increments of 0.5 per cent of the load. Means to verify the accuracy of the scales shall be provided.

3.20.03 Dry Chemical Feeders

Dry chemical feeders shall

a) measure chemicals volumetrically or gravimetrically,

b) provide adequate solution water and agitation of the chemical in the solution pot,

c) provide gravity or pumped feed from solution pots, and

d) completely enclosed chemicals to prevent emission of dust to the operating room.

3.20.04 Positive Displacement Solution Pumps

To feed liquid chemicals, positive displacement type solution feed pumps should be used, but shall not be used to feed chemical slurries.

3.20.05 Liquid Chemical Feeders-Siphon Control

Liquid chemical feeders shall be such that the chemical solutions cannot be siphoned into the water supply by

a) assuring discharge at a point of positive pressure, or

b) providing vacuum relief, or

c) providing an air gap.

3.20.06 Cross-Connection Control

Provide cross-connection control to assure that

a) the service water lines discharging to solution tanks shall be properly protected from backflow as required by the Authority,

b) liquid chemicals solutions cannot be siphoned through solution feeders into the water supply as required in Section 3.20.05.

c) no direct connection exists between any sewer and a drain or overflow from the feeder, solution chamber or tank by providing that all draims terminate at least 15 centimeters (6 inches) or two (2) pipe diameters, whichever, is greater, above the over flow rim of a receiving sump, conduit or waste receptacle

3.20.07 Chemical Feed Equipment Location

Chemical feed equipment shall

a) be located in a separate room to reduce hazards and dust problems,

b) be conveniently located near points of application to minimize the length of feed lines, and

c) be readily accesible for servicing, repair, and observation of operation.

3.20.08 Service Water Supply

Service water supply shall be

a) adequate in pressure and ample in supply

b) provided with means for measurement when preparing specific solution concentrations by dilution,

c) when necessary, properly treated for hardness, and

d) properly protected against backflow

3.20.09 Storage of Chemicals

a) Space should be provided for:

1- a chemicals supply for at least 30 days,

2- convenient and efficient handling of chemicals,

3- dry storage conditions, and

4- a minimum storage area of 13.94 square meters (150 square feet).

b) Liquid chemicals storage tanks and pipe lines shall be specific to the chemicals and not for alternates.

c) Chemicals shall be stored in covered or unopened shipping containers, unless transferred into an approved storage unit.

d) Liquid chemical storage tanks must

1- have a liquid level indicator, and

2- be provided with an overflow and a receiving basin or drain capable of receiving accidental spills or overflows.

e) Handling

1- provide carts, elevators and other appropriate means for lifting chemical containers to minimize excessive lifting by operators,

2- made provisions for disposing of empty bags, drums or barrels by an approved procedure which will minimize exposure to dusts.

3- made provisions for the proper transfer from shipping containers to storage bins or hoppers of dry chemicals in such a way as to minimize the quantity of dust which may enter the room in which the equipment is installed. Control should be provided by use of,

a- vacuum pneumatic equipment or closed conveyor systems,

b- facilities for emptying shipping containers in special enclosures, and/or

c- dust filters and exhaust fans which put the hoppers or bins under negative pressure

d- provision shall be made for measuring quantities of chemicals used to prepare feed solutions.

3.20.10 Solution Tanks

a) A means which is consistent with the chemical solution shall be provided in a solution tank to maintain an uniform strength of solution. To maintain slurries in suspension, continous agitation shall be provided.

b) To assure continuity of supply in servicing a solution tank, two solution tanks of adequate volume may be required for a chemical.

c) Means shall be provided to measure the solution level in the tank.

d) Chemical solutions shall be kept covered. Large tanks with access openings shall have such openings curbed and fitted with tight over-hanging covers.

e) Subsurface locations for solution tanks shall

1- be free from sources of possible contamination and

2- assure positive drainage for ground waters, accumulated water, chemical spills and overflows.

f) Overflow pipes, when provided should

1- be turned downward, with the end screened,

2- have a freefall discharge, and

3- be located where noticeable.

g) Acid storage tanks must be vented to the outside atmosphere, but not through vents in common with solution tanks.

h) Each tank shall be provided with a valved drain, protected against backflow in accordance with Sections 3.20.05 and 3.20.06

i) Solution tanks shall be located, and protective curbings provided,so that chemicals from

equipment failure, spillage or accidental drainage shall not enter the water in conduits, treatment or storage basins.

3.20.11 Day Tanks

a) Where bulk storage of liquid chemical is provided, day tanks shall be provided.

b) Day tanks shall meet all the requirements of Section 3.20.10

c) No more than a 30 hour supply should be held by day tanks

d) Day tanks shall be mounted on scales, or have a calibrated gauge painted or mounted on the side if liquid level can be observed in a gauge tube or through translucent sidewalls of the tank. In opaque tanks, a gauge rod extending above a reference point at the top of the tank, attached to a float may be used. The ratio of the area of the tank to its height must be such that unit readings are meaningful in relation to the total amount of chemical fed during a day.

e) Hand pumps may be provided for transfer from a carboy or drum. A tip rack may be used to permit withdrawl into a bucket from a spigot. Where motor-driven transfer pumps are provided, a liquid level limit switch and an over-flow from the day tank, which will drain by gravity back into the bulk storage tank, must be provided.

f) To maintain uniform strenght of solution in a day tank, a means which is consistent with the nature of the chemical solution shall be provided. Chemical slurries may be maintained in suspension by providing continuous agitation.

g) Tanks shall be properly labeled to designate the chemical contained.

3.20.12 Feed Lines

Chemical solution feed lines should be

a) as short as possible in length of run, and

1- of durable, corrosion resistant material,

2- easily accessible throughout the entire length,

3- readily cleanable and maintainable

b) should slope upward from the chemical source to the feeder when conveying gases,

c) shall be designed consistent with scale-forming or solids depositing properties of the water, chemical, solution or mixture conveyed,

d) should be color coded.

3.20.13 Housing

a) Floor surfaces shall be smooth and impervious, slip-proof and well drain with 2.5 per cent minimum slope.

b) Storage facilities, equipment exhaust and vents from feeders shall discharge to the outside atmosphere above grade and far from air intakes.

3.21 Operator Safety (See Chapter VIII)

3.21.01 Ventilation

Special provisions shall be made for ventilation of chlorine feed and storage rooms.

3.21.02 Respiratory Protection Equipment

Where chlorine gas is handled, respiratory protection equipment that meets the requirements of OSHA (Occupational Safety and Health Administration) shall be available and shall be stored at a convenient location, bu" not inside any room

where chlorine is used or stored, The units shall use compressed air, have at least a 30 minutes capacity, and be compatible with or exactly the same as units used by the Fire Department.

3.21.03 Chlorine Leak Detenction

An automatic alarm equipment that detects chlorine gas leakage shall be provided. A bottle of ammonium hydroxide, 56 per cent ammonia solution, shall be available for chlorine leak detenctions where ton containers are used, a leak repair kit approved by the Chlorine Institute shall be provided.

3.22 Specific Chemicals

3.22.01 Chlorine Gas

a) Chlorine gas feed and storage shall be enclosed and separated from other operating areas. The chlorine room shall be

1- provided with an acrilic panel inspection window installed in an interior wall,

2- constructed in such a manner that all openings between the chlorine room and the remainer of the plant are sealed,and

3- provided with doors equipped with emergency hardware assuring ready means of exit and opening only to the building exterior.

b) Full and empty cylinders of chlorine gas should be

1- isolated from operating areas,

2- restrained in position to prevent upset,

3- stored in rooms separate from ammonia storage, and

4- stored in areas not in direct sunlight or exposed to excessive heat.

c) Where chlorine gas is used, the room shall be constructed to provide the following;

1- a ventilating fan with a capacity which provides one complete air change per minute when the room is occupied for each room,

2- the ventilating fan shall take suction near the floor as far as practical from the door and air inlet, with the point of discharge so located as not to contaminate air inlets to any rooms or structures,

3- air inlets should be through louvers near the ceiling,

4- fans and light switches shall be outside the room, at the entrance, when the fan can be controlled from more than one point, a signal light indicating fan operation should be provided at each entrance,

5- vents from feeders and storage shall discharge to the outside atmosphere, above grade.

d) Chlorine feed lines shall not carry chlorine gas beyond the chlorinator room.

3.22.02 Acids

a) Acids shall be kept in closed acid-resistant shipping containers or storage units.

b) Acids should be pumped in undiluted form from original containers through suitable hose to the point of treatment or to a covered day tank, but should not be handled in open vessels.

CHAPTER III-A

CLEAR WATER PUMPING STATIONS

This chapter is a complement of the preceding Chapter III, it is separated considering that it can form a unit by itself. However, these norms are not limited to consider only the types of pumps, but factors which may influence or affect these norms are considered throughout the entire length of this work, its location, units, elevation, ventilation, maintenance, and the pumps in themselves.

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CHAPTER III-A

CLEAR WATER PUMPING STATIONS

3A.0 General

Pumping facilities shall be design to maintain the sanitary quality of pumped water. Sub-surface pits or pump rooms and inaccessible installations should be avoided. No pumping station shall be subject to flooding.

3A.01 Location

Located so that the proposed site will meet the requirements for sanitary protection of water quality, hydraulics of the system and protection against interruption of service by fire, flood or any other hazard.

3A.01.01 Site Protection

The station shall be

a- placed elevated to a minimum of 30 cm. (1foot) above the highest recorded flood elevation, or protected to such elevation,

b- readily accessible at all times the station is in service,

c- graded around the station so as to lead surface drainage away from the station,

d- protected to prevent vandalism and entrance by unauthorized persons or animals.

3A.02 Pumping Stations

Pumping stations for both raw or clear water shall

a- provide the necessary space for the installation of additional units if needed, and for the safe servicing of all equipment,

b- be of durable construction, fire and weather resistant and with outward-opening doors,

c- have floor elevation of at least 15 cm. (6 inches) above finished grade

d- have underground structure water proofed,

e- provide all floors with drains so that the quality of the potable water will not be endangered.

f- have a suitable outlet for drainage from pump glands without discharging into the floor.

3A.02.01 Suction Well

The pump suction wells or chambers shall

a- be watertight,

b- have floors sloped to permit removal of water and entrained solids,

c- be covered or protected against contamination.

3A.02.02 Equipment Maintenance

Pump stations shall be provided with

a- eyebolts, hoist beams, crane-ways, or other adequate facilities for servicing or removal of pumps, motors or other equipment,

b- openings in floors, roofs or wherever else needed for removal of heavy or bulky equipment,

c- a convenient tool board, or other facilities as needed, for proper maintenance of the equipment.

3A.02.03 Stairways and Ladders

Pumping stations shall be provided with stairways or ladders

a- between all floors, and in pits or compartments which must be entered,

b- with handrails and treads of non-slip material. See Chapter VIII.

3A.02.04 Ventilation

Adequate ventilation shall be provided for all pumping stations in accordance with the requirements of OSHA and EPA. Forced ventilation of at least six changes of air per hour shall be provided for

a- all underground rooms, pits and other structures

b- any area where unsafe atmosphere may developed.

3A.02.05 Dehumidification

Means for dehumidification should be provided in areas where excess moisture could cause hazards to safety or damage to equipment.

3A.02.06 Lighting

Pump stations should be adequately lighted throughout. All electrical work shall conform to the norms and requirements in effect of the National Electric Code and the P.R. Electric Energy Authority.

3A.02.07 Sanitary Facilities

All pumping stations should be provided with potable water, lavoratory and toilet facilities, except in the case of small automatic stations or where such facilities are otherwise available. Plumbing must be so installed as to prevent contamination of a potable water system supply. Wastes shall be discharge in accordance with Section 3.18.

3A.03 Pumps

At least two pumping units shall be provided. With any pump out of service, the remaining pump or pumps shall be able of providing the maximum daily pumping demand of the system. The pumping units shall:

a- have ample capacity to supply the peak demand without dangerous overloading,

b- be driven by primer mover able to operate against the maximum probable head

c- have spare parts and tools readily available for maintenance and repairs.

3A.03.01 Suction Lift

If possible, suction lift should be avoided or be within the allowable limits, preferably less than 4.6 meters (15 ft.).

3A.04 Booster Pumps (See Fig. No. 23 and 24)

Booster pumps may be of the vertical barrel type or horizontal submersible type. Shall be located or controlled so that:

a- they will not produce negative pressure in their suction,

b- automatic or remote control devices shall have a range between the start and cutoff pressure which will prevent excessive cycling.

3A.04.01 In Line Booster Pump

In addition to all mentioned conditions the inline booster pumps shall be accesible for maitenance and repair.

3A.05 Automatic and Remote Controlled Stations

All automatic stations should be provided with automatic signaling apparatus which will report when the station is out of service. All remote controlled stations shall be eletrically operated and controlled and shall have signalling devices of proven performance. The electrical equipment shall be installed in accordance with the applicable requirements of the National Electric Code and the Electric Energy Authority.

3A.06 Appurtenances

3A.06.01 Valves

To permit satisfactory operation, maintenance and repair of the equipment, all pumps shall be adequately valved.

If foot valves are necessary, they shall have a net valve area of at least 2 1/2 times the area of the suction pipe and they shall be screened.

A positive-acting check valve shall be installed on the discharge end, between the pump and the shut-off valve.

3A.06.02 Piping

In general piping shall

a) be design so that the friction losses will be minimized,

b) not be subject to contamination,

c) provided with watertight joints,

d) be protected against surge or water hammer,

e) be such that each pump has an individual suction line or that the lines shall be so manifolded that they will insure symilar hydraulics and operating conditions.

3A.06.03 Gauges and Meters

Each pump shall have

a) a standard pressure gauge on its discharge line,

b) a compound gauge on its suction line,

c) recording gauges in the large stations,

d) means for measuring the discharge.

The station should have indicating, totalizing, and recording metering of the total water pumped.

3A.06.04 Water Seals

Water of a lesser sanitary quality than that of the water being pump, shall not be used to supply the water seals.

3A.06.05 Controls

Pumps, their prime movers and accessories, shall be controlled in such a manner that they will operate at rated capacity without dangerous overload. Provision shall be made for alternation, where more than one pump are installed. Energizing the motor, in the event of a backspin cycle, shall be prevented. Electrical controls shall be located above grade.

3A.06.06 Electric Power

If cessation of minimum essential service would result due to power failure, provisions shall be made to supply power from at least two indepedent sources or a stand-by or an auxiliary source.

3A.06.07 Water Pre-Lubrication

When automatic pre-lubrication of pump bearings is necessary and an auxiliary power supply is provided, the pre-lubrication line shall be provided with a valved by-pass around the automatic control so that the bearings can, if necessary, be lubricated manually before the pump is started.

CHAPTER IV

GENERAL STANDARDS FOR THE DESIGN OF SANITARY SEWERS

The quantity of waste in a community is fundamental in the design of its facilities for collection transportation, pumping, treatment and disposal. With modern trend for Regional Treatment Plant and Disposal, more responsible information is needed concerning water consumption, population, studies, runoff, infiltration, industries, etc; This norm not only covers per capita consumption but also advises about how to determine branch capacities, volume of flows, minimum velocities, manhole depths, etc.

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CHAPTER IV

GENERAL STANDARDS FOR THE DESIGN OF SANITARY SEWERS

4.01 The sanitary sewer systems will be designed for the disposal of domestic sewage and industrial wastes. Combined systems (sanitary and storm sewer) will not be approved.

4.02 Contributions

4.02.01. Domestic

1) Private Housing Projects	: 1325 liters (350 gallons) per day per housing unit.
2) Public Housing Projects Renewal Projects and other Public Communal Projects ----------	: 1136 liters (300 : gallons) per day per : housing unit
4.02.02. Industrial ----------	: 22.710 liters (6000 gallons) per day per "cuerda"
4.02.03. Comercial ----------	: 15140 liters (4000 gallons) per day per "cuerda"
4.02.04. Hotels ---------- Hotels with all services and facilities----------	1987 liters (525 : gallons) per day : per room
Deductions for facilities or services not rendered.	: :
Laundry----------	: 416 liters (110 gallons) per day per room
Beach----------	: 284 liters (75 gallons) per day per room
Food Service----------	: 284 liters (75 gallons)per day per room

	Swiming Pool----------:	151 liters (40 gallons) per day per room.
4.02.05	Hospitals----------:	1136 liters (300 gallons) per day per bed.
4.02.06	Medical Centers----------:	1136 liters (300 gallons) per day per bed.
4.02.07	Apartment Buildings and Condominiums----------:	1325 liters (350 gallons) per day per housing unit.
4.02.08	Office Buildings----------:	1136 liters (300 gallons) per day per 92.9 square meters (1000 ft^2) of floor space.
4.02.09	Schools----------:	76 liters (20 gallons) per student
4.02.10	Infiltration----------:	290 liters (75 gallons) per day per housing unit or 37,850 liters (10,000 gallons) per day per mile per inch-diameter of piping, whichever is more restrictive. However, for the initial inspection, not more than 280 liters per day per kilometer of pipe per centimeter of diameter (300 gals. per day per mile of pipe per inch of diameter) for concrete pipe. For other types of pipe the Authority will determine the maximum permitted.

4.03 The capacity of lateral ramifications and subcollectors will be designed according to the following formula:

Design flow : 2(1.75 Average Daily Domestic Flow + Infiltration + Industrial).

4.04 The capacity of the collectors: 1.33(1.5 Average Daily Domestic Flow + Infiltration + Industrial).

4.05 For hydraulic estimates, Ganguillet's or Manning formulas will be used, with the following coefficient of rugosity:

Concrete pipe----------0.013
Vitrified clay pipe----------0.013
Plastic pipe----------0.011

4.06 The minimum velocity for a flow equal to (1.75 average daily flow +Infiltration) in sewers should be 61 cm./sec. (2 feet/sec.). The maximum velocity for a flow equal to (1.75 average daily flow +Infiltration) in sewers will be 3.05 meters/sec. (10 feet/sec.). The velocity can be increase to 4.57 meter/sec. (15 ft./sec.) when cast iron or vitrified clay pipe is used, but only when average flow depth is not less than 5.1 cm. (2 inches) and transitions will be design for each case, where slopes change abruptly.

The following table indicates the maximum number of housing units permitted for piping of 8", 12", 15" diameter:

N= .015		
D	Slope	Units
8"	0.003	---
10"	0.002	330
12"	0.0015	523
14"	0.00115	739

N= .011		
D	Slope	Units
8"	0.002	418
10"	0.0015	375
12"	0.0012	625
14"	0.00115	---

4.07 The maximum slopes will be those corresponding to the maximum velocities and will never exceed 10% for concrete piping and 15% for cast iron, ductile iron pipe, vitrified clay, and plastic material.

The minimum slopes with a coefficient of rugosity of 0.013 will be the followings:

Cast Iron - Vitrified Clay								
Diameter:	4"	6"	8"	10"	12"	14"	15"	16"	18"
Slope :	.01	.005	.003	.002	.0015	.0012	.001	.00095

20"	21"	24"	27"	30"	33"	36"
.00065	.0006	.0005	.00045	.0004	.00035	.0003

4.08 Depths

5.08.01 In critical cases with sewer lines without water connections, in which it is necessary to place the crown or upper part of the piping, not less than 0.61 meters (2 feet) below ground surface, cast iron pipe for 150 pounds pressure, must be used, with concrete protection according to Fig. No. 35 on natural soil foundation of adequate firmness. The Authority may consider alternate propositions.

4.09 The installation of sanitary sewer systems that crosses a storm sewer will not be permitted when interfering with the water flow. In cases where the sewer is installed on bridge crossings, sewers, or other similar structures, such sewer should be of ductile iron piping, bell and spigot for 150 pound minimum pressure. The pipe should be made according to specifications ASA-A21.6 or A21.8 latest revision.

4.10 When sewer piping and water mains cross each other or when laid at a horizontal distance of less than 1.52 meters (5 ft.) from each other, the water main should be installed at a higher

level than the sewer piping and no less than 0.30 meter (1 foot) between the outside of the water main and the sewer. See Fig. No. 6.43.

4.11 Sewers crossing water mains shall be laid to provide a minimum vertical distance of 30 cm. (12 inches) between the outside of the water main and the outside of the sewer. When a water main crosses under a sewer, or the soil is not solid enough, adequate structural support shall be provided for the sewer to prevent damage to the water main.

4.12 Trenching

All sewers shall be designed to prevent damage from superimposed loads. Proper allowance for loads on the sewer shall be made because of the width and depth of the trench. Where necessary to withstand extraordinary superimposed loading, special bedding, concrete cradle or special construction may be used.

Requirements shall be set forth in the specifications for the pipe and methods of bedding and backfilling thereof so as not to damage the pipe or its joints, impede cleaning operations and future tapping, nor create excessive side fill pressures or ovalition of the pipe, nor seriously impair flow capacity.

The width of trench shall be ample to allow the pipe to be laid and jointed properly and to allow the backfill to be placed and compacted as needed. The trench sides shall be kept as nearly vertical as possible. When wider trenches are dug, appropriate bedding class and pipe strenght shall be used.

Ledge rock, boulders, and large stones shall be removed to provide a minimum clearance of 10 cm. (4 inches) below and on each side of all pipe(s).

The minimum trench width or excavation for the installation of sewer pipe, shall be determined by the following formula:

Vitrified clay pipe : 10/7D + 0.23m
Concrete pipe 60" or less: 1.6D +0.15 m
or more: 1.25D + 0.69m
Plastic pipe : D + 0.67 m.

D = Size of pipe in inches.

Note: Minimum width for D.I. pipe is not shown since it it rarely use in sewer installations.

Minimum Trench Width

Diameter*	Plastic Pipe		Vitrified Clay Pipe		Reinforced Concrete Pipe	
	Meter	Inch	Meter	Inch	Meter	Inch
8	0.61	24	0.51	20	0.47	19
10	0.66	26	0.58	23	0.55	22
12	0.76	30	0.66	26	0.63	25
15			0.76	30	0.76	30
18			0.89	35	0.89	35
21			0.99	39	0.99	39
24			1.09	43	1.12	44
27			1.19	47	1.24	49
30			1.32	52	1.37	54
33			1.42	56	—	—
36			1.52	60	1.63	64
42					1.85	73
48					2.11	83
54					2.34	92
60					2.59	102
66					2.77	109
72					2.97	117
78					3.15	124
84					3.35	132
90					3.53	139
96					3.75	147
102					3.91	154
108						

*Diameter in inches.
The minimum trench widths tabulated above do not include fractions of inches as calculated by the foregoing formula.

4.13 Minimum Diameter

No gravity sewer conveying raw sewage shall be less than 8 inches in diameter.

4.14 Minimum Size for House Connection

The minimum size of the house connection shall be four (4) inches in diameter. In case concrete pipe is used, it shall be type 5.

4.15 Manholes

4.15.01 Manholes shall be installed at the start of each line, at all changes in pipe material, grade, size, aligment, at all intersections with other sewers. They should have a minimum depth of one meter over the top crown of the pipe, except on initial ramifications which will not be extended, that will be of 0.90 meter depth.

4.15.02 The distance between manholes will not be more than 85 meters for pipe 18" or less in diameter, nor larger than 100 meters for pipes 20" to 36" in diameter, nor larger than 150 meters for pipe over 36" in diameter. In some cases, previous approval by the Authority, these distances could be 10% greater, as when a manhole is on a green zone, and not on a sidewalk, street or road.

4.15.03 The manholes must be constructed of concrete and must be built according to the design shown on the typical plans adopted by the Authority (Fig. No. 37 to 41D). The concrete must be class B with a compressive strength of 2500 pounds per square inch, at 28 days after casting and should be built according to the specifications adopted by the Authority. The walls shall have a minimum thickness of 0.20 meters (8 inches). The foundation shall consist of a 0.20 meter thick slab for the bottom, cast monolithically with the walls to prevent infiltration. On this slab the transition channel must be built shaped as an "U" with semicircular bottom and sides high enough to prevent the spilling of water in the bottom by elevating them to the crest or upper part of the pipes. The floor shall have a slope to the channels of 15%.

The installation of prefabricated manholes will be permitted by previous consultation and approval by the Authority and built as indicated in section 4.17.

4.15.04. Manholes on sewers up to 15" diameter will have an interior diameter of 1.20 meters, of 16" to 27" diameters of 1.50 meters and in sewers of 30" diameter or larger, will be square or of irregular shape with the same interior width as the diameter of the piping plus 1.00 meter and the walls will be made of concrete.
Square manholes should have a circular hoop of 1.20 meters interior diameter, when the depth of the manhole is greater than 2 meters over the crown of the piping. For details of manholes for sewers of 30" diameter or larger, the Authority must be consulted.

4.15.05. The transition channel shall not be horizontal. It should have at least the slope of the piping.

4.15.06. When the manhole is located out of roads or streets, the top must be 30 cm(12 inches) above natural ground elevation, except in cases where for ornamental or other reasons, its height could be reduced to a minimum of two inches if previously approved by the Authority.

4.15.07. The manholes frame and cover will be made of cast iron with only one hole for ventilation. It will be adapted to the typical detail illustrated on Fig. No. 36 and specifications of the Authority. The covers will be adjusted to the frames to prevent noise and movement when light or heavy vehicles pass over it.

4.15.08. The Authority will not permit the construction of manholes in private land or lots. When there is no alternative, the manhole cover shall be bolted and sealed.

4.16 Drop Manholes

4.16.01. Drop manholes will be built when the use of standard manholes is precluded due to the difference in elevations between the inlet and outlet pipes of the manhole.

4.16.02 The piping will discharge to the crown of the pipe, with a drop pipe which will be connected to the manhole with a "Y" according to detail drawing (Fig. No. 40).
When the difference in level between the bottom of the manhole and the invert of the inlet piping is greater than 1.0 meter and when the sewer is larger than 12 inches in diameter, the drop pipe will be installed in a vertical position as detail drawing (Fig. No. 41). In special cases of connections to existing excessive deep manholes, the drop pipe connection inside the manhole may be permitted as indicated in Fig. No. 39.

4.17 Prefabricated Inspection Manholes

4.17.01 The Authority may authorize the use of prefabricated concrete manholes in lieu of those cast on site provided the contractor shall be responsible for verifying and measuring their elevation in accordance with the plans and/or ground final grade and that he will make all the necessary adjustments call for during or as a result of the project construction.

4.17.02 Every prefabricated manhole shall comply with the following additional conditions and/or requirements and will be accepted whe.. after its installation the hydrostatic and/or infiltration and/or exfiltration tests are performed as required, and the results are accepted by the Authority.

a) The construction of the sections and/or pre-fabricated manholes shall comply strictly with requirements of specifications ASTM C-478 (last revision) as modified, amended and/or suplemented by the following:

1- All welding shall comply with the welding code of the "American AWS D-1.1 and AWS D12.1"

2- All joints shall be provided with a prefabricated seal made of plastic or synthetic material resistant to chemical action and deterioration, which guarantee the hydraulic seal of the joint and comply with the

requirements of federal specification ss-s-210A (1). Sealing Compounds, Preformed Plastic for Expansion Joints and Pipe joints.

3. The specimens for the absorption test shall not be less than a core from a prefabricated section for each 20 or fraction of prefabricated sections cast daily.

4. The specimens for the compression test shall be not less than a set of three cylinders or cores representative of 20 or fraction of prefabricated sections casted each day. The specimens shall be cured in the same manner as the sections and tested 28 days after casting.

5. The inspector shall require that the manufacturer test the design and construction of the joints by hydrostatic means and performs infiltration and exfiltration tests as frequently as is deemed necessary to guarantee that the joint complies with the specification, but never to exceed six months intervals.

6. The ladder rungs shall be as approved by the Authority and according to OSHA requirements and set in place when casting the sections or by mechanical installation which guarantee each and all of the established requirements.

7. Sections may be repaired, if necessary, using pre-mixed material, manufactured for that purpose.

8. The manufacturer may mark or destroy rejected sections. The mark shall be "REJECTED BY AAA" in letters not less than 8" high at four longitudinal areas and spaced the same as the exterior perimeter, with bright red waterproof paint. Otherwise the exterior of the section will be totally painted.

9. Any section may be rejected if it fails to comply with the specifications and/or modifications previously described, or for the following:

   a- Fractures and/or cracks that crosses the wall of the section

   b- Defects that indicate imperfect proportioning and mixing or casting of the concrete.

c. Superficial defects indicative of empty or shallow spots, porous texture and others.

d. Damaged and/or rejected joints, that might prevent perfect joints that may cause infiltrations.

e. Any continous crack that measures on the surface more than 0.25 mm (0.01 inch) wide and/or in excess of 305mm (12 inches) long.

f. Any group of non continous cracks o.25mm (0.01 inch) wide or more and that their added length exceed 610mm (24 inches).

10. Every Manufacturer should own an up-dated Quality Control Manual that includes every thing concerning the prefabricated section, which shall be accessible at all times to the Authority inspectors.

11. Minimum interior diameter shall be 1.22 meters (48 inches), the wall and bottom minimum thickness shall be 15 cm. (6 inches) and the top slab shall not be less than 20cm. (8 inches) thick. The least possible number of joints shall be provided.

12. The orifices for connecting the pipes to the sections, shall be provided by the manufacturer and made at the plant when casting. The maximum diameter of the orifice shall not exceed the required pipe exterior diameter plus 15cm. (6 inches). No orifice shall be permitted in the base section and in case of making orifices for interconnections (drops, interceptors, etc.) at the project site, the joints shall be designed according to manufacturer's recommendations and which guarantee a positive seal and watertight, using a mortar, premixed and manufactured for this purpose and applied on both the interior and exterior.

13. Prefabricated manholes shall be installed on firm ground providing a 95% compaction and subject to the approval of the Authority.

14. Prefabricated base sections may be supplied with precast invert channels or the invert may be cast in the field using concrete Class B of 2500 lbs. minimum compressive strength and cement mortar.

15. All prefabricated manhole shall be subject to filtration tests, which shall be done by sealing the inlet and the outlet and filling the manhole with water. After a period of no less than an hour, the original water level shall be restored and the loss in an hour in the manhole calculated and expressed in gallons. A loss not exceeding, 0.68 gal./day/ft/ft. is acceptable.

16. Manholes exceeding a depth of 6.10 meters (20 feet) shall be provided with safety devices according to OSHA such as Safety Cages, Intermediate Platform, and/or Saf-T-Climbs Fall Prevention Systems.

17. Prefabricated manholes shall be designed to prevent floating and capable of resisting seismic force according to P.R. Commonwealth Building Regulations, vehicles live loads (including braking), and other loads, lateral pressures, and ground subsurface water level.

18. Prefabricated manholes installed in crosscountry shall have a top elevation of 30 cm. (12 inches) higher than ground elevation. In every case where part of the top section is above ground, adequate joint shall be provided to resist impact.

4.17.03 The Authority may require the use of paints and/or coatings on those prefabricated manholes, which due to the design, will be subject to the action of hydrogen sulphide and/or subject to high turbulence, such as drop manholes, and, as so, shall be shown in the drawings and specifications.

It shall also be required for exterior surfaces of prefabricated manholes which shall be affected by ground conditions such as excessive alkalinity, sulphate action and others.

1- Paintings

Prefabricated manhole surfaces, exterior, interior or both, shall be painted as indicated on the plans and specifications or as required by the specific conditions of the project and in a manner approved by the Authority, which shall consist basically of a Coal Tar Epoxy corrosion resistance coating with a final 20 thousandths of an inch dry

thickness and shall comply with the following:

a- Paint shall be applied in strict accordance with the techinical especifications prepared and recommended by the manufacturer.

b- Paint shall be applied on all surfaces including any joint which meets any surface to be painted.

c- The method of application shall consist basically of the following

1- Surface preparation

2- Primer application if required

3- Apply two or more coats of Coal Tar Epoxy to obtain a minimum dry thickness of 20 thousandths of an inch. Deficiencies in thickness shall be corrected by the application of additional coat or coats.

4- Allow the coating to dry before placing in service the prefabricated manhole.

d- Instruments for measuring the moisture content of the concrete, before applying the paint, shall be provided if required by the manufacturer or if a maximum moisture content is specified.

e- The paint application shall be inspected by electrical means to detect any imperfections or defects, the paint coat thickness shall be checked in accordance with specifications and the paint adhesion to concrete shall be verified.

f- The installation may be defective or rejectable if the inspection detects any openings, blisters, sags, wrinkles, inclusions, and/or any other damage or defects in the painting.

g- Every joint and concrete cast in site shall be painted or sealed with material provided or recommended by the manufacturer.

2. Prefabricated Lining

All exterior, interior or both surfaces as indicated on the plans and specifications or as required by the specific conditions of the project shall receive a prefabricated lining approved by the Authority, which shall consist basically of a plastic or synthetic material resistant to chemical action durable, and not less than 65 thousandth of an inch thick and designed so as to provided an integral bond with the concrete at the time of casting.

a- The lining shall be applied in strict accordance with the manufacturer specification and written recommendation.

b- Prefabricated joints shall be provided according to manufacturer specifications.

c- Every joint or concrete cast in place shall receive the treatment recommended by the manufacturer or shall be provided with the painting system describeu in part 1 of this section.

d- Any lining showing wear or abrasion, cracks or any other damage or defects shall be rejected. It may be repaired if accomplished in strict accordance with manufacturer's instructions.

4.18 Inverted Siphons

4.18.01 Inverted siphons are generally constructed to clear or overcome obstacles that might be met in the piping alignment, such as rivers, creeks, ground depressions, crossing underground structures.

4.18.02 The inverted siphons shall be design by the Hazen-Williams formula with coefficient of C-100.

4.18.03 It is advisable to use several barrels, arranged in parallel alignment, so that each one is used according to the flow, maintaining adequate velocity.

4.18.04 Inverted siphons shall be constructed of cast iron pipe; protected by concrete encasement.

(See Fig. No. 40). Minimum pipe diameter permitted shall be 8 inches. When crossing rivers or creeks, the minimum difference in elevation between the top of the sewer line and the water bed shall be 1.83 meters (6 feet).

4.19 House Connections

4.19.01 For every house or building sewer service a house connection shall be provided. (See Fig. No. 33)

4.19.02 House connections shall be made, by installing a "Y" fitting in the sewer as indicated in detail drawing adopted by the Authority. (See Fig. No. 31 to 33). The house connection will extend from the "Y" piece to the property line front of the lot.

4.19.03 The size of the house connection for housing units up to five (5) families groups shall be 4inches in diameters. For buildings with a larger number of living units or other type of buildings shall be made according to tables for discharge and pipe sizes for drainage enclosed in regulations of the Planning Board and the Regulation and Permits Agency.

4.19.04 The piping and joints for house connections shall be made of cast iron, concrete or PVC (SDR-35) and according to specifications ASTM standards latest revisions.

4.19.05 Joints for cast iron pipe will be made with rubber gaskets according to prevailing regulations.

4.19.06 A cleanout manhole will be provided at the end of the piping inside of the lot as close to the property line as possible, according to the Authority's requirements. See standard detail Fig. No. 33 and 34

4.19.07 House connections to sanitary mains that are 3.05 meters (10 feet) under ground level will not be permitted. An auxiliary parallel line will be installed to connect the house connections and the existing line will remain as a main sanitary line.

4.20 Other Dispositions

4.20.01 The discharge of piping into another of smaller diameter will not be permitted regardless of its capacity.

4.20.02 The connections of the lateral sewers and subcollectors to the main line, will be made so that the invert of the lateral sewers be at the level of the top interior part of the subcollectors.

4.20.03 The sewers will connect to other lateral or subcollector so that the invert of the lateral will be level with the axis of the lateral or subcollector.

4.20.04 In installations under the water table level, vitrified clay, cast iron, or ductile iron pipe with rubber gasket joints or concrete pipe with rubber gasket and steel joints, or plastic pipe shall be used.

4.20.05 In installations crossing rivers or creeks the minimum protection between the exterior pipe top and river bed shall be 1.83 meters (6 feet). Concrete pipe shall meet the requirements of specifications ASTM C-14, C-76 and AWWA C-301 and C-302 latest revision.

CHAPTER V

SEWAGE PUMPING STATIONS

This norm is not limited to just the unfortunate and great problem that faces the Engineers today like "How to select and apply the best pump for known conditions" but also contains norms regarding pumps housing, equipment, sanitary and safety conditions. It also includes the right of the Authority to accept any equipment.

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CHAPTER V

SEWAGE PUMPING STATION

5.01 Pump Houses

Pump houses shall be built of reinforced concrete, of adequate size to accomodate the equipment to be installed. For all types of pumping stations a plan shall be submitted for approval of the Authority.

5.02 Sewage Pumping Stations

Pumping stations that do not discharge into sewage treatment plants, shall be provided with at least three (3) units of the same capacity. Each shall be capable of handling flows of 2.5 times the expected average daily flow. A system which will alternate the operation of each pump shall be provided. The speed of the pump will not exceed 1750 R.P.M. Pumps of the submergible type will be acceptable. See Section 5.02.25 for requirements.

5.02.01 The pumping station shall be provided with the following:

1- A screened chamber, with clear openings not exceeding 3.81 cm. (1 1/2 inches).

2- Electric comminutor or mechanical screen with grinder, including bypass with bar screen.

5.02.02 The effective capacity of the suction pot should be 4 minutes minimum at maximum flow, and not greater than 15 minutes at average flow. (See Fig. 52)

5.02.03 An electric power generator activated by an automatic start Diesel engine, will be provided for the pumping stations. Generating unit size shall be adequate to provide power to operate the comminutor, pumps motor starting currents, controls, at maximum flow, and for lighting, ventilation and other auxiliary equipment necessary for safety and

proper operation of the station.

A Deisel storage tank (See Fig. 3) shall be installed with a capacity of no less than 379 liters (100 gallons), enough to keep the equipment operating 24 consecutive hours with the necessary equipment to measure the fuel in the tank. The construction of the tank shall be in accordance with all Safety Standards in effect. It shall be installed at the adequate level to prevent dumping the fuel by gravity into the generator.

5.02.04 Adequate ventilation shall be provided to all pumping stations suction pits and basements by mechanical ventilators made of aluminum. Ventilation may be either continous or intermittent. Ventilation in the suction pits, if continuous, shall provide at least 12 complete air changes per hour, or if intermittent, at least 30 complete air changes per hour. Mechanical ventilators provided in the basement of the pumping stations, if operated continuously, shall provide at least 6 complete air changes per hour, and if intermittent, at least 30 complete air changes. Ventilator motors shall be located in such place as to not be in the air path.

5.02.05 The sequence of the pump's operation will be controlled by an automatic system using water level sensors, of the air bubbler type, or sealed electrodes. Also adequate equipment for level measuring shall be installed.

5.02.06 Spiral stairways with rails or hand rails may be used for access to the basements. They will not be over 4.57 meters (15 feet) high. The design shall be in accordance with the model adopted by the Authority. (See Fig. No. 46). Pitched ladders may be used with no height limit.

5.02.07 To facilitate the removing of pumps, ajustable connections shall be provided at the suction and discharge ends of the pumps.

5.02.08 Wall sleeves shall be provided when piping crosses the wall of a tank or suction pit to prevent leaks.

5.02.09 One or more intermediate platforms shall be provided for inspection and maintenance of the pumps' flexible shaft.

5.02.10 Copper piping shall be installed to drain stuffing box drippings, discharging directly to the sump pit.

5.02.11 Sufficient lighting shall be provided equivalent to forty (40) footcandles at a 1.50 meters (5 ft.) level from both floors.
These lights shall be controlled by switches located on the interior housing wall, close to the entrance door; and duplex receptacles, one on the top floor and another on the lower floor. All electrical installations will be to a main panel and in accordance with electric codes in effect.

5.02.12 When pumping pipes discharge into a sewer manhole it should not be less than 1.20 meters deep and have the connection as parallel as possible to the direction of the flow.

5.02.13 Pumping stations shall be located at a distance not less than 15 meters from the nearest existing or projected structure. The pumping station lot shall be paved.

5.02.14 A 3/4 inch diameter water connection with meter box shall be provided, followed by a reduced pressure type back flow preventer of equal diameter as indicated in the project plans. There shall be no physical connection between any potable water supply and a sewage pumping station which under any conditions might cause contamination of the potable water supply.

5.02.15 Pumping stations with a capacity of 1 MGD, or more, a restroom shall be provided, with toilet, lavatory, and shower.

5.02.16 A Motor Control Center shall be provided for pumping stations with motors larger than 40 H.P., with main switch, amperimeter, voltimeter,

non-reverse phase relay, pump alternator for the main pumps, as well as for seal pumps, individual switches with magnetic starters for the pumps and switches for the lighting and ventilation systems. At sewage treatment plants where there is a pumping station, said center shall be provided.

5.02.17 All electric installations shall be made with adequate size conduits and shall be shown on the final drawings. Every electric installation work shall comply with the National Electrical Code requirements and the regulations of the Puerto Rico Electric Power Authority, latest revision. The electric plans shall be submitted by the designer to the Electric Power Authority for approval before submitting then for the consideration of the Aqueduct and Sewer Authority.

5.02.18 Lighting circuits shall be color coded to facilitate its identification and maintenance.

5.02.19 In pumping stations of 2,270 liters (600 gallons), or more, per minute, Duplex clean water pump system for stuffing box seals, shall be provided, with a water tank with a capacity of not less than 190 liters (50 gallons), with an automatic float valve to maintain the water level in the tank. Said pumps will operate one at a time, with solenoid valves in the main units, which shall be activated by the control system according to the demand. For pumps of less than 2270 liters (600 gallons) per minute, an Automatic Oiler Grease Sealer shall be provided operated by water pressure from the pump or any other source, with its own solenoid valve for automatic operation or a mechánical automatic oil or grease sealer. The Authority shall determined the type of seal to be used in each case. An overflow valve shall be provided to recirculate the excess water pumped to the seals.

5.02.20 An electric control system shall be provided for low water level in the seal pump's tank to prevent them from operating when the tank is dry. Also, a relief valve shall be installed in the main discharge. The solenoid valves shall be installed on the upper floor or on other accessible location. A mercury switch shall be installed to assure the proper water flow and pressure to provide lubrication and cooling of the seal prior to starting the pumps.

5.02.21 In order to meet E.P.A. requirements, an automatic system shall be installed to convey signals to the nearest control center that is manned 24 hours. The alarm shall be activated in cases of power failure, pump failure, unauthorized entry or any cause of pump station malfunction.

5.02.22 The minimum size of solids shall be 6.4 centimeters (2 1/2 inches). In pumping stations that do not discharge into a sewage treatment plant, comminutors will not be required when the pumps are able to pass solids over 10 cm. (4 inches).

5.02.23 In cases where the sewage treatment plants require a bar rack or communitor, recess impeller may be used, as long as their horse power does not exceed 50 per cent of that needed for an open impeller. In all cases, pump curves shall be required including NPSH.

5.02.24 The velocity in the suction piping will not exceed 1.5 meters (5 feet) per second.

5.02.25 Submersible Pumps

1. Pumps shall be capable of passing spheres of at least 7.6 cm. (3 inches) in diameter and their minimum efficiency shall not be less than 50%

2. Pump removal - Submersible pumps shall be readily removable and replaceable without dewatering the wet well, disconnecting any piping in the wet well or stopping the operation of other units.

3. Operation - Submersible pumps should be capable of operating without being completely submerged, with no damage or reduction in service capacity, otherwise mechanisms shall be provided to assure pumps submersion.

4. Controls - The motor control center shall be located outside the wet well and be protected from wet well atmosphere, humidity and vandalism and meeting requirements of the National Electrical Code and the Electric Energy Authority.

5. Valves - Valves required for the control of the discharge line shall be located in a separate pit, installed horizontally and well protected from weather and vandalism.

6. Electric Equipment - Installation of a lightning arrester is required to provide protection to the equipment.

5.02.26 The Authority reserves the right to accept or reject any equipment which do not conforms to these Norms.

5.03 Instructions and Equipment

Sewage pumping stations and their operators should be supplied with a complete set of operational instructions, including emergency procedures, maintenance schedules, special tools, and such spare parts as may be necessary.

5.04 Force Mains

At design average flow a velocity of at least 0.61 meters (2 feet) per second shall be maintained. An automatic air relief valve shall be installed at high points in the force main to prevent air locking. Force mains should enter the gravity sewer system at a point not more than 60 cm. (2 feet) above the flow line of the receiving manhole.

The force main and accessories, including thrust blocks shall be designed to withstand normal pressure and pressure surges (water hammer). Friction losses through force mains shall be based on the Hazen and Williams formula, using a value of "C" of 100 for iron or steel pipe and "C" of 120 for P.V.C. pipe.

Sanitary sewer force mains and water mains shall be installed mantaining a horizontal separation between them of at least 3 meters (10 feet) and a vertical separation of not less than 46 cm. (18 inches) between the outside of the force main and the outside of the water line. (See Fig. No. 43).

CHAPTER VI

WASTEWATER TREATMENT PLANT

The Sanitary Engineering field is going through a period of dynamic development. Old ideas are being re-evaluated and new concepts are being formulated. To take active part in the development of this field, the Engineer must understand thoroughly its fundamentals. Therefore the purpose of these norms is to delineate the principal involved in the treatment of wastewater and guide the designer with them.

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CHAPTER VI

WASTEWATER TREATMENT PLANT

6.01 Before the approval of project plans, the builder or any authorized person must obtain in writing from the Planning Board, Environmental Quality Board, Regulations and Permits Administration, and the Puerto Rico Aqueducts and Sewer Authority the approval for the proposed site. As well as the endorsement from the Department of Natural Resources and the United States Army Corps of Engineers for the discharge of the effluent to the selected receiving body of water.

6.02 Plant Location

6.02.01 Requirements

1. The plant must be located as far as possible from present or future developmented areas and not less than fifty (50 mts) distance from housing unit, or any other construction where people meet. This distance shall be measured from the construction to the nearest plant structure or treatment unit.

2. Take into consideration the direction of the prevailing winds.

3. It shall be located at an elevation above flood level, or otherwise be adequately protected against flood damage.

4. Easily accesible by all-weather roads.

5. Plot should be large enough to allow expansion and addition of future facilities.

6. Local soil characteristics, geology, hydrology, and topography available to minimize pumping.

7. Access to receiving body of water.

8. Treatment process compatibility with the present and planned future land use, including noise, potential odors, air quality, and anticipated technics for the sludge processing and disposal.

6.03 Quality of Effluent

The degree of wastewater treatment required shall be based on

the effluent requirements and water quality standards stablished by the Environmental Quality Board, the Health Department, and the Environmental Protection Agency.

6.04 Design

6.04.01 Type of Treatment

In the selection of the type of treatment, as a minimum, the following items shall be considered;

1. Present and future effluent requirements;
2. Location of and local topography of plant site;
3. Space available for future plant constructions;
4. The effects or industrial wastes that might be encountered;
5. Sludge ultimate disposal;
6. Capital cost of the system;
7. System operating and maintenance cost, including basic energy requirements;
8. Process complexity governing operating personnel requirements and;
9. Environmental impact on present and future land use.

6.04.02 New Processes, Methods and Equipment

The Authority will consider the use of new processes, methods, or equipment for the treatment of wastewaters under the condition that the operational reliability and effectiveness of the processes or device shall have been demostrated with a suitably-sized prototype existing installation operating at its design load conditions. The Authority may approve its use on an experimental basis.

6.04.03 Industrial Wastes

If industrial wastes are involved, their nature should be taken into consideration when designing

the plant. Contaminant wastes must be pretreated at the site of the industry before discharging to the sewer system.

6.04.04 Flow

The design flow for the plant should be determined by the contribution as stipulated on Section 3.02 adding the industrial flow involved.

6.04.05 Design Load for Existing Systems

1. Field Information.

2. Sewage Flow and Concentration. When there is an existing system, the volume and strenght of existing flows shall be determined for both dry-weather and wet-weather. Flow will be measured and the strength shall be determined by laboratory analysis of samples taken and composited, so as to be accurately representative, for a period of 24 hours.

6.04.06 Hydraulic Load

The design of the treatment units must be based on the average future flow rate except on special cases. Industrial flows will be determined by its rate during critical periods.

6.04.07 Volume of Maximum and Minimum Flow

Prolonged maximum and minimum flows can affect adversely the retention period of the units or the flow characteristics in the pipes, so it should be taken into consideration in the design. The percentages to be considered for flow variations will be as follows:

Less than 5678 m^3/day (1.5 MGD):

Minimum Flow = 30% Average Flow
Maximum Flow = 250% Average Flow

More than 5678 m^3/day (1.5 MGD):

Minimum Flow =50% Average Flow
Maximum Flow =200% Average Flow

6.04.08 Design Load for New Systems

In the case of new systems, information and data from similar communities in the area may be used; however, a thorough previous investigation that is adequately documented should be made to establish the reliability and applicability of such data. If not possible a BOD loading of 300 mg/l and suspended solids load of 325 mg/l will be used.

6.04.09 Flows During Raining Periods

This should be taken into consideration especially if they are frequent, when determining the volume of flow, an infiltration/inflow study shall be made if required by the Authority.

6.04.10 Recirculation

Recirculation should be given consideration in accordance with the type of process selected.

6.04.11 Organic Load

It should be determined in the same way as the design flow and include the following consideration:

1. Receiver sources should be able to assimilate the waste when the treatment units receive the organic loads during a period shorter than 24 hours.

2. Impact due to large contributions in short periods of time during the treatment process.

6.04.12 Conduits

All piping and channels must be designed to carry the maximum flow expected. Piping for incoming sewer should be designed for unrestricted flow. Bottom of channesl must be filleted. Conduits must be designed to avoid creation of pockets and corners where solids can accumulate. Suitable gates should be placed in channels to seal off unused sections which might accumulate solids.
The use of shear gates or stop planks is permitted where they can be used instead of gate valves or sluice gates.

Non-corrodible materials shall be used for these control gates.

6.04.13 Arrangement of Units

Units should be arranged for greatest operating and maintenance convenience, flexibility, economy, continuity of maximum effluent quality, and ease of future units installation.

6.05 The wastewater treatment facilities shall be able to operate satisfactorily during emergencies and maintenance periods. This shall be accomplished by including in its design the installation of multiple equipment and units. All treatment plants with flow design of 378.5 m^3/d (100,000 GPD) or greater shall be so equiped.

6.06 Treatment Plant Details

6.06.01 Installation of Mechanical Equipment

The specifications should be so written that the installation and initial operation of major items of mechanical equipment will be supervised by representatives of the manufacturer and the Authority.

6.06.02 Units By-pass

Except in cases where duplex units exists, properly located and arranged by-pass structures and piping shall be provided so that each unit of the plant can be removed from service independently. The design of the by-pass shall be such that facilitates plant operation during unit emergency repair and maintenance so as to minimize deterioration of effluent quality and insure rapid process recovery upon return to normal operational mode. By-passes permitting discharge of unprocessed wastewater into the receiving body shall not be permitted.

6.06.03 Drains

Each unit shall be provided with means to dewater it to an appropriate point in the process. Due consideration shall be given to the possible need

6.06.07. Grading and Landscaping

The ground should be graded upon completion of the plant. Concrete or gravel walkways should be provided for access to all units. Concrete road for heavy vehicles access to all units must be provided. Steep slopes, where possible, should be avoided to prevent erosion. No suface water shall be permitted to drain into any unit. Particular care shall be taken to protect trickling filter and sludge beds from stormwater runoff. Provision should be made for landscaping, specially when a plant must be located near residential areas.

6.07 Plant Outfall

6.07.01. Flow Dispersion

Consideration should be given in each case to the dispersion of the outfall flow in the receiving water body, as needed to protect aquatic life movement and growth.

6.07.02. Outfall Pipe

The outfall pipe line should, when possible, be extended up to the minimum water level of the receiving water to assure the right disposal of the waste. The outfall extreme must be submerged. Headwalls can be used when adequate diffusion is obtained without the extension of the discharge pipe into the receiving water.

6.07.03. Design and Construction

The outfall pipe shall be so constructed as to be protected against the effects of floodwater, tide, or other hazards. At the shore end of all gravity sewers extended into the receiving waters, a manhole should be provided. When designing a submarine outfall, all permits required should be obtained from the appropriate agencies, such as E.P.A., E.Q.B., N.R.D., C.of E., and P.B.

6.08 Essential Facilities

6.08.01. Emergency Power Facilities

An automatic start electrical power generator run by a Diesel engine, will be provided to allow continuity of operation of the basic treatment units, the pumping station, and the lighting system, during power failures. For more information see Art. 5.02.03.

6.08.02. Water Supply

An adequate supply of potable water under pressure should be provided for used in all the plant areas. No piping or any connections shall exist in any part of the tratment works which, under any conditions, might cause the contamination of a potable water supply. A back-flow preventer must be provided for the protection of the potable water system. (See Fig. No. 19). Potable water from the public supply system may be used directly at the following points:

a. Lavatory;
b. Water closet;
c. Laboratory sink;
d. Shower;
e. Drinking fountain;
f. Eye wash fountain; and
g. Safety shower.

6.08.03. Check Valves

Check valves must be used in all faucets and hose bibs.

6.08.04. Indirect Connections

When a potable water supply is to be use for any purpose other than those mention in Art. 6.08.02, a break tank, pressure pump, and pressure tank shall be provided. Water shall be discharged to the break tank through an air gap at least 15.2 cm. (6 inches) above the maximún flood line or the spill line of the tank, whichever is higher. A warning sign shall be permanently posted at every faucet, hose bib, hydrant located on the water system beyond the break

tank indicating that the water is not safe for drinking.

6.08.05. Separate Potable Water Supply

If it is not possible to obtain potable water from a public water supply, a separate well may be provided. Its location and construction must comply with the requirements of the Department of Health and the Enviromental Quality Board.

6.08.06. Separarate Non-Potable Water Supply

Where a separate non-potable water supply is to be provided, a break tank is not necessary, but all outlets shall be posted with a permanent sign indicating the water is not safe for drinking.

6.09 Sanitary Facilities

Lavatory, toilet, and shower facilities should be provided.

6.10 Laboratory

Every plant must be provided with a laboratory equiped as specified and accepted by the Authority and the Enviromental Quality Board to make the necessary analysis and tests required. Refer to Section 6.60 of this chapter.

6.11 Flow Measurement

Facilities to measure and register automatically the sewage flow at the inlet and outlet points of the plant, must be provided.

6.12 Floor Slope

Floor surfaces shall be sloped adequately to a point of drainage.

6.13 Stairs

Refer to Art. 5.02.06, (Pumping Stations), 8.01.02, 8.01.10 (Safety Regulations).

6.14 Screening, Grit Removal, and Settling

a. Screening Devices
b. Bar Racks

6.14.01. When Required

Protection for pumps and other equipment must be provide by installing bar screens or bar racks, (4.45 to 6.35 cm.) (1 3/4" to 2. 1.2"). These racks should be readily accessible for operation and maintenance. At least two units must be provided.

6.14.02. Location

1. Screening areas shall be provided with stairway access, adequate lighting and ventilation, and a convenient and adequate means for removing the screenings.

2. Screening devices should be accessible only through a separate outside entrance, when installed in a building where other equipment or offices are located.

6.14.03. Design and Installation

1. Bar spacing

a- Manually Cleaned - Clear openings between bars should not be less than 2.54 cm. (1 inch)

b- Mechanical Cleaned - Clear openings may be as small as 1.59cm. (5/8 inch)

c. Maximum clear openings should be 4.44 cm. (1 3/4 inches)

6.14.04. Slope

Except those for emergency use, manually cleaned screens should be placed on a 30 to 45 degrees slope from the horizontal.

6.14.05. Velocities

For manually and mechanical raked bar screens, the

chamber should be designed to mantain a velocity through the chamber of approximately 46 cm./sec. (1.5ft./seg.) at average flow. For average flow the velocity should not exced 61 cm./seg. (2 ft/sec. and for maximum flow shall not exceed 91 cm./sec. (3 ft/seg.)

6.14.06 Channels

The channels preceding and following the screen shall be shaped to avoid settling and stranding of solids. Corners should be rounded to prevent accumulation of solids.

6.14.07 Inverts

The invert of the screen channel should be a minimum of 15.2 cm. (6 inches) below the invert of the incoming sewer to provide space for the accumulation of retained material. A 15.2 cm. (6 inches) minimum additional space should be considered to compensate for head losses through the screen. In all cases, the head losses should be calculated.

6.14.08 Control System

1- Timing Divices

All mechanical units which are operated by timing devices shall be provided with auxiliary controls which will set in operation the cleaning mechanism at a preset high water elevation.

2- Electrical Fixtures and Controls

Electrical fixtures and controls located in screening areas where hazardous gases may accumulate shall meet the requirements of the "National Board of Fire Underwrites; the Electric Power Authority, and OSHA.

6.15 Disposal of Screenings

Facilities must be provided for removal, handling, storage, and disposal of screenings in a sanitary manner. Separate grinding of screenings and return to the sewage flow is unacceptable.

An accessible platform from which the operator may rake screenings easily and safety should be included in manually cleaned screening facilities. Suitable drainage facilities shall be provided for both the platform and the storage areas. Consideration should be given to the disposal of screenings by burying or by incinaration. Disposal in open areas is prohibited.

6.16 Channels

Channels shall be equipped with the necessary gates to divert flow from any screening unit. Provision for dewatering each unit must be made.

6.17 Auxiliary Screens

When mechanical cleaned screen or comminutors are used, an auxiliary manually cleaned screen shall be provided. The design should include provisions to deviate sewage flow (peak design flow) through the auxiliary screens, when the regular units fail.

6.18 Fine Screens

The use of fine screens in lieu of sedimentation is not permitted. Fine screens should not be considered equivalent to primary sedimentation. Where fine screens are used, additional provision for the removal of floatable oils and greases shall be considered.

6.19 Grit Removal Facilities

6.19.01 When Required

For all sewage treatment plants, mechanical grit removal facilities should be provided and are required for plants receiving subtancial amount of grit from sewer systems. In plants with a capacity of less than 1.9 MLD (0.5 MGD) the Authority may, depending on the conditions, approve the use of manual grit removal. The design shall include provision for future installation.

6.19.02 Location

Grit removal facilities, except under special

conditions, should be located ahead of pumps and comminuting devices and should be preceded by coarse bar racks.

6.19.03. Type and Number of Units.

Grit removal facilities for sewer treatment plants should have at least two (2) mechanical cleaned units. In plants of less than 1.9 MLD (0.5 MGD) and where the Authority so permits, the use of one mechanically cleaned unit and one manually cleaned unit may be provided, depending on each case. Facilities other than channel-type may be acceptable if provided with adequate and flexible controls for agitation and/or air supply devices and with grit collection and removal equipment.

6.19.04. Design Factors

The design effectiveness of a grit removal system shall be commensurate with the requirements of the subsequent process units.

a- Inlet - The turbulance at the inlet should be minimized.

b- Velocity and Detention - Channel type chambers shall be designed to control velocities, as close as possible to 30 cm./s (1foot/sec.), during normal variations in flow. The size of the particles to be removed shall be the base for determining the detention time. Adequate automatic control devices to regulate detention time, agitation, and air supply shall be provided for all grit removal facilities.

c- Grit Washing - The method of final grit disposal shall determining the need for grit washing.

d- Drains and Isolation - Provision shall be made for isolating and dewatering each unit.

e- Water - An adequate supply of water under pressure shall be provided for cleanup.

6.19.05 Grit Removal

Facilities for grit removal, located in deep pits shall be provided with mechanical equipment for hoisting or transporting grit to ground level.

6.19.06 Grit Handling

Impervious, non-slip, working sufaces with adequate drainage shall be provided for grit handling areas. Grit transporting facilities shall be provided with protection against loss of material.

6.20 Flocculation

Flocculation of the sewage by air or chemical agitation with or without coagulating agents, shall be considered if reduction of the strength prior to the treatment is desired. For this purpose a minimum of two (2) units shall be used.

6.20.01 Arrangement

The units should be design so that removal from service will not interfere with the normal operation of the rest of the plant.

6.20.02 Retention Period

Coagulation - If air or mechanical agitation is used in conjuntion with chemicals for coagulation or flocculating the sewage, the retention period should be about thirty (30) minutes at the design flow. When reduction in B.O.D. is desired, the detention period should be at least forty five (45) minutes at the design flow. However, if polymers are used, this may be varied.

6.20.03 Agitators

a. Paddles - The peripheral speed of the paddles should range from 46 to 76 cm./sec. (1 1/2 to 2 1/2 ft./sec.) to prevent deposition of solids.

b. Aerators - Any of the type of equipment used for aerating activated sludge may be used. Provision to control agitation; should be included in order to obtain good mixing and maintain self cleaning velocities across the tank bottom.

6.20.04 Details

The design shall include adequate inlet and outlet devices to insure proper distribution and prevent short-circuiting. Convenient means for grit removal, should be provided.

6.20.05 Rapid Mix

At plants designed with flocculation tanks using chemicals, a device shall be provided for rapid mixing of the chemicals with the sewage so that the sewage passing to the flocculator tanks will be of uniform composiiton. The detention period provided in the rapid-mix chamber should be short, 1/2 to 3 minutes.

6.21 Settling Tanks

6.21.01 Inlets

Inlets should be designed to dissipate the inlet velocity, to distribute the flow equally both horizontally and vertically, and to prevent short-circuiting. Channels should be designed to maintain a velocity of at least 30 cm./sec. (1 ft./sec.) at one-half of the design flow. Corner pockets and dead ends should be eliminated and corners fillets or channeling used where necessary. Provisions shall be made for elimination or removal of floating material in the inlet structure.

6.21.02 Dimensions

Unless special provisions are made to prevent short circuiting, the minimum length of flow inlet to outlet should be 3 meters (10 feet). The liquid depth of mechanically cleanded settling tanks shall be as shallow as practicable, but not less than 2.1 meters (7 feet). Final clarifiers following the activated sludge process shall have depths of at least 2.44 meters (8 ft.).

6.21.03 Scum Removal

Effective scum collection and removal, including baffling, shall be provided ahead of the outlet weir on all settling tanks and shall be located so

that the direction of the prevailing winds aids in the removal of the scum. Provisions may be made for discharge and treatment of scum with the sludge. However, other provisions, such as incineration, may be necessary to dispose of floating materials which may adversely affect sludge handling and disposal.

6.21.04 Weirs

Overflow weirs shall be adjustable for leveling. Weir loading should not exceed 124 m^3/l.m./day (10,000 gal./day/lft.) for plants designed for average flows of 3785 m^3/d (1.0 mgd) or less. Higher weir loadings may be used for larger average flows, but should not exceed 186 m^3/m/d (15,000 g/day/linear foot).

6.21.05 Submerged Surfaces

The tops of troughs, beams, and submerged construction elements shall have a minimum slope of 1.4 vertical to 1 horizontal. The underside of such elements should have a slope of 1 to 1 to prevent accumulation of scum and solids.

6.21.06 Multiple Tanks

Where removal from service of a single unit for a short period will result in objectionable conditions or material damage, multiple units shall be provided. (See Art. 6.05)

6.21.07 Protective and Service Facilities

All settling tanks shall be provided with easy access for maintenance and protection to operators. Such features shall appropriately include stairways, walkways, handrails of non-corrosive materials, etc. If side walls are extended above the liquid level to provide flood protection or for other purpose, convenient walkways shall be provided to facilitate care and maintenance.

6.21.08 Surface Settling Rates

1. Primary Settling Tanks

   a- Follow by secondary treatment:

Plants up to 7.57 MLD (2 MGD) - 93.3 L/D/Cm^2 (800 gal/day/ft^2)
More than 7.57 MLD (2 MGD) - 124.2 L/D/Cm^2 (1000 gal/day/ft^2)

b- Not follow by secondary treatment:

Plants up to 7.57 MLD (2 MGD) -70.3 L/D/Cm^2 (600 gal/day/ft^2)
More than 7.57 MLD (2 MGD) - 99.3 L/D/Cm^2 (800 gal/day/ft^2)

2. Intermediate Settling Tanks:

124.2 L/D/Cm^2 (1000 G/D/Ft^2)

3. Final Settling Tanks:

a- Plants up to 7.57 MLD (2.0 MGD) - 99.3 L/D/Cm^2 (800 gal/day/ft^2)

b- More than 7.57 MLD (2.0 MGD)- 124.2L/D/Cm^2 (1000 gal/day/ft^2)

c- The surface settling rates in plants with digested sludge shall be computed according to the desired load of settled sludge at the final tank.

6.21.09. Sluge Removal

A sludge well shall be provide or adequate equipment installed for observing and sampling the sludge. Facilities for the continuos removal of sludge from the final settling tanks shall be provided. Each sludge hopper shall have and individually valved sludge withdrawal line at least 15 cm. (6 inches) in diameter. The static head available for withdrawal of sludge shall be 76 cm. (30 inches) or greater. Sludge hoppers shall be accessible for maintenance from the operating level. Sludge hoppers side walls shall have a minimum slope of 1.7 vertical to 1.0 horizontal. Clearance between the end of the withdrawal line and the hoppers walls shall be sufficient to prevent "bridging" of the sludge. Hopper bottoms shall have a maximum dimension of 61 cm. (2 feet).

6.21.10 Efficiency of Primary Settling Tanks

In the design of a treatment plant, it will be presumed that primary settling will remove 50% to 60% of the suspended solids and a 30% to 35% of the influent BOD.

6.22 Flow Equalization

Flow equalization can reduce the dry-weather variations in organic and hydraulic loadings at any wastewater treatment plant. It should be provided where large diurnal variations are expected.

6.22.01 Location

Equalization basins should be located down-stream of pretreatment facilities such as bar screens, comminutors, and grit chambers.

6.22.02 Type and Size

Flow equalization can be provided by using separate basins or on-line treatment units, such as aeration tanks. Equalization basin capacity should be sufficient to effectively reduce expected flow and load variations to the extent deemed to be economically advantageous.

6.22.03 Operation and Control

To maintain adequate mixing, aeration or mechanical equipment should be provided. Corner fillets and hopper bottoms with draw-offs should be provided to alleviate the accumulation of sludge and grit. Inlets and outlets for all basin compartments shall be suitably equipped with accessible external valves, weirs, or other devices to permit flow control and the removal of an individual unit from service. Facilities shall also be provided to measure and indicate liquid levels and flow rates.

6.23 Sludge Handling and Disposal

Sludge digestion process may be classified as anaerobic or aerobic.

6.23.01. Anaerobic Sludge Digestion

1. Multiple Units - The use of multiple units is required. Provision for sludge storage and supernatant separation in an additional tank may be required, depending on raw sludge concentration and disposal methods for sludge supernatant.

2. Depth - The proportion of depth to diameter should be such as to allow for the formation of a reasonable depth of supernatant liquor.

3. Maintenance Provisions - The following features are recomended:

   a. Slope - The tank bottom should slope to drain toward the withdrawal pipe. For tanks with mechanical suction for withdrawal of sludge, a bottom slope not less than 1:12 is recomended. A slope of 1:4 is recomended where the sludge is to be removed by gravity alone.

   b. Access Manholes - At least two 91 cm. (36 inch) diameter access manholes should be provided in the top of the tank in addition to the gas dome. To reach the access manholes stairways should be provided. A separate sidewall manhole shall be provided with an opening large enough to permit the use of mechanical equipment to remove grit and sand.

4. Sludge Inlets and Outlets - Multiple recirculation withdrawal and return points, to enhance flexible operation and effective mixing, should be provided, unless mixing facilities are incorporated within the digester. In order to assist in scum breakup, the returns should discharge above the liquid level and be located near the center of the tank. The sludge withdrawal to disposal should be from the bottom of the tank.

5. Tank Capacity - In recent years a number of modifications to the conventional anaerobic digestion process have been developed, specially in the area known as high rate digestion. The design standards, operating data, and experience for some of these modifications are not well established. This should be consider when selecting and designing the process. The total digestion tank capacity should be determined by rational calculations based in the latest accepted mathematic model that include such factors as sludge concentration, solid percent and nature, the temperature to be maintained in the digesters, the degree or extent of mixing to be obtained, the degree of volatile solids reduction required, and the size of the installation with adequate allowances for sludge and supernatant storage. Calculations should be submitted to justify the basis of design. The kinetic coefficient should determined by laboratory tests. When not possible and after consulting with the Authority, the values listed in the following tables should be used:

Coeft.	ANAEROBIC DIGESTER	20° TO 35° RAW SLUDGE
K	6.67 day^{-1}	
K_C	1.8 grm COD/L	1/2 COEF-COMB
1/a	0.04 grm/grm COD	(a, L, P)
1/	0.103 grm/grm COD	
b	0.03 day^{-1}	

	KINETIC COEFFICIENT FOR ACTIVATED SLUDGE AT 20°C (AERATION TANK)
Y	0.35 - 0.45 mg. MLVSS/mgCOD
b	0.05 - 0.10 day^{-1}
k	6-8 mgCOD/mg MLVSS/Day
k_s	25-100 mg/L COD

In cases where the mathematic model can not be used, the digester tank capacity may be designed based on other factors, approved by the Authority.

6. Gas Collection, Piping and Appurtenances

a- All portions of the gas system, including the space above the tank liquor, the storage facilities and the piping, shall be so designed that under all normal conditions, including sludge withdrawal, the gas will be maintained under positive pressure. All enclosed areas where any gas leakage might occur shall be adequately ventilated.

b- Safety Equipment - Where gas is produced, all necessary safety facilities shall be included. Pressure and vacuum reliefs valves and flame traps, together with automatic safety shut off valves, shall be provided. Water seal equipment shall not be installed. Gas safety equipment and gas compressors should be housed in a separate room with and exterior entrance.

c- Gas piping and Condensate - Gas piping shall be of adequate diameter and shall slope to condensate traps at low points. The use of float- controlled condensate traps is not permitted.

d- Gas Utilization Equipment - Gas-fired boilers for heating digesters should be located at ground level and in a separate room not connected to the digester gallery, and well ventilated. Gas lines to these units shall be provided with adequate flame traps.

e- Electrical Fixtures - Electrical fixtures and controls, in enclosed areas where hazardous gas may accumulate shall comply with the specifications of the National Board of Fire Underwritters, the P.R. Electric Power Authority, and O.S.H.A., for hazardous conditions.

f- Waste Gas - Waste gas burners should be readily accessible and should be located at least 7.6 meters (25 ft.) away from any plant structure if placed at ground level, or may be located on the roof of the control building if sufficiently separated from the tank. In remote locations it may be permissible to discharge the gas to the atmosphere through a return-bend screened vent terminating at least 3 meters (10 ft.) above the

ground surface, provided the assembly incorporates a flame trap.

g- Ventilation - Any underground enclosures connecting with digestion tanks or containing sludge or gas piping or equipment shall be provided with forced ventilation. To minimize the spread of gas at connecting passageways and tunnels, tightly fitting, self closing, automatic-locking doors should be provided.

h- Meter - A gas meter with by pass shall be provided to meter total gas production.

i- It is understood that in no case these conditions shall prevail, if are in violation of OSHA's regulations.

7. Digester Mixing - Where required for proper digestion because of loading rates or other features of the system, facilities for mixing the digester contents, shall be provided.

8. Supernatant Withdrawal

   a- Piping Size - Supernatant piping should not be less than 15.2 cm. (6 inches) in diameter.

   b- Withdrawal Levels - Piping should be arranged so that withdrawal can be made from 3 or more levels in the tank. A positive unvalved vented overflow should be provided.

   c- Withdrawal Selection - The supernatant withdrawal level, on fixed cover tanks, should preferably be selected by means of interchangeable extension valves at the end of the piping.

   d- Backwash - High pressure backwash facilities shall be provided.

9. Sampling - Provision should be made for sampling at each supernatant draw-off level. Sampling pipes shall be at least 1 1/2 inches in diameter and should terminate at a suitably-sized sampling sink or basin.

10. Alternate Supernatant Disposal - Supernatant should be returned to the plant inlet. Consideration should also be given to supernatant conditioning, where appropriate, in relation to its effect on plant performance and effluent quality.

6.23.02 Aerobic Sludge Digestion

1. General - Aerobic sludge digestion can be accomplished in a single or in multiple tanks, designed to provide stabilization and reduction of the organic matter in the presence of air.

2. Digestion Tanks - The use of multiple tanks is recommended. A single sludge digestion tank may be used in the case of small treatment plants (1 MGD or less) or where adequate provision is made for sludge handling and where a single unit will not adversely affect normal plant operation.

3. Mixing - Aerobic sludge digestion tanks shall be designed for effective mixing by satisfactory aeration equipment. If diffusers are used, the nonclog type is recommended, and they should be designed to permit removal for inspection, maintenance, and replacement without dewatering the tanks.

4. Tank Capacity - The size and number of aerobic sludge digestion tank or tanks should be determined by means of the calculations based on the most recently accepted mathematic model, considering such factors as percent solids reduction required, size of installation with appropriate allowance for sludge and supernatant storage. Calculations should be submitted to justify the basis of design. If the mathematic model cannot be use, the Authority should be consulted as to the method to be used.

Note: Page VI-24 was deleted.

6.23.03. Sludge Pumps

1. Capacity - Pumps capacities should be adequate. Variable speed pumps are required, whenever possible.

2. Duplicate Units - Duplicate units shall be provided where failure of one unit would seriously hamper plant operation.

3. Type - Plunger pumps, screw feed pumps, and other types of pumps with demostrated solids handling capability shall be provided for handling raw sludge.

4. Minimum Head - A minimum positive head of 61 cm. (2 feet) shall be provided at the suction side of centrifugal-type pumps and is desirable for all types of sludge pumps. For plunger pumps, the maximum suction lift should not exceed 3.0 meters (10 feet).

6.23.04. Sludge Piping

1. Size and Head - Sludge withdrawal piping should have a minimum diameter of 6 inches for pump discharge and 8 inches for gravity withdrawal lines. Where withdrawal is by gravity, the available head on the discharge pipe, should not be less than 1.52 m. (5 feet).

2. Slope - Gravity piping should be laid on uniform grade and alignment. Slope of gravity discharge piping should not be less than 3 percent. Provisions should be made for cleaning, draining and flushing discharge line.

6.24 Sludge Dewatering

6.24.01. Sludge drying beds - The drying beds should be of the type with concrete floor and with percolation channel. (See Fig. No. 44).

1. Area - In determining the area for sludge drying beds, consideration shall be given to climatic conditions, the volume and the character of

the sludge to be dewatered, the method and schedule of sludge removal, and other methods of sludge disposal. It shall never be less than 0.19 m^2/ person (2.0 ft^2/ capita)

2- The sizing of the drying bed may be estimated on the basis of 0.19 m^2/person (2 ft./capita) when the drying bed is the primary method of dewatering, and 0.09 m^2/ person (1.0 $ft.^2$/capita) if it is to be used as a back-up dewatering unit.

3- Percolation Type

a- Gravel - The lower course of gravel around the underdrains should consist of gravel 0.64 cm. to 1.98 cm. (1/4 to 3/4 inch) in size and should be 30.5 cm. (12 inches) in depth, extending at least 15.2 cm. (6 inches) above the top of the underdrains. It is desirable to place this in two or more layers. The top layer of at least 7.6 cm. (3 inches) thick should consist of gravel 0.32 to 0.64 cm. (1/8 inch to 1/4 inch) in size.

b- Sand - The top layer should consist of 15.2 to 22.9 cm. (6 to 9 inches) of clean coarse sand. The finished sand surface should be level.

c- Underdrains - The underdrain should be clay pipe or concrete drain tile at least 4 inches in diameter laid with open joints covered with cheese cloth.

4- Walls - The walls should be watertight and extent at least 46 cm. (15 to 18 inches) above the sludge level. Outer walls should be curbed to prevent soil from washing onto the beds.

5- Sludge Removal - At least two beds should be provided and should be arranged to facilitate sludge removal. Truck access to all percolation type sludge beds should be provided.

6- Sludge Influent - The sludge pipe to the drying beds should terminate at least 30.2 cm. (12 inches) above the surface and be so arrange that it will drain.

6.24.02 Additional Dewatering Facilities

At both ends of the percolation channel overflow rings should be provided at a distance not more than 30.2 cm. (12 inches) from the walls.

6.24.03. Drainage and Filtrate Disposal

Drainage from beds or filtrate from dewatering units shall be returned to the sewage treatment process at the plant inlet at an appropiate point to insure the same treatment as the influent.

6.24.04. Other Dewatering Methods

If the use of other methods are proposed the Authority should be consulted and its approval obtained before proceeding with the design.

6.25 Sludge Final Disposal

6.25.01. Final Disposal

The final sludge disposal shall be subject to E.Q.B. Standards and other pertinent requirements.

6.25.02. Incinaration and Other Oxidation Methods

Facilities for residue disposal and air pollution control should be provided.

6.25.03. Sanitary Landfill

Sanitary landfill must be considered as another alternative for sludge disposal.

6.26 Biological Treatment

6.26.01. Trickling Filters

1. Applicability - Trickling filters may be used for treatment of sewage amenable to treatment by aerobic biologic process. Effective settling tanks equiped with scum and grease collecting devices, or other suitable pretreatment facilities must preceed trickling filters.

2. Design Basis - Filters shall be designed to provide for reduction in biochemical oxygen demand in accordance with water quality standards established by the pertinent agencies, or to properly condition the sewage for subsequent treatment processes.

3. Distribution - The sewage may be distributed over the filter by rotary distributors or other suitable devices which will ensure uniform distribution to the surface area. At design average flow the deviation from a calculated uniform distributed volume per square meter (ft^2) to the filter surface shall not exceed plus or minus 10 percent at any point from the calculate volume.

4. Dosing - Sewage may be discharge to the filters by siphons, pumps or by gravity discharge from the preceding treatment units when suitable flow characteristics have been developed. Discharge of the sewage shall be practically continous. Recirculation shall be considered when designing the piping system.

5. Hydraulics - All hydraulic factors involving proper distribution of sewage on the filters shall be carefully calculated. Such calculations should be submitted to the Authority for approval. For the reaction type distributors, a minimum head of 61 cm. (24 inches) between the invert of the efluent channel of the clarifer and center of the arms is desirable.

6. Clearance - A minimum clearance of 15 cm. (6 inches) between the filter media and the distributor arms shall be provided.

7. Media - The media may be crushed stone, or specially manufactured material approved by the Authority. The media shall be durable, resistant to spalling or flaking and relatively insoluble in sewage. The top 46 cm. (18 inches) shall have a loss by the 20 cycle, sodium sulfate soundness test of not more than 10 percent, as prescribed by ASCE Mannual of Engineering Practice; No. 13. The balance is to pass a 10-cycle test using the same criteria. Manufactured media should be structurally stable, chemical and biological inert.

8. Depth - Crushed stone filter media shall have a minimum depth of .91 m (3 feet) above the underdrain and should not exceed 1.83 m (6 feet) in depth, except when special construction is justified through extensive pilot studies. In the case of specially manufactured material the depth shall be determined by means of studies.

9. Size and Grading of Media

   a- Rock and similar media shall not contained more than 5 percent by weight of pieces whose longest dimension is three (3) times the least dimension. They shall be free from thin, elongated and flat pieces, dust, clay sand or fine material.

They shall conform to the following size and grading when mechanically graded over vibrating screen with square openings.
Passing 11.4 cm. (4 1/2 inch) screen-100% by weight.
Retainded on 7.6 cm. (3 inch) screen - 95-100% by weight.
Passing 5.1 cm. (2 inch) screen - 0-2% by weight
Passing 2.5 cm. (1 inch) screen - 0-1% by weight.

b- Stone Place by Hand

Maximum stone dimension - 12.7 cm.(5")
Minimum stone dimension - 7.62 cm.(3")

c- Manufactured Media - Suitability of this media will be evaluated on the basis of experience with installations handling similar wastes and loadings.

d- Handling and Placing of Media - Material delivered to the filter site shall be stored on wood-planked or other approved hard-surfaced, clean areas. Similar material shall not be screen again at the filter site. This material shall be carefully place by hand to a depth of 30 cm. (12 inches) above the drains, so as not to damage them. The remainder of material may be placed by means of belt conveyors or any other method approved by the Engineer. Trucks, tractors, and other heavy equipment shall not be driven over the filter during or after construction.

10. Underdrains System

a- Arrangement - Underdrains with semicircular inverts or equivalent should be provided and the entire floor of the filter shall be covered by drainage system. Inlets openings into the underdrains shall have an unsubmerged gross combined area equal to at least 15 percent of the surface area of the filter.

b- Slope - The underdrains shall have a minimum of 1 percent. Effluent channels shall be design to produce a minimum velocity of 61 cm./sec. (2 ft./sec.) at average flow plus recirculation.

c- Flushing - Provision should be made for flushing the under drains. The use of a peripheral head channel with vertical vents, is accepted for flushing purposes in small filters. Inspection facilities should be provided.

d. Ventilation - The underdrainage system, effluent channels, and effluent pipe shall be design to permit free passage of air. The size of drains, channels, and pipe should be so that not more than 50 percent of their cross-section area will be submerged under the design peak hydraulic loading. Consideration should be given to possible future increase in hydraulic load, when designing the effluent channels.

11. Special Features

a- Flooding - Consideration should be given when designing the filters to provide appropiate valves to enable flooding for fly (psychoda) control.

b- Freeboard - To maximize the control of windblown spray, a free board of 1.2m (4 feet) or more should be provided for tall filters using manufactured media.

c- Maintenance - All distribution devices, underdrains, channels and pipes, shall be installed so that they may be properly maintained , flushed or drained.

12. Two-Stage Filters - The foregoing standards also apply to second stage filters.

6.26.02 Design of Stone Media Filters

1. The organic filter load must be of 1814 kg. (4000 lbs.) BOD per acre/ft. equivalent to 41 kg/m^3 (90 $lbs/1000\ ft^3$).

2. The hydraulic load of the filter must be between 38 and 114 million liters (10 and 30 million gallons) per acre of filter surface per day.

3. The yield of the final filtered and settling system will be calculated by combine formulas of the National Research Council, WPCF No. 8 Sewage Treatment Plant Design, last edition.

4. The recirculation factor shall not be less than 1:1 nor higher than 4:1

5. Recirculation Pumps

a- The return rate of each pump will not be less

than half of the volume used for the plant design.

b. Two pumps which will operate alternately shall be provided for each sump. In total four (4) pumps will be installed.

c. Recirculation pumps will be provided with ajustable mechanical weirs to vary the recirculation factor when necessary.

d. Recirculation pumps must meet the following requirements:

1. Epoxy encapsulated motor for exposed pumps.

2. Nema 4 enclosed float switch.

3. One quart solenoid oiler, for exposed pumping stations.

4. Pump discharge should not be less than 2 1/2 inches and the piping not less than 4 inches.

5. A 3/4 inch diameter piping with an 1/8 inch diameter opening of flexible copper must be installed, surrounding the pump chamber to break the scum, and this one connected to the recirculation discharge (overflow).

6. A shear gate must be provided in the inlet piping.

e. Recirculation pump suction chamber should be constructed with a hopper type bottom, with a 45 degrees slope toward pump suction to prevent dead ends at corners, and in accordance with section 5.02.02.

6.26.03. Activated Sludge

1. Applicability - The activated sludge process and its various modifications may be used where sewage is amenable to biological treatment. Close attention and competent operating supervision, including routine laboratory control is required for this process. These requirements shall be considered when proposing this type of treatment.

2. Energy Requirements - To meet aeration demands, mayor usage of energy is required by this process. Energy costs and potential mandatory emergency public power reduction events in relation to critical water quality conditions most be carefully evaluated. While still maintaining process viability, capability of energy usage phasedown, both under normal and emergency energy availability conditions, must be included in the activated sludge design.

3. Specific Process Selection - The activated sludge process and its several modifications may be used to accomplish various degrees of removal of suspended solids and reduction of five (5) days B.O.D. The degree and consistency of treatment required, type of waste to be treated, proposed plant size, anticipated degree of operation and maintenance, and operating and capital costs will influence the choice of the process most applicable. All designs must provide for flexibility in operation. Plants treating more than 3.785 MLD (1 MGD) shall be design to facilitate easy conversion to various operation modes.

4. Pretreatment - Effective removal or exclusion of grit, debris, excessive oil or grease, and comminution of solids shall be accomplished prior to the activated sludge process.

5. Settling Tanks - The following requirements are in addition to those set forth in Art. 6.21.01 of these Standards.

   a- Where primary settling is used, provision shall be made for discharging raw sewage directly to the aeration tanks following pretreatment.

6. Final Settling Tanks

   a- The inlets, collection facilities and sludge removal should be designed to minimize the density currents and to provide rapid sludge return to the aeration tanks.

b- Floating Material Removal - For all final settling tanks, provision for effective baffling, including equipment for scum removal, should be made.

c- Capacity - Since the rate of recirculation of return sludge from the final settling tanks to the aeration or reaeration tanks is quite high in activated sludge process, surface settling rate and weir overflow rate should be adjusted for the various processes to minimize the problems with sludge loadings, density currents, inlet hydraulic turbulence, and occasional poor sludge settleability. The following design parameters should be observed in the design of final settling tanks for the following activated sludge processes, except that due consideration must be given to the flow duration (for example, school flows may occur in a 6 hour period).

Type of Process	Average Design Flow (M.L.D.) (M.G.D.)	Detention Time Hours	Surface Settling Rates liter/day/ sq. cm. (gal./day/ sq. ft.)
Conventional, Modified or High Rate and Step Aeration	Up to 1.89 (0.5)	3.0	2.44 (600)
	1.89 (0.5) to 5.68 (1.5)	2.5	2.85 (700)
	5.68 (1.5) up	2.0	3.26 (800)
Contact Stabilization	Up to 1.89 (0.5)	3.6	2.04 (500)
	1.89 (0.5) to 5.68 (1.5)	3.0	2.44 (600)
	5.68 (1.5) up	2.5	2.85 (700)
Extend Aeration	Up to 0.19 (0.05)	4.0	1.22 (300)
	0.19 (0.05) to 0.57 (0.15)	3.6	2.04 (500)
	0.57 (0.15) up	3.0	2.44 (600)

7. Aeration

a- General - A number of modifications of the activated sludge process have been developed, some of which are referenced herein. Design standards, operation data and experience for some of this are not well established. This should be considered when selecting a process modification. The conventional process and its various modifications, except for the so called "High Rate" process, may be expected to remove 85 to 90 percent of the BOD applied to the aeration tanks within the boundaries of the design parameters described herein, with effective operation and, in the case of extended aeration, provision for sludge wasting. The so called "High Rate" modification may be expected to remove from 50 to 90 percent of the BOD applied, depending on loadings, solids under aeration and other variables.

b- Aeration Tanks - The size of the aeration tank for any particular adaptation of the process shall be determined by full scale experience, pilot plant studies, or rational calculations based mainly on such factors as the size of the plant, degree of treatment desired, mixed liquor suspended solids concentration, BOD loading, and ratio of mixed liquor solids to BOD loading. Calculations should be submitted to justify the basis for design of aeration tank capacity.

8. Arrangement of Aeration Tanks

a- General - Ordinarily, liquid depths should not be less than 3.05 m (10 feet) nor more than 4.57 m (15 feet) except in special design cases. For very small tanks or tanks with special configuration, the shape of the tank and the installation of aeration equipment should provide for positive control of short circuiting through the tank.

b- Inlets and Outlets Controls - Inlets and outlets for each aeration tank unit shall be suitably equipped with valves, gates, stop plates, weirs, or other devices to permit controlling the flow to any unit and to maintain reasonably constant liquid level. The hydraulic properties of the system shall permit

the maximum instantaneous hydraulic load to be carried with any single aeration tank unit out of service.

c- Conduits - Channel and pipes carrying liquids with solids in suspension shall be designed to maintain self-cleaning velocities or shall be agitated to keep such solids in suspension at all rates of flow within the design limits.

d- Measuring Devices - In all plants, devices should be installed for indicating flow rates of raw sewage or primary effluent, return sludge, and air to each tank unit. For plants designed for sewage-flows of 3.785 MLD (1MGD) or more, these devices should totalize and record, as well as indicate flows. Where the design provides for all return sludge to be mixed with the raw sewage (or primary effluent) at one location, then mixed liquor flow rate to each aeration unit should be measured.

e- Freeboard - All aeration units shall have a freeboard of not less than 46 cm. (18 inches). Additional freeboard or windbreak may be necessary to protect against windblown spray.

9. Aeration Equipment

a- General - Oxygen requirements generally depend on BOD loading, degree of treatment and level of suspended solids concentration to be maintain in the aeration tank mixed liquor. Aeration equipment shall be capable of maintaining a minimum of 2.0 mg/l of dissolved oxygen in the mixed liquor at all times and providing a thorough mixing of the mixed liquor. Weather protection shall be provided for all electrical controls.

b- Diffused Air Systems - Air requirements shown below will be considered normal requirements. In any case, the general requirements of previous clause 9 (a) should be met.

Minimum air to be applied, Cubic Meters of Air/Gm. BOD_5 (Cubic Feet of Air/lb. BOD_5), Aeration Tank Load.

Process	Load of Aeration Tank
Conventional	0.81 (1,500)
Step Aeration	0.81 (1,500)
Contact Stabilization	0.81 (1,500)
Extended Aeration	1.26 (2,000)
Modified or "High Rate"	0.26 to 0.81 (400 to 1,500) (Depending on expected BOD_5 removal)

The above requirements assume equipment capable of transffering at least 1.0 lb. of oxygen to the mixed liquor per pound of BOD_5 aeration tank loading. To air requirements calculated above shall be added air required for channel, pumps, or other air-use demand.

The specified capacity of blowers or air compressors, particularly centrifugal blowers, should take into consideration that the air intake temperature may reach 40°C (140°F) or higher and the pressure might be less than normal.

Blowers shall be provided in multiple units, so arranged and in such capacities as to meet the maximum air demand with the single largest unit out of service. The design shall also provide for varying the volume of the air delivered in proportion to the load demand of the plant.

Diffuser systems shall be capable of providing for the diurnal peak oxygen demand or 200% of the design average oxygen demand whichever is larger. The air diffusion piping and diffuser system shall be capable of delivering normal air requirements with minimal friction loss. The spacing of diffucers should be in accordance with the oxygen requirements through the length of the channel or tank, and shall be design to facilitate adjustment of their spacing without mayor revision to air header piping. The arrangement of diffusers shall also permit their removal for inspection, maintenance and replacement without dewatering the tank and without shutting off the air supply to other diffusers in the tank.

Individual assembly units of diffusers shall be equipped with control valves, preferably with indicator markings for throttling, or for complete shutoff. Diffusers in any single assembly shall have substantially uniform pressure loss.

c. Mechanical Aeration Systems - The mechanism and drive unit shall be designed for the expected conditions in the aeration tank in terms of the power performance approved. Multiple mechanical aeration unit installations shall be so designed as to meet maximum oxygen demand and maintain process performance with the largest unit out of service. Provision should be made for varying the amount of oxygen transferred in proportion to the load demand in the plant.

10. Return Sludge Equipment

a. Return Sludge Rate - The return sludge rate shall be established according to each case or by pilot study. Experience have shown that this rate generally varies between 10 to 200 percent and should be determined according to an accepted mathematical model.

The rate of sludge return shall be varied by means of variable speed motors, drives, or timers (small plants) to pump sludge at the above rates.

11. Return Sludge Pumps - If motor driven return sludge pumps are used, the maximum return sludge capacity shall be obtained with the largest pump out of service. A positive head should be provided on pump suctions. Pumps should have at least 7.6 cm. (3 inches) suction and discharge openings. If air lifter are used for returning sludge from each settling tank hopper, no stand-by unit will be required, provided that the design of the air lifter are such to facilitate their rapid and easy cleaning and provided other suitable stand-by measures are provided. Air lifters should be at least 7.6 cm. (3 inches) in diameter.

12. Return Sludge Piping - Discharge piping should be at least 10 cm. (4 inches) in diameter and should be design to maintain a velocity of 0.61 m/sec. (2 ft./sec.) when return sludge facilities are operating at normal return sludge rates. Suitable devices shall be provided for observing, sampling and controlling return sludge flow from each settling tank hopper.

13- Waste Sludge Facilities - Waste sludge control facilities should be designed using the established mathematic models.

a- Anaerobic Digestion - The digestion capacity shall be determined by the established mathematic model. The detention time varies from 20 to 60 days.

b- Aerobic Digestion - The detention time for aerobic digestors shall be from 5 to 20 days. The mathematic model reffered to in this standards are in the latest edition of Metcalf and Eddy text Book.

c- Air Requirements - Sufficient air should be provided to keep the solids in suspension and maintain dissolved oxygen between 1 and 2 mg/l. The mathematic model shall be used to determine the air to be provided for aerobic digestion process.

6.27 Disinfection

6.27.01 Purpose

Since the effluent from sewage treatment plants might create a public health hazard, disinfection of the effluent will be required. The use of chlorine or other chemical agents is necessary to kill all microorganisms or pathogenic germs.

6.27.02 Chemical Agents

Chlorine is the most commonly used chemical for wastewater disinfection, and the forms most often used are liquid chlorine and calcium or sodium hypochloride. If approved by the Authority other disinfectants, including chlorine dioxide, ozone, and others, may be used. The chemical should be selected after due consideration of waste flow rates, application and demand rates, pH of the wastewater, equipment cost, chemicals availability and maintenance problems.

6.27.03 Feed Equipment

1. Type - Solution-feed vacuum-type chlorinators are generally preferred for large chlorination installations. The preferred method of

generator of chlorine dioxide is the injection of a sodium chloride solution into the discharge line of a solution-feed gas-type chlorinator, with subsequent formation of the chlorine dioxide in a reaction chamber at a pH of 4.0 or less.

2. Capacity - Required chlorinator capacity will vary depending on the uses and the points of application of the disinfecting chemical.
For disinfection, the capacity should be adequate to produce a concentration of residual chlorine in the plant effluent, measured by a standard method, that will dependably and consistently reduce the coliform concentration to meet the limits specified by the Environmental Quality Board for the receiving waters.

3. Stand-by Equipment and Spare Parts- Stand-by equipment of sufficient capacity to replace the largest unit during shut down, should be available. Spare parts shall be available for all chlorinators to replace parts which are subject to wear and breakage.

4. Water Supply - An ample supply of water for the operation of the chlorinator, shall be available. When the water pressure in the chlorinator is less than 1.76 kg/cm^2 (25 lbs./sq. in.)a booster pump is required. Duplicate equipment should be provided, and when necessary, stand-by power as well.

6.27.04 Chlorine Supply

1- Cylinders - Where the average daily chlorine consumption is over 68 kg. (150 lb.), the use of one-ton containers should be considered.

2- Scales - Scales for weighing cylinders shall be provided at all plants using chlorine gas. At large plants (5.0 MGD or over), scales of the indicating and recording type are recommended. At least a platform scale shall be provided. Scales shall be of corrosion-resistant material.

3- Evaporators - Consideration should be given to the installation of evaporators, to produce the quantity of gas required, where manifolding of several cylinders is required.

4. Leak Detention and Controls - A bottle of ammonium hydroxide solution shall be available for detecting chlorine leaks. A leak repair kit, approved by the Chlorine Institute, shall be provided. At large chlorination installations, consideration should be given to the installation of automatic gas detection and alarm equipment.

5. For chlorination equipment housing and respiratory protection equipment see Chapter VIII.

6.27.05 Piping and Connections

Piping systems shall be as simple as possible, specifically selected and manufactured to be suitable for chlorine service, with a minimum number of joints. The correct weight or thickness of steel is suitable for use with DRY chlorine, liquid or gas. Even minute traces of water added to chlorine results in a corrosive attack that can only be resisted by pressure piping utilizing materials such as silver, gold, platinum or Hasteloy "C".

Low pressure lines made of hard rubber, saran - lined, polyethylene, polyvinylchloride (PVC), or Uscolite materials are satisfactory for wet chlorine or aqueous solutions of chlorine. All lines designed to handle dry chlorine should be protected from the entrance of water or air containing water, due to the corrosiveness of wet chlorine.

6.27.06 Application of Chlorine

1. Contact Time - After thorough mixing, as rapidly as possible, a minimum contack period of 15 minutes at peak hourly flow or maximum rate of pumpage, shall be provided.

2. Contact Tank - In primary plants, chlorine should be applied in two stages: ahead of the settling tank and following the settling tank. The chlorine contact tank should be constructed so as to reduce short-circuiting of flow to a practical minimum. To minimize short circuiting, "Over-and-under" or "end-around" baffling, shall be provided. The tank design shall provide facilities for maintenance and cleaning without reducing effectiveness of disinfectation. The drain should be valved. The point of discharge, which may require pumpage, shall be

such as to assure adequate treatment. Duplicate contact tanks shall be provided. A submerged outfall sewer may be use in lieu of a final chlorine contact tank. Flushing facilities should be provided.

6.27.07 Evaluation of Effectiveness

1. Sampling - Facilities shall be included for sampling the disinfected effluent after contact. Grab or continous sampling, as conditions warrant, may be considered.

2. Residual Chlorine Testing and Control - Equipment sahll be provided for measuring chlorine residual employing accepted procedures. The equipment used should enable residual measurement to the nearest 0.1 mg/l and to an accuracy of approximately 25 percent above 0.5 mg/l.

   The installation of demostrated effective facilities for automatic residual analysis, recording and proportioning systems, should be considered at all installations, where the discharge occurs at points requiring rigid bacteriological controls such as in water supply watersheds, recreational watersheds or shell fish waters or water tributary thereto.

6.28 Dual facilities and adequate equipment to chlorinate the effluent, will be provided. Chlorinators will be solution feed of adequate capacity and automatic type. Additonal automatic facilities to regulate and register graphically the residual chlorine should be available. The automatic chlorination system will depend on the receiving waters of the plant effluent and the minimum will be controlled by volume. Calculation for the selection of chlorine capacity will be based on a minimum residual chlorine strength of two (2) parts per millon and at least three (3) times the normal capacity. In special cases the Authority may require automatic chlorinators regulated by the chlorine residual.

6.28.01 The contact period in the contact chamber will not be less than 30 minutes based on average flow. The contact chamber will be divided in two (2) sections so that the operation will not be interrupted while cleaning one of them.

6.29 General Considerations

The positive hydraulic head from the center of the sludge removal piping, from the inlet channel of the sludge beds, or to the minimum water level in the digester tank, or to the sludge beds will not be less than 1.53 meters (5 feet).

6.29.01 When the sludge is discharged by gravity, the piping slope should not be less than 3 percent.

6.30 The plot grounds, where the sewage treatment plant is located will be graded and conditioned. Slopes and adequate drainage will be provided for rain water.

6.30.01 Concrete sidewalks, one meter wide and not less than 10 cm. (4 inches) thick, reinforced with 6x6 wire mesh, will be provided between structures to facilitate access to them.

An access road 4 meters wide and one meter wide shoulders at both side will be built. In case of a concrete road construction joints every 5.49 meters (18 feet) should be provided. Access final grading should be 0.60 meters minimum above maximum flood elevation. The road should reach the sludge drying beds, providing space for the trucks to turn.

6.31 For water service to the plant, cast iron piping, not less than two (2) inches in diameter shall be installed, connected to the nearest aqueduct pipe line with enough capacity and pressure. A back flow preventer valve shall be installed in this piping located between the control house and the rest of the plant structures.

6.32 For watering the grass on the grounds of the plant, a sprinkle system will be provided of copper or plastic piping not less than 3/4 inch in diameter with check valve, hose bibbs and sprinkles.

6.33 The plot of the plant, which will be transferred to the Authority, shall be fenced with 1.83 meter (6 feet) high galvanized wire mesh (Cyclone Fence) with a concrete base not less than 10 cm. (4 inches) width and 30 cm. (1 foot) high above ground, with three strands of barbed wire at the top. Gates will be installed at the access to the plant grounds. See Fig. No. 1 .

6.34 All metallic equipment will be factory painted with #9374 Orange Primer, first layer and #9390 white primer for second coat, manufactured by Rust Oleum Corp. Also a finish coat (#9300) after installation, of a color selected by the Authority. Piping at treatment plants and pumping stations will be color coded and indentified according to Art. 6.06.05. Refer to Art. 2.07.08 for paint for concrete surfaces.

6.35 Adequate lighting will be provided in all the plant control and operation structures, also light post outside lighting and receptacles at convenient and accesible locations.

6.35.01 All the electric installations shall be done using adequate size conduits and must be indicated as built on the final construction plans for the plant. The electrical installation should meet the latest requirements of the "National Electrical Code of the National Board of Fire Underwriters" and the P.R. Electric Power Authority.

6.35.02 The wiring should be color coded to facilitate its identification and the maintenance of the electrical installation.

6.36 Where the sewage treatment plants include pumping stations, three units of vertical centrifugal pumps (dry pit types) shall be provided. Each one with 1.25 average flow capacity. Two of these pumps will be of variable flow and in accordance with norms on Chapter V (Sewage Pumping Stations).

6.37 When discharge by gravity is not possible a pump for the sludge removal of the primary tank will be provided, and located as near to the tank as possible.

6.38 The control house shall be provided with an adequate size restroom, including shower, lavatory and toilet bowl.

6.39 All piping conveying sludge will be provided with drills 1" diameter with corporation stops to facilitate cleaning.

6.40 Windows shall be made of aluminum, "Miami" type of a design and quality previously accepted by the Authority. They shall be factory painted in a color selected by the Authority.

6.41 Sludge drying beds shall be of concrete and constructed as close as possible to the digester tanks or clarigester.

6.42 Sludge drying beds shall be built using as a guide Fig. No. 44 but designed for each particular case.

6.43 Changes during construction shall be limited to strictly neccessary ones and must be submitted for the approval of the Authority in one sepia and five copies of the plan sheets affected by the change requested.

6.44 All electric and mechanical equipment shall be labeled and numbered to facilitate identification.

6.45 At the time of final inspection the builders and/or contractor will deliver all keys and other tools supplied with the equipment installed. Also all catologs, and plans, installation, operation and maintenance manuals of the equipment installed at the plant must be delivered.

6.46 All plans of sewage treatment plants, prepared for approval, shall include a hydraulic profile along the plant axis showing plant operation including elevations, dimensions, etc.

6.47 An instrument to measure and register grafically the effluent must be provided. Fiberglass, Koroseal, bronce, stainless steel or cast iron will be the material used for those instruments.

6.48 Oil drainage in the transmission box of primary and secondary clarifier tank, will be provided.

6.49 To facilitate the elimination of waste, an incinerator will be provided next to the screen chamber if PRASA approves.

6.50 Piping to recirculate the digestor supernatant to the recirculation pump pit that goes to the primary tank or to the wet pit of the pumping station at the entrance of the plant should be provided. In case this can not be accomplished by gravity, a pump must be provided.

6.51 The maximum flood level of the receiving water body must be determined to prevent floods.

6.52 A house or space, 1.22 by 1.83 meters (4 ft. by 6 ft.) minimum, with access to the exterior, should be provided at the control or pump house for the storage of materials and tools.

6.53 A gas burner for the digestor tank shall be provided.

6.54 A control plank or a gate valve should be provided at the plant intake, before the screen chamber.

6.55 In installations where the digester is located separately from the primary clarifier, a telescopic valve should be provided at the primary tank to discharge the sludge into a separate chamber, from which the sludge pump, will in turn pump it to the digester.

6.56 Aluminium bar screen should be used at the entrance of the plant. Where, due to its weight, the screen can not be removed or replaced manually, it shall be divided in sections or mechanical means provided to facilitate this operation and the bar screen ahould be of stainless steel.

6.57 All controls installed in the exterior shall be weather and dust proof (NEMA-4)

6.58 Facilities should be provided for scum pit pumps manual and mechanical operation by the installation of an electrode activated switch.

6.59 Plastic material of 0.64 mm (1/4 inch) thickness or other material of better quality and approved thickness, should be used for outlet weirs. Screws for the weirs shall be brass and placed at a maximum distance of 30 cm. (12 inches) center to center.

6.60 Guides for Laboratory Facilities at Sewage Treatement Plants

1. Introduction

The recent adoption of guidelines for the water quality control, makes mandatory the improvement of the sewage treatment and its optimum operational control. In general, better facilities will include at least secondary treatment, phosphorus removal, and facilities for better bacteriological control.
Efficient operation control is the main function of an adequate plant laboratory. A carefully planned and well equipped laboratory with efficient personnel is the control center of the plant and of each one of the processing units. The analytical results provide information that is used to:

a- Evaluate the efficiency of the plant and its processing units.

b. To determine the effluent's characteristics and to control its quality.

c. To determine the effluent's effect on the receiving body.

d. To insure that regulating requirements are met and to inform of operational trends.

e. To forsee difficulties and suggest operational changes to prevent and solve difficulties, if any.

f. To determine future changes in design.

g. To produce public information related to plant operation, costs, and needs.

2. Design

The three key words for any laboratory of sewage treatment plants are:

a. Flexibility - Which provide for future changes in requirements.

b. Adaptability - For changes in arrangement.

c. Expansion - For changes in future needs for expansion.

3. Location

The laboratory should be located on ground level, easily accessible to all sampling points, with environmental control as an important consideration. It shall be oriented to the north light, away from vibrating machinery and equipment which might have adverse effects on the performance and precision of laboratory instruments or the analyst or shall be designed to prevent adverse effects from vibrations. The optimum use of the laboratory is possible in a pleasant and confortable environment.

4. Space

a. A minimum of 9.3 square meters (100 feet^2) of floor

space should be allocated for the laboratory. The final space to be required in each case in particular, would be determined by the authority, according to the capacity of the plant.

b. Minimum ceiling height should be 2.59 meters (8'-6"). This height, if possible, could be increase for the installation of wall-mounted equipment with extended height requirements.

c. The above minimum space does not provide office or administration space.

5. Materials

a. Accustical tile should be used for ceilings, except in high humidity areas, where they should be constructed of cement plaster.

b. Interior walls will have light-colored ceramic tile from floor to ceiling.

c. Floor surfaces should be either vinyl or rubber, fire resistance, and highly resistance to acids, alkalies, solvents, and salts.

d. Windows (Refer to Art. 6.40 of this Norms) Doors shall be located to permit a straight egress from the laboratory, preferably at least one to outside of the building. They should have large glass windows, for easy visibility of approaching or departing personnel, panic hardware, and automatic door closers. Swinging doors should not be used due to the hazzard to persons carrying chemicals.

6. Cabinets and Working Table Tops

a. Wall-hung cabinets are useful for dust-free storage of instruments and glassware. Sliding glass door units are preferable. They should be hung so the top shelve is easily accessible but still not interfere with the equipment on the working table. At least one cupboard-style cabinet shall be provided, the rest should be drawer units. Drawers should slide out so that the entire contents is visible and provided with stops.

b. Cabinets should be build of #18 or better metal and covered with a corrosion-proof layer after built. All cabinet shelving must be resistant to acids, alkalies, solvents, abrasives, and water. Stainless steel cabinets should meet AISI type 316 specifactions. Warm glasses should be 1/4 inches thick and heat resistant.

c. Water, gas, air, and vacuum service fixtures; traps, strainers overflows, plugs and tailpieces, and all electrical service fixtures shall be supplied with the laboratory furniture.

d. Generally, working tables and bench-top height should be 91 cm. (36 inches) and will cover 35% of the laboratory area. However, areas to be used exclusively for sit-down type operations should be 76 cm. (30 inches) high. Tops should be constructed of hard natural stone impregnated with resine and a 2.54 cm. (one-inch) overhangs and drip grooves should be provided.
The tops should be furnished in large sections, 3.18 cm. (1-1/4 inches) thick and should be field joined into a continous surface with acid, alkali, and solvent-resistant cements which are at least as strong as the material of which the top is made.

7. Hoods

a. Location

Fume hoods shall be located where air disturbance at the face of the hood is minimal. Persons walking past the hood, heating, ventilating or air-conditioning systems, and drafts from opening or closing doors may create air-disturbance.

Safety factors should be considered in locating a hood. A secondary means of egrees must be provided if a hood is situated near a doorway. Bench surfaces should be available next to the hood so that chemicals need not be carried long distances.

b. Design and Materials

Gas hoods shall be made of plastic or a material of equal chemical resistance. Exterior finish should harmonize with the laboratory furniture. Interior lining and defectors shall be made of "Resisto-Roc" or its equivalent. A glass case shall be provided. Using sliding windows (vertical or horizontal).

c. Fixtures

A cup sink should be provided inside each fume hood. All switches, electrical outlets, and utility and baffle adjustment handles shold be located outside the hood. Light fixtures should be explosion-proof.

d. Exhaust

Continous, twenty-four hour exhaust capability should be provided. Exhaust fans should be explosion-proof. Exhaust velocities should be checked when installing the fume hoods.

e. Alarms

A static pressure gauge and a buzzer for indicating exhaust fan failure, should be placed in the exhaust duct. High temperature sensing device located inside the hood should be connected to the buzzer.

f. Canopy Hoods

Canopy hoods should be installed over the bench-top areas where hot, plate, steam baths, or other heating equipment or heat-releasing instruments are used. The canopy should be made of steel, plastic, or equivalent material, and finished in enamel to blend with other laboratory furnishings.

8. Sinks

A minimum of three (3) sinks (not including cup sinks) should be provided in the laboratory. At least two (2) of them should be double-well with drainboards. Additional sinks should be provided in separate work areas as needed, and identified for the use intended.

Sinks should be made of epoxy resin or plastic material with all appropriate characteristics for laboratory applications. Waste openings should be located toward the back so that a standing overflow will not interfere. All water fixtures on which hoses may be used should be provided with reduced zone pressure backflow preventers to avoid water lines contamination. Traps should be made of glass, plastic, or lead and easily accessible for cleaning.

9. Ventilation and Lighting

Laboratories should have independent air conditioning units, with external air supply for 100% make-up volume. In addition, separate exhaust ventilation should be provided. Ventilation outlet locations should be remote from ventilation inlets.
In the laboratory, good lighting, free from shadows, is important for reading dials, meniscuses, etc.

10. Electric Power

To eliminate voltage fluctuactions, electric lines supplying the laboratories should be controlled with a constant voltage, harmonic neutralized, CVS type transformer. This transformer should contain less than 3% total root mean square (RMS) harmonic content in the output, should regulated to 1% for an imput of 15% of nominal voltage. With an output of 118 volts. The 240-volt lines for high voltage requirements, should be similarly regulated.

11. Gas and Vacuum

The laboratory should be supplied with natural gas. Digester gas should not be used.
With outlets throughout the laboratory, an adequate-sized line source of vacuum should be provided.

12. General

A balance table which will minimize vibration of the balance shall be provided. It shall be located so that air movement and excessive vibrations will not affect the scale readings.

The administration personnel of the laboratory should have a library at their disposal with reference books, catalogs, and pertinent magazines.

For illustration of proper laboratory arrangements see Figs. No. 47, 48, 49, 50 and 51

CHAPTER VII

GUIDES FOR DESIGN AND REVISION OF ELECTRICAL PLANS

For an electrical system optimum design, two basic points shall be very carefully considered by the designer of an electrical system for a plant ..... this should be a system adequate for present and future probable loads, economical and safe.
The designer should know the voltage, etc. available from the P.R.E.P.A., should know its total load, present and future and the norms that follow:

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CHAPTER VII

GUIDES FOR DESIGN AND REVISION OF ELECTRICAL PLANS

7.01 Offsite Facilities

7.01.01 Plans must be approved by the Electric Power Authority and must:

a- Indicate point of connection for three phase service.

b- Show extension of existing lines and/or installation of new lines if necessary.

c- Include details of existing rights-of-way and/or new ones to be acquired.

In the case of new rights-of-way to be acquired a plot plan shall be included to facilitate the acquisition of the right-of-way by the Aqueduct and Sewer Authority and transfer and cede to the Electric Power Authority not later than a year.

d- A note indicating the charges assessed by the A.E.E. for work to be performed by that Authority.

e- Note indicating that the three (3) transformers for the electrical substation shall be mounted in a pole located within the lot, for the use of the Authority, supplied and included in the Contract. The pumps should operate alternately, that is, only one pump at a time. Only one motor load, lighting, etc. shall be consider for the total load to be required by the substation.

f- In urban areas, the installation for the substation shall be done on concrete utilities poles according to A.E.E. standards if so required.

g- In special cases and after previous approval by

both the Aqueduct and Sewer Authority and the Electrical Power Authority, the A.E.E. shall supply the transformers to be used, only for the substation of the project, according to the general clauses for rates in force.

7.02 Electrical Connection for Interior Lighting

7.02.01 Aerial connections shall be provided, if ground conditions permits it, no longer than 22.86 meters (75 feet) using stranded weatherproof cable and heavy duty clamps.

7.02.02 Minimum entrance feeder shall be T.H.W. for 100 amps in galvanized rigid conduit.

7.02.03 The base for the meter, shall be for 100 amps minimum, adjustable thermal magnetic main circuit breaker "HI-LO" weather proof type for exterior use.

7.03 Motor Remote Control System

7.03.01 Tanktrol - Equipment known as tanktrol or approved equal shall be used at pumping stations which pump to distribution tanks.

7.03.02 Cable Wire - At pumping systems, open tanks, or filtration plants, electrodes, mercury switches or combination of both shall be used as necessary for each particular case. Communication cable, telephone low capacitance (voice graded type) cable or messenger cable shall be used. At least a minimum of two cables (spare, tapped, capped), watertight shall be provided for future use.

7.04 Equipment Protection System

7.04.01 Phase Failure Reversal and Under voltage Relay.

Phase failure, low voltage or phase reversal: An adequate device connected to the bus bars at the entrance of the control panel shall be provided. It shall be electrically protected by a block of current limiting fuses at the entrance of the equipment. A set of spare fuses shall be provided for future use. This device shall maintain a pair

of contactors normally closed.

7.04.02 Water Low Level Cut-Off

At the pump suction end or at the pit, electrodes shall be provided to prevent pumping while dry. In underground or in line pumping stations, the water connection to the electrodes holder shall be installed between the strainer and the pump. An air vent, properly located, shall be provided to prevent air pockets. An adjustable (15 to 180 seconds) time delay relay shall be provided to avoid unnecessary on and off cycles due to flow fluctuations. The delay relay should be installed in the control panel, the vent and electrode holder in the pump box.

7.05 Chemical Feeders Control System in Filtering Plants

7.05.01 Provide auxiliary contactors to open control circuits of the magnetic starters of the feeders to stop its operation when the plant is not operating.

The same shall be provided for the solenoid valve installed at the water inlet in plants supplied by gravity. In plants supplied by a pumping system the raw water intake pumps operation shall be interrupted when the plant is not in operation.

7.05.02 The plans should indicate that the chlorine application system should be automatically suspended when the plant is not in operation.

7.05.03 Where dual pumps are installed for the application of chemicals, they shall operate alternatelly and follow provisions indicated in Section 7.04.04 (b) regarding starting of the other motor when one fails to start.

7.06 Control Panels

All control panels shall be for exterior installation and of the outdoor type, raintight, weatherproof for duplex pump control for dead-front (switchboard) operation, double door design with lock facilities and factory wired. Including:

7.06.01 Magnetic starters, combination type with magnetic only circuit breaker, adequate heaters, quick-trip adjustable overload relays + 10% full load.

7.06.02 Time delay relays and contactors shall be provided so that when a pump motor is to start and does not after the reasonable adjustable, 15 to 180 seconds, lapse of time, the other motor will start and a red light alarm should come on. A push-to-test bottom should be provided to test condition of the alarm light and also spare bulbs.

7.06.03 A drained area to locate the equipment with entrances, exits and water connections shall be provided independently of the section for electric connections and equipment. The construction shall be such that water leakage will not be a hazard to personnel or equipment.

7.06.04 Only one hand-off auto selector switch shall be provided to prevent that non skilful personnel will connect or start two motors simultaneously.

7.06.05 Secondary lightning arresters shall be installed at the breakers of each of the magnetic starters when installed underground or outdoors.

7.06.06 Phase failure, undervoltage, reversable relay.

7.06.07 Low level cut-off relay.

7.06.08 Time delay relays.

7.06.09 Alternators

7.06.10 Tanktrol or remote control relay

7.06.11 Circuit breakers, 1 pole - 120V - 20A each to provide protection to lighting, receptacles and control lines.

7.06.12 Duplex convenient outlets, 120V - 20A, specification grade grounding type with industrial galvanized cover for occasional use.

7.06.13 Lighting wall or ceiling outlet with rosette and 100 volts bulb and switch.

7.06.14 Connections and electric wiring diagram.

7.06.15 Diagrams of the water connections, tanktrol, etc. Pressure graphs shall be equipped with two pens for in line stations and one pen for filtration plants or distribution tanks.

CHAPTER VIII

SAFETY REGULATIONS

Two basic Safety Categories exists in the design of an Aqueduct or Sewer System:

1. Enviromental Health
2. Physical Safety

This norms emphasied the Physical Safety and the designer is made responsable for the Environmental Health.

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CHAPTER VIII

SAFETY REGULATIONS

8.01 General Regulations

8.01.01 Two main basic categories of environmental concern exist in the design of "Aqueducts and Sewer Systems," these being, the Occupational Health and Physical Safety.

Because the norms or premises to be used in the phase of Occupational Health vary according to the design criteria established by the designer, this Authority has emphasize the Physical Safety matter, however, it is the designer's responsability to consider in the design the requirements for the protection of the Occupational Health.

8.01.02 Every vertical and/or conventional stairway will comply with the requirements of the "General Safety Regulations", OSHA 2206 (29 CFR 1910).

8.02.03 Every lot where an installation is built, will be protected on all sides by a 1.83 meters (6 feet) high chain link fence with barbed wire on its upper part and a 0.30 meter (1 foot) high concrete continuous base. (See Fig. No. 1). High voltage warnings shall be placed on each side.

8.01.04 Rubber mats shall be installed in front of electric panels. They will have a Dielectric Strength of 20,000 volts and will be 0.76 meters (30 inches) wide and 4.8 millimeters (3/16 inches) thick.

8.01.05 Exposed moving parts of the machinery (pulleys, belts, shafts, etc.) shall be protected with guards to prevent accidental contact of persons with them.

8.01.06 Inside structures manhole covers shall be made of aluminium.

8.01.07 Hand rails and guards, around tanks, trenches, pits, stairwells and other hazarduous structures, shall be provided and built fastened to concrete.

8.01.08 All electric equipment shall be connected to a common ground.

8.01.09 Platforms or suspended passage ways over 1.07 meters (3.5 feet) above floor will be protected with rails on all open sides.

8.01.10 Vertical stairways, 6.10 meters (20 feet) high or more, shall be provided with a safety cage.

8.01.11 Fire extinguishers shall be installed 1.07 meters (3.5 feet) above floor level, from the hooking point.

8.01.12 Conventional stairsways with four (4) or more steps, shall have hand rails on the closed sides and a rail installed on open sides.

8.01.13 A cold water fountain shall be provided at all installations where Authority personnel is on duty.

8.01.04 At all installations where chlorine cylinders are used, equipment shall be provided to check and control gas fumes.

8.02 Aqueduct Systems

8.02.01 The manhole covers of the tanks shall be made of aluminum and provided with padlocks. See Fig. No. 26.

8.02.03 A ten (10) pound CO_2 fire extinguisher shall be provided at Filtration Plants and a five (5) pounds one at Pumping Stations.

8.02.04 Provision shall be made for exterior lighting at Filtration Plants and Pumping Stations.

8.02.05 Railing for safety around filter areas adjacent to sidewalks or catwalks shall be provided.

8.02.06 Aluminum hand rails, 1.52 meters (5 feet) long and 1.07 meters high, (3.5 feet) shall be installed at a ninety (90) degree angle, at the corner where the manhole is located, on the roof of distribution tanks that are 1.22 meters (4 feet) high or higher.

8.02.07 Electric panels will not be built embeded in or fastened to any tank wall.

8.02.08 A rail shall be installed to protect open sides of the float valve enclosure.

8.03 Sewer Pumping Stations

8.03.01 The aluminum rail around floor or wall openings to unload, lower or bring up equipment and/or materials shall be fastened to the floor. The side in front of entrance door and one side of the floor opening will be removable. Floor openings will be provided with a concrete or block curb.

8.03.02 Lighting in the dry pit shall be explosion and rust proof. No lighting will be installed in the wet pit.

8.03.03 All exposed electrical conduits shall be P.V.C.

8.03.04 The inlet valve shall be controlled from the control floor by means of an extension.

8.03.05 Pumps shall be driven by explosion proof motors.

8.03.06 A five (5) pound CO_2 fire extinguisher shall be provided and located near the entrance door.

8.03.07 The pump station shall be provided with exterior lighting.

8.03.08 The generator's vent pipe shall be protected with an asbestos cover and will discharge above the roof level of the pumping house.

8.04 Sewer Treatment Plants

8.04.01 Near the entrance door to the main building a ten (10) pound CO_2 fire extinguisher shall be installed.

8.04.02 Exterior lighting shall be provided

8.04.03 The gas burner shall be 1.83 meters (6 feet) above the upper level of the digestor dome.

8.04.04 Recirculation pump pits shall be provided with aluminum grating of 1.2 centimeter maximum diameter openings.

8.04.05 The stairway to the digestor dome shall be of the spiral type following the lateral curve of the digestor. A hand rail shall be provided on the open side and a minimum width of 0.61 meter (2 feet).

The stair treads shall be 20 centimeter (8 inch) and the riser will be 25 centimeters (10 inches). From the upper end of the stair to the center top of the dome a rail on both sides shall be provided.

8.04.06 Conventional stairways to the tanks and other units of the plant shall have slopes between 50° and 30° (preferably near the latter) from the horizontal to facilitate carrying samples, tools etc. Hand rails, 84 centimeters (34 inches) high shall be provided.

8.04.07 Aluminum posts and removable chains shall be provided at all rail openings leading to basements or pits.

8.04.08 Spiral stairs with handrail or railing shall be provided for access to basements. The hight of the stairs shall not exceed 4.57 m (15 ft.). The design should follow the model approved by the Authority (See Fig. 46). No hight limit will be required for inclined stairs.

8.04.09 Lighting in the dry pit shall be explosion and corrosion proof. No lighting will be installed in the wet pit.

8.04.10 P.V.C. pipe shall be used in all exposed electrical piping.

8.04.11 The generator exhaust pipe shall be protected with an asbestos covering and will discharge above the roof level of the house.

8.05 Chlorination Room

8.05.01 If chlorine cylinders or gas chlorination equipment are to be in a building used for other purposes, a gas-tight room shall separate this equipment from the rest of the building. Floor drains from the chlorine room should not be connected to floor

drains from other rooms. Doors to the chlorine room shall open only to the outside of the building, and shall be equipped with panic hardware. These rooms shall be at ground level and should permit easy access to all the equipment. Chlorine storage area should be separated from the feed area. To permit the chlorinator to be viewed without entering the room, a clear glass, gas-tight, window shall be installed in an exterior door or interior wall of the chlorinator room.

The chlorination rooms should be protected from excess heat. Cylinders shall be kept at room temperature. A forced or mechanical ventilation shall be installed which provides one complete air change per minute when the room is occupied.
The system shall be made of corrosion-resistant material and the motor shall be explosion proof and located away from the air path. The entrance to the air exhaust duct from the room shall be near the floor and the point of discharge shall be so located as not to contaminate the air inlet to any buildings or inhabited areas. Locate air inlets so as to provide cross ventilation with air and at such temperature that will not adversely affect the chlorination equipment. The vent hose from the chlorinator shall discharge to the outside atmosphere above grade.

8.05.02 A depressed floor slab shall be designed to place the scale platform at floor level, and an adequate discharge will be provided.

8.05.03 The air exhaust shall be installed 0.15 meters (6 inches) off the floor and discharge to the outside atmosphere.

8.05.04 All doors shall be metal (steel or aluminum) doors of a type and quality accepted by the Authority and provided with lock and door pull. Doors should open to the outside, and supplied with one coat of factory applied protective primer.

8.05.05 Switches for lights and fans shall operate automatically when the door is open, and also manually from the outside of the room without opening the door.

8.05.06 At least two (2) gas masks, in good operating condition and of a type approve by MSHA and by OSHA, as suitable for high concentrations of chlorine gas shall be available at all installations where chlorine gas is handled. These shall be stored outside any room where chlorine is used or stored and at a convinient location. Instruction for testing and using the equipment shall be posted. The use of self-contained, oxygen - supplying equipment shall be considered.

8.05.07 One ton cylinder lifting equipment shall be provided when this size cylinders are used.

8.05.08 At least a pair of rubber gloves, a respirator of a type certified by NIOSH for toxic dusts or acid gas (as necessary), an apron, or other protective clothing, and goggles or face mask shall be provided all in accordance with the requirements of the Authority.

A water holding tank that maintains water at room temperature will be installed to supply the line feeding the deluge shower and eye-washing device.

8.06 Electric Sub-Stations

8.06.01 The chain link fence protecting the sub-station shall be connected to common ground.

8.06.02 On each side of the fence a warning sign shall be installed, reading "Danger, High Voltage", size 25 cm.x36cm (10"x14"). Equal or similar to sign #135-A from catalog #14 of Stonehouse Signs Co.

8.07 Unfire Pressure Vessels

8.07.01 The unfire pressure vessel for the compressors will be ASME coded and stamped.

8.07.02 A safety valve with a tester shall be connected directly to the vessel.

8.07.03 So that the inside pressure can be check a manometer shall be connected to the vessel.

8.07.04 The safety valve with the tester shall have a sign, showing the pressure at which the valve will open.

8.07.05 The manometer shall be graded for a higher pressure than the design pressure of the tank.

CHAPTER IX

WATER SUPPLY NORMS FOR APARTMENTS AND CONDOMINIUM BUILDINGS

Is is of common knowledge the existing problems in the supply, metering and billing of water to apartments and condominium buildings. The Authority has studied and established a series of alternatives to be considered by the potential customers in this category.

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CHAPTER IX

WATER SUPPLY NORMS FOR APARTMENTS BUILDINGS AND CONDOMINIUMS

9.01 Foreword

The basic system to measure water consumption in apartment buildings and condominiums is by a main water meter, which will measure the total water consumption of the building. However, at the request of the owner of the building or condominium, the Authority will accept the installation of individual meters for each apartment. In which case, each tenant is made responsible for the contract and payment of the water and sewer facilities supplied to each apartment. Any of these methods, with their different variations, will be in accordance with the requirements of the following alternatives.

9.02 Manners of Measuring and Billing Water Consumption

See Fig. No. 55

9.02.01 Alternative A

Total water consumption of the building will be measured by a general meter. The Owner of the building or the Administration of the condominium will be invoiced. Installation of facilities so that the Owner or the Administration of the condominium establishes and invoices, the individual consumption of each tenant, by means of individual water meters, located every three (3) floors as explained in the special conditions.

9.02.02 Alternative B

Separate water consumption and invoicing to tenants, by individual meters installed on the ground floor or basement of the building. A separate meter will be installed to measure water used for common needs of the building.

9.02.03 Alternative C

Water consumption measured and invoiced separately to each tenant by meters installed every three (3) floors as explained in the special conditions. Water used for common needs measured by a meter.

9.02.04 Alternative D

Separated water consumption and billing directly to tenants by individual meters and without main water meter.

9.03 Special Conditions

The following special conditions will affect each individual alternative as indicated below:

9.03.01 Alternative A

Total water consumption of the building will be measure by a main water meter. The Owner of the building or the Admistration of the condominium will be invoiced. In addition, if so wished and at his own cost, the Owner may supply and install individual meters to measure and bill each tenant himself. These meters shall be installed every three floors, grouped on the intermediate floor, in a "closet" and in an area accessible to personnel of the Authority. A stop valve shall be installed in the supply line for each apartment accessible only to the tenant or owner.

a- The operation and maintenance of these meters will be the responsability of the Owner or Administration of the Condominium.

b- At the request of the Owner of the building or Administration of the condominium, the Authority will calibrate and repair the meters, charging for this service.

When the Owner or Administration requests the verification of any fluctuations in the water consumption registered by the main meter and the total registered by the individual meters, the Authority will limit itself to determine whether the readings were correct or not, without any intervention with individual or common service installations.

9.03.02 Alternative B

Separate consumption measuring and invoicing to tenants by individual meters installed at ground level floor or basement. A separate meter shall be installed to measure water used for common needs.

a- The owner of the building or condominium shall supply and install water meters, meter boxes, and any other necessary accessories to measure the individual water consumption of each apartment. These meters will be installed parallel to each other, on the ground floor or basement of the building in an accessible area, where vehicles can not be parked. They will become the property of the Authority.

b- The Authority will invoice each tenant according to the reading of the corresponding meter.

c- The Authority will bill the Owner of the building or the Administration of the condominium for the balance between the main meter reading and the total of the consumption registered in the individual meters, which difference may be the result of defects in the system or unauthorized connections. Such water consumption of the building measured by the main meter, will be paid subject to the rates established by the Authority.

d- The Authority will be responsible for the maintenance of the water connection up to the main water meter and the individual meters. The Owner or the Administration will be responsible for the operation and maintenance of the installation between the main water meter and the individual meters, as well as beyond the individual meters.

e- If the water meters are installed within the property limits of the building, the Authority will be exonerated of any responsability for damages to the building, tenants, or any other person, as the result of the operation or maintenance of these meters. (A clause to that effect will be included in the contract documents).

9.03.03 Alternative C

Water consumption and invoice to tenants by individual meters, installed every three floors and grouped at the intermediate floor. Water used for common needs shall be measure by a separate meter installed for that purpose.

a- The Owner of the building or the Administration shall supply and install the water meters, meter boxes, and other equipment, according to requirements of the Authority, to register the water used by each apartment. The meters may be of the remote reading type.

b- The meters may be grouped every three floors, installed on the intermediate floor in a room or cabinet, located as near to the elevator exit as possible. The room or cabinet shall be provided with a door and lock to prevent access to non-authorized persons in such a manner that permits the easy reading and maintenance by the Authority personnel. The type of locks shall be selected by the Authority so as to master keyed them.

c- The remote reading mechanism shall be grouped and installed on the ground or basement level in an area or cabinet accessible only to the Authority's personnel.

d- These meters, remote reading devices and accessories shall become the property of the Authority.

e- The Authority shall not be held responsible for damages to the building, to any person or property as a result of operation and maintenance of these meters. (A clause to that effect shall be included in the service contract).

f- Each tenant shall be billed by the Authority for the water used according to the reading registered in the corresponding meter.

g- The Authority will invoice the Onwner or the Administration for the balance shown between the reading of the main meter and the total

consumption register by the individual meters. This difference will be assumed to be the amount used for common use, defficiencies in the installation and un-authorized connections. Water consumption, register by the main meter shall be subject to the rates established by the Authority.

h- The Authority shall be responsible for the maintenance of the water connection up to the main water meter or for the individual water meters. The Owner or Administration shall be responsible for the operation and maintenance of the installation between the main water meter and the individual meters, as well as the installations beyond the meters.

i- The piping system for the common needs shall be separated from the system for the tenants use, and shall be provided with a meter and shutoff valve.

9.03.04 Alternative D

Water consumption metered and invoiced to the individual tenant, with no main water meter.

a- Installation of individual meters may be permitted in those buildings where water service may be totally provided by gravity.

b- In such installation the Authority shall provide the meters.

c- The Owner or Administration of the building shall supply and install the meter boxes and other necessary equipment, according to the Authority requirements, needed to measure and register the water consumption by each apartment and for common needs. The meters shall be installed parallel to each other and located in the planting strip, side walk or other place approved by the Authority.

d- The Authority will bill each tenant or condominee the corresponding water used and the Owner or Administration the water used for common needs.

e- If the meters are installed within the property limits, the Authority shall be exempted of all responsability for any damages to the building, persons, resulting from the operation and/or maintenance of the water meters. A hold harmless agreement shall be included in the contract for services.

9.04 General Conditions

9.04.01 The following general conditions will govern in all cases:

a- The Authority shall determine the diameter of main water meter to be installed and shall supply it free of charge.

b- The Owner or Administration of the building will supply the facilities needed for the installation of the meter, including the lateral bypass if it is larger than 2 inches in diameter. Will also build a concrete protection box with steel frame and cover. These accessories will become the property of the Authority.

c- When the installation of a pumping system is necessary, the water supply to the building shall be stored in a suction pit, from where it will be pumped. The main water meter shall be installed before the suction pit.

d- A combined system which will supply the building partly by direct connection to the main line and partly by a pumping system will not be permitted. Either a complete pumping system or a direct connection to main line system shall be used.

e- In case the fire hydrants, installed in the building are use, either to put out a fire or for a bonafide fire drill, the water used for these purposes will be free of charge.

A credit will be given to the amount registered by the meter. No credit will be given for water used for any other purpose. The installation of a "Detector Device" shall be required, to check the use given to the water from the fire hydrants.

f- During the designing or planning stages the designer should consult the Authority regarding the water and sewer facilities available in the area where the building will be constructed.

g- The Authority requires that plans for the water and sewer installations for apartment buildings three stories or higher, or providing service for ten (10) or more apartments, shall be submitted for approval.

h- In addition to the Special and General conditions aforementioned, the Regulations for Water Supply and Sewer Service of the Authority, described in Chapter 10 of this Norms, shall apply.

i- In front of each meter box, a bronze plaque will be provided, indicating the floor and apartment to which it corresponds.

j- The service contract for water supply for the common use of the building shall be signed by the Owner or Administration of the Condominium.

k- In those cases where the water meters are located within the property limits (ground floor, basement, parking areas, etc.) they shall be protected in such a way that will permit access, at all times, to the meters.

Clause that should be included in all service contracts for apartment buildings or condominiums where individual water meters are installed within the property limits of the building:

If the installation of individual water meters is approved by the Puerto Rico Aqueducts and Sewer Authority for the apartments and or

common use of the building, located on the ground floor, basement or other approved location, the owner of the building and tenants hereby exonerate the Puerto Rico Aqueduct and Sewer Authority of any responsability for any damages, either personal or to the property, caused as a result of the operation and maintenance of said water meters,

1- The case of water meters embedded in a wall or vertically installed, shall be considered.

RULES AND REGULATIONS FOR THE SUPPLY OF WATER AND SEWER SERVICE

PUERTO RICO AQUEDUCT AND SEWER AUTHORITY

1976

CHAPTER X

RULES AND REGULATIONS FOR THE SUPPLY OF WATER AND SEWER SERVICE

Considered very usefull for those who deal with Aqueduct and Sewer, our Rules and Regulations for the services we render as of 1976.

Content

The contents are included within the Regulation.

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CHAPTER I

PRELIMINARY PROVISIONS

Section 1.01:- Legal Basis

These Rules and Regulations issued in compliance with and pursuant to Section 4, Paragraphs 5 (j) and (k) and Section 19 of the Aqueduct and Sewer Act, as amended by Law 163 of May 3, 1949 (22 L.P.R.A. 144 and 159), shall have force of law and any violation thereof shall be deemed a misdemeanor.

Section 1.02:- Statement of Motives

The purposes of these Rules and Regulations are to comply with the provisions of the Aqueduct and Sewer Act, which requires their promulgation (see Legal Basis, Section 1.01); facilitate the rendering of the public services, for which purpose the Authority was created, in an orderly way; protect the installations of said instrumentality's systems; safeguard the public health, and establish the rights and obligations of the customers and users, the public, and the Authority.

These Rules and Regulations are intended to be administered in a spirit of cooperation with the public, consumers, and users, without failing to enforce compliance therewith.

Section 1.03:- Definitions

The following words and phrases appearing herein shall have the following meanings, unless other meanings can be clearly construed from the context of the provisions or from the Rules and Regulations:

1- Customer - Any natural or legal person having an account registered with the Authority under his name as regards the services rendered by the latter.

2. Service Connections:

(a) Water Service Connection - The connection from the main pipeline to the water meter, or in its absence, to the point where it enters the particulars property.

(b) Sewer Service Connection - The connection from the main sewer pipe to the point where it enters the particular property.

3. Fast Meter - Registration by a water meter in excess of the correct consumption.

4. Tributary - A stream or river flowing into a bigger one.

5. Sewage - The waste products flowing from the customer's or user's interior installations or sludge discharged therefrom, not including stormwater.

6. Sewer - Shall only mean the sanitary sewer.

7. Authority - The Puerto Rico Aqueduct and Sewer Authority.

8. Charge - The amount invoiced the customer for water and/or sewer service rendered, according to the rates in force.

9. Sewer Main - The primary pipeline collecting sewage.

10. Consumption - The volume of water supplied a customer or user.

11. Meter - The measuring device registering water consumption.

12. Testing - To prove the exactness of a water meter.

13. Account - The individual record maintained by the Authority for services rendered to customers.

14. Branch - The extension or diversion of the water pipelines.

15. Illegal Discharge - The unauthorized disposal of sewage, inclu-

ding water from private sources, or any unauthorized substance, through the Authority's sewer systems.

16. **Industrial Waste** - Any discharge in liquid, gaseous, or solid form, or any combination thereof, resulting from industrial, manufacturing, and/or commercial processes.

17. **Accessory Building** - Any building dependent upon another for its use, located within the limits of the same property.

18. **Apartment Building** - Any structure of two or more units belonging to the same owner, regardless of whether these units are used for residences, offices, commercial establishments, or any other use.

19. **Condominium Building** - Any structure of two or more units of housing, offices commercial establishments, or for any other use pursuant to the Horizontal Property Act or the provisions of the Puerto Rico Civil Code.

20. **Reservoir** - The body of water created for the community's supply. This term shall also include the adjacent grounds and surrounding structures.

21. **Source of Supply** - The springs, river beds, torrents, streams, rivers, deep wells, shallow wells, reservoirs, lakes, lagoons, and any other natural or artificial body of water supplying the Authority's waterworks.

22. **Interior Installations** - The whole set of pipelines and/or appurtenances thereto located beyond the service connection.

23. **Main Line** - The principal pipeline.

24. **Shutoff Valve** - The valve located just before the meter, interrupting the flow of water through it.

25- **Organic Matter** - The matter causing a degrading in the quality of water.

26. **Nipple** - A piece of pipe used to connect the meter with the customer's or user's private pipeline.

27. **Person** - Any natural or legal person.

28. **Sewerage Wells:**

    (a) **Septic Tank** - The tank where sewage settles and decays.

    (b) **Filter Well** - A well that allows filtration into the surrounding ground.

    (c) **Cesspool** - An absorbing well.

29. **The Public** - Any person or persons with the exception of the Authority.

30. **Leakage** - Water escaping from pipes or installations.

31. **Hidden Leakage** - An undetected leakage from subterraneous pipes or from pipes located beneath tiles or embedded in walls.

32. **Water Service** - The water supplied to customers or users.

33. **Combined Water Service** - The use of water for combined residential and non-residential purposes.

34. **Sewer Service** - The service rendered to customers or users by means of a sanitary sewer system.

35. **Water System** - The installations, pipelines, and appurtenances thereto functioning as a unit to provide water service to a community.

36. **Sewer System** - The installations, sewer mains, and appurtenances thereto functioning as a unit to provide sewer service to a community.

37. **Illegal Connection** - An illegal connection to the Authority's water and/or sewer system. This term shall also include the unauthorized reconnection to a suspended or discontinued service.

38. Cleanout Hole - An opening to facilitate the cleaning of the sewer service connections.

39. User:- Person enjoying the water and/or sewer service.

(a) **Registered User** - The person enjoying the water and/or sewer service registered in his name at the Authority.

(b) **Non-registered User** - The person enjoying water and/or sewer service registered in the name of another person.

(c) **Illegal User** - Person enjoying water and/or sewer service without authorization.

CHAPTER II

GENERAL PROVISIONS

Section 2.01:- Regularity of the Services Rendered by the Authority

The Authority shall render its water and sewer services in the most regular and continuous possible manner, but may interrupt them by reason of special circumstances, such as, but not limited to, a decrease in the volume of water, repair and improvements to the systems in operation. The Authority, however, reserves the right to interrupt these services without prior notification, for emergency repairs and to prevent damages to its property in case of strikes, orders from competent authorities, or due to accidental causes or acts of God, public enemies, or when dangerous situations threaten the life, health, or property of the citizenry. Such interruptions shall not constitute a breach of contract on the part of the Authority and, neither the Authority, nor its employees shall be held responsible for service interruptions due to such causes. Nevertheless, the Authority shall use all the reasonable means available to reestablish the services as soon as possible. Whenever possible, the Authority shall inform the public of any necessary interruption of the services.

Section 2.02:- Operation of the Water and Sewer Systems - Interference with these Systems Prohibited

Only the employees and duly authorized agents of the Authority shall operate the water and sewer systems of this instrumentality and shall install connections and perform other works in said systems. It is hereby prohibited to any unauthorized person to perform said acts to manipulate, alter, obstruct, deface, mutilate, destroy, or tamper with any installation or any part of said systems.

Section 2.03:- Visits to the Authority's Plants

Visits to the Authority's plants will only be permitted by means of an authorization in writing.

No person, group, or entity shall visit said plants without the corresponding authorization.

Section 2.04:- Protection of the Water Supply Sources

It is hereby prohibited to throw into the water supplys sources or its tributaries, untreated sewage, industrial wastes and substances, liquids or any matter or objects that may pollute the waters and/or cause any harm to its plants and equipment. This prohibition includes the throwing or depositing on the banks or shores of water sources or in any service box of said wastes, or any substances, liquids, solid matter or objects. In general, any act that may pollute the waters of the Authority's waterworks or hinder its effectiveness, is prohibited.

Section 2.05:- Other Provisions for the Safeguard of the Public Health

It is likewise prohibited to bathe, swim, wash clothes, water and bathe animals, spit, wash vehicles, in the water sources or to use the waterworks and the waters of their tributaries in any such way as to jeopardize the public health or alter the physical, chemical, or bacte-

riological state of the waters. It is also prohibited to urinate, defecate, throw or deposit urine, excrement, or manure on the sorrounding grounds, on the tributaries banks as well as depositing molasses, any waste or garbage, animal carcasses, refuse from slaughter houses, pounds, or meat - markets where the water sources might become polluted, or any refuse containing organic matter, or chemicals harmful to the quality of the waters, such as, but not limited to: detergents and petroleum derivatives, etc.

The Authority may order the removal or interment of the infectious matter and, if not removed within twenty-four hours (24) it may do so at the expense of the offender.

Section 2.06:- Location of Septic Tanks and Cesspools

Pursuant to regulations on water pollution control of the regulatory agencies of the Commonwealth of Puerto Rico, it is hereby prohibited to locate latrines, septic tanks, or cesspools in the vicinity of the water supply sources of the Authority's waterworks, where they may contaminate the waters therein.

Section 2.07:- Additional Prohibitions

Any activity jeopartizing the water and sewer systems of the Authority, or detrimental to the purity and conservation of the water supply sources, is hereby prohibited. The Authority is empowered by law to correct or eliminate such situations.

Illicit intake or discharge connections shall constitute a violation to these Rules and Regulations and the Authority shall eliminate them at the violator's expense if he does not remove them voluntarily within fifteen (15) days after being notified in writing.

Section 2.08:- Prohibitions to Employees

The Authority's employees are hereby prohibited from soliciting or accepting any compensation for their personal benefit in exchange

for services rendered to the public while representing the Authority. It is also prohibited to carry out, modify, or overlook any charges, obligations, terms, or conditions of contracts or documents, except when such action is done pursuant to the Authority's rules and regulations.

Section 2.09:- Judicial Procedures

The Executive Director of the Authority, in representation thereof, may request an injunction procedure an any such other legal resources according to law to make efective the terms contained in these Rules and Regulations.

Section 2.10:- Other Provisions

None of the provisions of these Rules and Regulations shall be construed as a restriction on the power of the Authority's Governing Board to amend and impose other terms and conditions that are not against the law.

CHAPTER III

COMMERCIAL RELATIONS OF THE AUTHORITY

Section 3.01 - Charges for Services Rendered by the Authority

The Authority shall operate on an economic basis that will permit it to be self-sufficient; thus, it will offer no service free of charge. All services rendered will be charged according to the rates or charges set for said services and will be subject to the rules and conditions stated in the following sections.

Section 3.02 - Applications for Service

Water and sewer services are available to the public upon filing a written application, personally or by telephone, subject to the prevailing or amended rates at the time of said application, provided

that in compliance to the procedures and requirements of the Authority the applicant has access to the supply mains in use, and provided that the available facilities permit rendering such service. Any person utilizing water and sewer services without a duly registered application with the Authority will be responsible for payment thereof and for compliance with the applicable rules and regulations.

Section 3.03 - Guarantees or Deposits

(a) The Authority reserves the right to require from any customer or user the guarantees deemed proper and satisfactory to secure payment for water and/or sewer service, by means of a deposit, bond from an insurance company acceptable to the Authority, or by any other means authorized by law. This guarantee is non-transferable.

(b) In order to insure its best interest, the Authority also reserves the right to require or increase the amount of the deposit, bond or any other accepted guarantee, to any customer or user who persistently fails to pay his bills on time. The amount may also be justifiable altered following changes in the customer's consumption pattern.

(c) Failure to pay this deposit within ten (10) days from the date the connection was made or the service was iniciated, or within ten (10) days after notification of any deposit increase due to delinquency or changes in the consumption pattern, may cause the Authority to suspend water and/or sewer service to the customer or user. The deposit required shall be computed on the basis of the average estimated consumption for two invoicing periods.

Section 3.04 - Payments, Suspensions, and Restoration of Service

(a) The Authority may schedule the meter reading, invoicing and collection procedures for water and/or sewer service at its discretion, either on a monthly or bimonthly basis, or otherwise, aiming at a better, more efficient and more economical service to the public. This scheduling shall take into consideration the characteristics and

nature of the water and sewer services rendered under different rates. Invoices shall be paid before the date due indicated thereon. If the date due for payment of the invoice falls on a Saturday, Sunday, or legal holiday, then the next working day shall be considered the date due. Lack of receipt of invoice does not relieve customer from payment thereof. Failure to pay the invoices prior to said date entails a written notification from the Authority advising the customer of its intention to suspend service for lack of payment. Once the customer is notified, he should pay within the prescribed time only at the commercial office in charge of his account. The Authority shall not be held responsible for suspension of service if payment is made elsewhere.

(b) If a customer or user disagrees with the invoiced charges, he may request an investigation within the next ten (10) calendar days from the date of receipt of invoice. This request may be made in writing or personally and should state the reasons for the claim.

(c) A customer or user requesting said investigation within the prescribed time shall not have service suspended nor shall be requested to post additional bond or deposit while the investigation is being carried out. If the investigation shows that the invoices are correct or that a revised payment thereof is due, claimant shall be notified said results in writing and advised that he has ten (10) calendar days from the date of notice to make payment or request an administrative hearing if still in disagreement with the outcome of the investigation. Claimant has the right to request said hearing before a higher ranking officer from an office other than the office that conducted the investigation or decided upon his claim. Once the ten day period is over, if claimant does not effect payment or request the before mentioned hearing, the Authority may suspend service.

(d) The customer or user requesting an administrative hearing within the prescribed time, shall pay, before this hearing is held, the amount determined by the investigation already conducted, or the average computed by the Authority based on the last three (3)

periods of normal consumption. In accordance with this, the Authority shall not suspend service.

(e) The customer or user shall have the right to be represented by an attorney during the administrative hearing and shall be able to introduce oral and documentary evidence in support of his claim, as well as able to examine the evidence introduced by the Authority to support its determination. If it follows from the administrative hearing that the customer's or user's allegations are correct, and that an adjustment in the charges is to be made, the Authority shall return or credit any amount paid in excess. If, on the contrary, it follows that the charges invoiced are correct, and the customer or user neither pays nor request judicial revision within ten (10) calendar days after being notified of the findings, the Authority shall suspend service.

(f) For the computation of the prescriptive ten day periods of this section, the date that shall prevail shall be the date when the customer or user, or his representative visits the corresponding office. If the claim is made through the mails, the date on the cancelled postage stamp shall prevail. The Authority shall turn down any claim made outside the prescribed time, unless claimant can prove to the Authority's satisfaction that for reason beyond his control this claim was not made within the mandatory tenday period.

(g) When service has been suspended for lack of payment, and the customer or user request reconnection, the amount of $10.00 shall be charged to cover the costs therefrom incurred by the Authority.

Section 3.05 - Charges for Water and/or Sewer Services when a Meter Reading is not feasible

Whenever it is not possible to determine the actual consumption due to a meter failure or if a meter reading cannot be effected, the Authority can charge for the concerned period an amount equivalent to the user's normal consumption. In case there is no record of the normal consumption a reasonable estimate shall be determined. In case of cessation of such cause, the Authority shall determine the

corresponding adjustment to the account.

Section 3.06 - Liability of Registered Customer

Each registered customer shall be liable for payment of all services rendered under his name. Said liability shall continue in effect even when said customer has ceased to use the services and the same continue to be used by other persons, with or without his consent. Said liability will only cease when the registered customer duly requests cessation of services.

Section 3.07 - Liability of Non-Registered Users

Each non-registered user shall file an account under his name and shall deemed responsible for total payment of services put to use. When said non-registered user has profit from services filed by a registered user both shall be held jointly and severally responsible for payment thereof. Likewise, the Authority can register said service under the name of the non-registered user and request him to fulfill all established requirements. Failure to compiy with these within ten (10) calendar days from the date of notice shall constitute sufficient cause for suspension of service.

Section 3.08 - Refusal to Render Service

The Authority can refuse to provide its services to any person owing any charges for services rendered and to any person who in any way violates these Rules and Regulations of the Puerto Rico Aqueduct and Sewer Act or any other applicable act or regulations.

Section 3.09 - Transfer of Debts to Current Accounts

The Authority may transfer any debt for services rendered to a customer or user to another account registered under his name and may charge the account of an customer or user with any debt contracted under the circumstances held within the preceeding Section 307.

Section 3.10 - Illicit Intakes and/or Discharges

All illicit intake and/or discharge connections are hereby prohibited. Any person using an illegal intake and/or discharge connection shall pay to the Authority the total estimated charges for aqueduct service and sewer discharges. A violation of this provision shall be sufficient cause for disconnecting said intake and/or discharge connection and decree the appropriate judicial procedures.

Section 3.11 - Legalization of Illicit Intakes and/or Discharges

Illicit intake and/or discharge connections as specified in the previous section may be legalized if the condition of the installation and service so warrant, provided that the other requirements established by the Authority are complied with and the interested party pays the debt for all services rendered plus those expenses incurred by the Authority to legalize the services.

Section 3.12 - Supply of Meters by the Authority

The Authority shall provide water meters up to a size of four inches (4"), except in condominiums or apartment buildings where it will only furnish a general meter. Meters larger than four inches (4"), shall be furnished by the subscriber and turned over to the Authority. In the case of condominiums and apartment buildings the provisions under the Standards of Design of the Authority shall apply.

Section 3.13 - Customer's Liability in Regard to the Authority's Property

All meters, house connections and any such other equipment supplied by the Authority shall remain its property and the latter reserves its right to substitute, remove or repair such equipment. Nevertheless, the customer or user shall deep guard to protect the Authority's property and take the necessary precautions in order to avoid any damage to said installations. Furthermore, the user shall watch over any tampering or otherwise interfering with the meters or

any other service equipment.

Section 3.14 - Handling of Water Meters

(a) The handiling or tampering in any way the water meters by persons other than the duly authorized agents of the Authority shall be prohibited. This includes the handling of all corresponding fittings, including the shutoff valve to said meters.

(b) Any violation of this provision shall be considered a misdemeanor. Furthermore, the violator shall be made responsible for all charges not registered as a result of such handling. This charge shall be compute according to his average consumption. All cost of the investigation and repairs shall also be his responsability.

Section 3.15 - Obstructions on the Water Meters

Nothing shall be layed on top of the meters or their protective housing that may prevent the meter reading or handling. Any such obstacle shall be considered a public nuisance and subject to the provisions of Section 19 of the Aqueduct and Sewer Act shall be removed by the Authority at the customer's or user's expense.

Section 3.16 - Destruction of Meters and/or Fittings

Any person who partially or totally destroys a water meter and/or its fittings shall be held responsible for the cost and reinstallment of said meter and/or fittings installed in the property if said damages prove malitious or negligent action on his part. In case the person held responsible for such action is an Authority's customer or user and fails to pay the costs of reinstallment, his service shall be discontinued and the deposited guarantee shall be forfeited. When necessary, legal action shall be initiated in order to recover the total cost of damages.

Section 3.17 - Relocation of Damaged Meter

Whenever a broken or damage meter is fixed on public property, the Authority may move it to a safer place which could be the private property being served. When moved at the request of the customer, user or any other concerned person or by any cause attributed to them, it shall be done at their expense.

Section 3.18 - Meter Testing by the Authority

The Authority shall test, at its own expense, the water meters when in its judgment, there shall be sufficient grounds to doubt of their efficient and exact functioning.

Section 3.19 - Meter Testing at Customer's or User's Request

Every customer or user shall have the right to require that the Authority test his water meter upon payment of the Authority's established fee for said purpose. He also shall have the right to watch the test, if he so specify, when making said request. Said fee shall be reimbursed if the results show that the meter is more than 2%o fast.

Section 3.20 - Adjustment in Case of Deffective Meters

Once the test is completed, if the meter is found to be 2%o slow or fast of the correct measure, the Authority shall adjust the customer or user's account for the last three billings.

Section 3.21 - Adjustment Due to Deficiency in Water Service

The Authority shall adjust the charges billed for water and sewer service when the customer or user has been subject to an irregular and insufficient water service for over a month, in accordance with the criterion established by the Standards for Adjustments on Deficient Water Service.

Section 3.22 - Inspection of Interior Installations

A customer or user with a high water consumption may request

the Authority to carry out an inspection of the interior installations of the affected property, persuant to the provisions of Article 3.04 of this chapter, to determine the cause for such a high consumption. However, the Authority is empowered, but no bound, to carry out an inspection on its own initiative at any moment it deems convenient. The customer shall allow the Authority's duly identified employees to enter his premises or properties in order to carry out an inspection. When an investigation is to be performed in a condominium or apartment building with only one meter, it shall be limited to a verification of the billed charges and the meter operation without in any way interfering with the service installations of any particular apartment or the building's communal areas.

Section 3.23 - Adjustment in case of a Hidden Leakage

If in any case the Authority concludes that a high consumption of water is due to a hidden leakage, the consumer or user shall be entitled to an adjustment of his account equal to half the amount in excess of his normal consumption and for not more than three consecutive billing periods, provided said leakage is repaired within fifteen (15) calendar days of the Authority's notifications in writing. No adjustments or reductions shall be made to the customer or user's account due to leakages or wastes of water when these are caused by cracks or deffective appliances such as sanitary fixtures, receiving tanks, water heaters, cooling systems, etc.

Section 3.24 - Diversified Water Service

The Authority may, in certain cases, permit a combined water service. As for the application of rates, the Authority shall classify said service as non-residential.

Section 3.25 - Adjustment of Charges in Water Consumed for Fire-Fighting

The Authority shall not charge for water used for fire extinguishing and shall make the necessary deductions to that effect,

provided such fires, regardless of their proportions, are reported to the Fire Department.

Section 3.26 - Extension of Water Service Contract to Include Sewer Service

All accounts or contracts registered with the Authority for water service, shall automatically be extended to cover sewer service as soon as the customer or user connects his property to such service. Customers or users of water service who desire to benefit from sewer service shall request an authorization from the Authority before making such connection. Any connection without the corresponding permit shall be considered illegal, pursuant to Article 3.10.

Section 3.27 - Sewer Service Invoicing

Whenever any customers or users benefit from both services, all bills for water service shall include the corresponding charges for sewer service.

Section 3.28 - Adjustments for Sewer Service

Upon application from the customer, accompanied by the necessary information, the Authority shall adjust the sewer service charges to business enterprises or industries not discharging a considerable amount of the water served. Such adjustment shall never be retroactive. The Authority may require the installation of the necessary measuring devices to determine the exact volume of the sewer discharge.

CHAPTER IV

WATER SERVICE

Section 4.01 - Who May Receive Water Service

The Authority shall furnish water service upon application by any

natural or legal person, whose property is accesible to the supply lines in operation and who has complied with all requirements established by the Authority in accordance with its purposes as a public corporation to provide the community with the most efficient and economical services.

Section 4.02 - Rights and Obligations Concerning Water Service Furnished

The Authority will adopt the necessary measures to furnish an efficient service and the customer or user of the water services shall be entitled to the pipe, quality and regularity of service that the Authority can fairly furnish within the available to it.

Section 4.03 - Pressure at Which the Water Service Shall be Furnished

The Authority shall not be required to furnish water service at any specific pressure. Those in need of a higher water pressure shall provide, themselves, at their own expense the necessary equipment to achieve the desire pressure. The use of any divice, equipment or installation in connection therewith sha'l have the Authority's official permission.

Section 4.04 - Water Tapping Service - Property, Maintenance and Diameter

All water installations connected to the water main, up to and including the meter shall be the property of the Authority and remain under its sole control, even when the customer or user defrays the cost of installation.

The Authority shall take care of maintenance services on its installations up to the meter or, in its absence, up to the private property limits. Beyond that point, maintenance shall be the customer's or user's responsibility.

Diameter of the requested tapping and the size of the meter shall

be determined by the Authority according to its use and to the conditions of the existing system.

Section 4.05 - Branch Service Connections

Branch service connections to adjacent properties or independent installations not included under the service contract shall be forbidden. However, such connections to accesory buildings are allowed.

Section 4.06 - Multiple Services

Service may be furnished through one water meter to two or more housing, office or commercial units under special rates in force for water and/or sewer services.

Section 4.07 - Pump Connection

The use of pumping implements directly connected to the Authority's water systems pipelines is hereby prohibited.

Section 4.08 - Connection of Independent Water Systems

The connections of independent or private water supply systems to the Authority's waterworks, without its previous consent are hereby prohibited. Failure to comply with this provision, besides constituting a violation to these Rules and Regulations, shall also constitute sufficient grounds for suspension of water service rendered by the Authority.

Section 4.09 - Use of the Water Service - Cession of Services

The use of water for purposes other than those contracted for and the partial or total use of said services for the benefit of others are also forbidden, except in case of fire.

Section 4.10 - Handling of Public Fire Hydrants. Restraint for other Uses

The use and handling of public service fire hydrants for other than emergency uses and fire exiguishing or official fire drills is hereby prohibited, except if previously authorized by the Authority.

Section 4.11 - Water Service for Fire - Fighting in Private Systems

Connections to private fire-fighting systems shall be allowed provided they comply with the Authority's requirements and regulations in force, the payment of established rates and that said service is used solely for that purpose. The use of said service for other purposes shall constitute a violations of these Rules and Regulations and the Authority shall charge extra payment in addition to the regular rates.

In case of a second violation, the Authority can discontinue the service.

The use of water from private fire-fighting systems for purposes other than fire extinguishing or official fire drills is hereby prohibited, except by previous authorization from the Authority.

Section 4.12 - Payment for Unauthorized Use of Services for Fire Protection

Any unauthorized use of water shall constitute a violation of these Rules and Regulations. Any person or persons who incur in such violation shall pay the charges imposed for the water consumed for such purposes.

Section 4.13 - Waste of Water

(a) Every customer or user is under the obligation to avoid the waste of water and shall be responsible for all waste of water due to deficiencies in his inner installations. To this end, said connections shall be kept in good conditions.

(b) If and when the circumstances so justify it, the Authority is empowered to adopt the necessary measures for the best use of water, and to prohibit its use for certain activities. The Authority shall enforce the fulfillment of these provision. Failure to comply with them shall

entail suspension for services besides constituting a violation of these Rules and Regulations.

Section 4.14 - Prohibitions on the Use of Public Fountains

Public fountains shall only be installed by the Authority or by its consent. All public fountains installed in violation of these regulations shall be disconnected without notification. Regarding their use, the following is hereby prohibited:

1- Depriving others of their rightful enjoyment.

2- Hose connections.

3- Car-washing or bathing of persons and/or animals.

4- Branch service connections.

CHAPTER V

SANITARY SEWER SERVICE

Section 5.01 - To Whom Shall the Authority Render the Sanitary Sewer Service

The Authority shall render sanitary sewer services to any natural or legal person whose property has access to sewer mains in use and has complied with all established requirements. The owner, tenant or administrator of any building or structure adjacent to any street, avenue or thoroughfare having a sanitary sewer system or which may have access to same, shall register as a subscriber under the terms and conditions required by the Authority. Said person shall cease to use any other means for the disposition of waste waters and other wastes, unless such person owns an independent system for such disposition, constructed and operated in accordance with the laws of the Commonwealth of Puerto Rico and the rules and regulations in force in the Government instrumentalities concerned.

Section 5.02 - Sanitary Sewer Service Tapping

Sewer service installations from the main sewer tapping up to the subscriber's or customer's installation at the particular property line, shall remain under the exclusive control of the Authority and shall become the property of the Authority even though the cost of said installations may have been defrayed by the subscriber or customer.

The Authority shall be responsible for the maintenance of the connections up to the subscriber's or customer's property limits. The latter shall be responsible for the maintenance of all installations within its property limits.

Section 5.03 - Discharge of Industrial Wastes into the Sanitary Sewer System

A- Industrial discharges into the sanitary sewer system shall not be permitted unless a formal service contract has been submitted as provided by these Rules and Regulations.

B- Subscribers to the sewer system who discharge industrial wastes into the system shall submit information as to quantity and characteristics of said wastes as determined by the Authority.

Should the subscriber fail to submit the information herein required, the Authority shall make an estimate and determine the volume and nature of said discharges, as hereafter provided.

C- The subscriber or customer shall install at his expense, in an appropriate location within the limits of the property, an inspection man-hole and a measuring device, or a monitoring station, subject to the Authority's need and approval. This shall allow the Authority to gauge and sample the effluent, in order to determine its volume, flow rate, and any such other characteristic of the discharge of said effluent into the sanitary sewer system.

D- The insoectors and other authorized representatives of the Authority shall have access to the installations hereinbefore indicated,

without undue dealy during the subscriber's or customer's normal operating hours, to gauge, evaluate, and otherwise test the discharge. The Authority may estimate the discharge and its characteristics when the subscriber's or customer's instruments are not operating properly, when not possible to have access to the installations, or for any such other reason or cause.

E- All measurements, tests, evaluations, and analyses of the industrial wastes shall be made as prescribed in the latest edition available of the "Standard Methods for Examination of Water and Wastewater", and pursuant to the provisions of these Regulations. The estimates made by the Authority shall be based on the most recent known characteristics of the discharge.

F- The Authority may require from the subscriber or customer the installation, operation, and maintenance of a pH meter to gauge, register, and regulate the pH of the industrial wastes to be discharged into the sanitary sewer system. The instrument shall be approved by the Authority prior to its installation. The graphs obtained therefrom shall be available to the Authority when it so requires.

G- The discharge of the following substances into the sanitary sewer system is hereby prohibited:

1- Stormwater, surface water, underground water, roof runoff water, subsurface drainage, unpolluted cooling or industrial process waters.

2. Wastes containing pollutants as those described below:

a) Gasoline, benzene, naphta, fuel oil or any liquid, solid or gaseous substances in sufficient amounts to, as deemed by the Authority, constitute a health hazard or harm to humans, animals; or produce stench, or become undersirable; or may cause explosions of fire, or harm the Authority's sewer system.

b) Any toxic or poisonous solids, liquids, and gaseous subs-

tances in sufficient amount which, in the opinion of the Authority after consideration of the peculiar conditions of each case, either singly or by interaction may interfere with the sewage collection or treatment process, or constitute a hazard to the health and life of human beings and animals; or become a public nuisance or constitute any other undesirable risk.

c) Any liquids or vapor having a temperature higher than one hundred fifty degrees Fahrenheit (150°F) or sixty-five degrees Centigrade (65°C), at the point closet to the discharge into the sewer system.

d) Concentrations higher than two milligrams per liter (2 mg/1) of cyanides or heavy metals such as nickel, lead, iron, chromium, copper, zinc, and any other similar objectionable or toxic substances, unless expressly allowed by the Authority. The Authority reserves the right to adopt or establish more restrictive standards than those herein stated and may require from the subscriber pre-treatment of the discharge in compliance with its own established standards and rules or some other order.

e) Substances having any corrosive property capable of causing damage to the Authority's sewer systems or to the personnel in charge of them. No industrial wastes with a pH lower than 6.5 or higher than 9.0 may be discharged, unless the Authority expressly allows it only after considering the special conditions and circumstances in each case.

f) Phenols in a concentration higher than 0.005 milligrams per liter (0.005 mg/1).

g) High concentrations of inert solids such as fuller's earth, diatomaceous earth, lime slurries and lime residues, metalic

compounds, and other undersirable substances that may obstruct the flow or normal operation of the sanitary sewer systems.

h) Concentrations of dissolved solids such as chlorides and sulfates that should cause the Authority to undertake extraordinary measures to keep its systems operating properly.

i) Any isotope or radioactive substance. The Authority may issue a special permit for the discharge of certain isotopes or radioactive substances if it considers that the half-life or concentration of said isotopes or radioactive substances does not exceed the limits established by the concerned government agencies in their standards for potable water.

j) Concentrations, of any kind, requiring the use of excessive amounts of chlorine, as determined by the Authority.

k) Wastes with concentrations of suspended solids and biochemical oxygen demand BOD (5 days at 20°C) in excess of 2,500 milligrams per liter (mg/1), and those with settling solids in concentrations over 1,250 milligrams per liter (mg/1). Under special circumstances the Authority may allow the discharge of wastes exceeding the limits hereinbefore mentioned, subject to the imposition of surcharges in accordance with the Authority's rates in force and the User Charge System,

l) Wastes, of any kind whatsoever, which, as determined by the Authority, contain excessive coloration, such as, but not limited to, dyes and tanning solutions.

m) Wastes containing noxious elements or antibiotic effects that, either singly or jointly, may alter the biological processes of the sanitary sewerage system.

3. Bones, egg shells and similar matter. Also prohibited is the

discharge of wastes from garbage grinders unless the particles have been reduced to less than half an inch in size. Under special circumstances the Authority may allow the installation and operation of garbage grinder equipped with a motor of three-fourths (3/4) horsepower or greater.

H- Whenever a subscriber or customer cause damages or obstructs the sanitary sewerage system with discharges substances exceeding the limits hereby established by these Regulations, he should refund the Authority the expenses incurred in the correction of said damages.

I- The Authority shall reserve the right to set limits regarding pollution levels, volume and flow rate of the discharges.

J- The rights reserved for the Authority by virtue of these Regulations are unequivocal and perpetual until they are modified, suspended or othewise relinquished by the Puerto Rico Aqueduct and Sewer Authority or by a higher authority.

K- The Authority may suspend water and sewer services to any subscriber or customer who violates in any way the provisions of these Regulations and specially those contained in this chapter.

Section 5.04:- Compulsory Use of Means for Separating Substances such as Fats and Oils from Certain Discharges

A- Gasoline stations, restaurants, hospitals, supermarkets, shops industries, or any such other kind of establishment producing wastes containing among other undersirable substances the following: lard, fats, oil, or settling matter such as sand or similar matter, shall install a trap or interceptor for such substances. Its design has to be approved by the Authority. The trap or interceptor shall be constructed before admitting the wastes into the sanitary sewerage system and shall be properly operated and maintained by its owner. The Authority may cancel the water and sewer services should it find that the trap or interceptor is not adequately operated and maintained. The Authority may provide at its discretion and free of charge drawings

and specifications of an acceptable trap or interceptor.

B- The discharge into the sewer system of any wastes containing lard, wax, fats, or oil, whether emulsified or not, in excess of one hundred milligrams per liter (100 mg/1), or containing substances which may solidify or become vicous, is hereby prohibited.

Section 5.05:- Bulk Discharges

A. The discharge into the sanitary sewer system by means of trucks, tanks, suction pumps, individual tanks, containers, or any such other medium, is hereby prohibited.

Under special circumstances, upon the issuance of the corresponding permit by the Authority and pursuant to the provisions in force, such discharges may be allowed only at the sewer treatment plants selected by the Authority for such a purpose. This service shall be charged according to the volume and concentration of the wastes.

CHAPTER VI

ADDITIONAL PROVISIONS

Section 6.01:- Provisions in Force - Repealed

These Rules and Regulations, adopted and approved by the Governing Board of the Puerto Rico Aqueduct and Sewer Authority, shall become in force immediately upon compliance with the provisions of Act. No. 112, approved June 30, 1957, known as the Regulations Act of 1958 (3 L.P.R.A. Sections 1041 to 1059).

Chapters I, II, III, IV, V, and VII of the former Rules and Regulations, which provisions, correspond to Sections 159-1 to 159-11 and 159-101 to 159-141 of Title 22 of the Rules and Regulations of Puerto Rico, are hereby repealed.

Section 6.02: - Separability

Should any section, clause, paragraph, or any part ot these Rules and Regulations be declared unconstitutional, or void, by a court with jurisdiction over them, such sentence shall not affect or invalidate the rest. Its effect shall be limited to the section, clause, paragraph, or part so declared.

Section 6.03:- Penalties

Any person who violates or causes anybody to violate any provision of these Rules and Regulations, shall be guilty of a misdemeanor, and the water and sewer service rendered to such person is subject to be suspended.

I, ISMAEL PAGAN COLBERG, Secretary of the Governing Board of the Puerto Rico Aqueduct and Sewer Authority, hereby CERTIFY, that these Rules and Regulations have been approved by the Governing Board at its meeting held on May 10, 1976.

ISMAEL PAGAN COLBERG

Printed at the duplicating machines of the Puerto Rico Aqueduct and Sewer Authority.

CHAPTER XI

ACT FOR THE CONSERVATION DEVELOPMENT AND USE

OF THE

WATER RESOURCES OF PUERTO RICO

LAW #136 APPROVED JUNE 3ra 1976.

(Cuba, for
H.B. 519)
(Reconsidered)
(Conference)

No 136

(Approved June 3, 1976)

AN ACT

To establish a new Law of Waters for Puerto Rico; to declare the waters of Puerto Rico patrimony and wealth of the People of Puerto Rico; to grant to the Secretary of Natural Resources authority to plan and regulate the use and utilization, conservation and development of the waters of Puerto Rico; and to implement the public policy and the regulations and norms pertinent to the waters of Puerto Rico; to repeal provisions of the Civil Code and of the Law of Waters of March 12, 1903; and to establish a special account in behalf of the Department of Natural Resources in the Treasury Department, and for other purposes.

STATEMENT OF MOTIVES

Water constitutes a versatile resource. It satisfies multiple needs of our daily life and man has applied it to a vast variety of uses. This versatility of water reveals to us that we are in the presence of a resource essential to the existance of the natural and social systems, of a natural property which must be administered with a strict sense of caution.

The misuse, waste and degradation of water contribute to the shortage of the resource in Puerto Rico and represent a considerable loss of its value for domestic consumption, ~~use and development~~ economic development

and recreation. This loss impairs the welfare and jeopardizes the safety of the Island which, because it does not have an unlimited and well-distributed abundance of the resource, it must extract from what it has the maximum benefit in terms that will satisfy the public interest.

The ever-growing competition for the use of water among different sectors of the Puertorrican society, the lack of a juridical system providing for the planning and administration of the resource in keeping with the development of the Island, as well as the waste which it all entails, justify the Commonwealth of Puerto Rico to adopt, with a sense of urgency, the legislation and Regulations and to establish the planning and administrative mechanisms necessary to protect our waters and insure their most efficient use. Toward those ends is aimed the public policy established through this act by the Legislature of Puerto Rico.

For an adequate administration of this policy it is necessary that we view our hydrological problems as a whole, in an integrated perspective. The very hydrological cycle, where the resource appears in its multiple modalities and forms, constitutes, bear in mind, a unit instead of a succession of isolated phenomena. Likewise, it is as an integral whole that this act must be administered.

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BE IT ENACTED BY THE LEGISLATURE OF PUERTO RICO:

Section 1.- Title.- This act shall be known as an "Act for the Conservation, Development and Use of the Water Resources of Puerto Rico".

Section 2.- Declaration of Public Policy.- It is the public policy of the Commonwealth to maintain the degree of purity of the waters of Puerto Rico required for the welfare, safety and development of the Island, to insure the water supply that may be needed by the present and future Puertorrican generations by establishing water reservation areas and using the waters and bodies of water in accordance with the public interest and with their best, most beneficial and most reasonable use. To this end, and apropos, it is expressly declared, in order to protect our people from the advendition of the shortage, misuse, waste and pollution of such an essential resource, as well as to attain that its utilization be compatible with the physico-natural realities surrounding it and with the social and economic needs of our Island, that the waters and bodies of water of Puerto Rico are the property and wealth of the People of Puerto Rico. The Commonwealth Government shall administer and protect this patrimony in the name and on behalf of the Puertorrican people.

Likewise it is the policy of the Commonwealth to achieve the most equitable and fairest distribution of its waters.

To that effect it is established that the water requirements inherent in domestic consumption and particularly human consumption, shall be satisfied with priority over any others and that in the adjudication of the surplus available, the public interest shall prevail over any other interest or claim.

Section 3.- Definitions.- For the purposes of this act, the following terms shall have the meaning stated below, unless within the context where they are used another meaning arises, or it is specifically otherwise indicated:

a. Waters and Bodies of Water.- This term includes the surface, subterranean coastal and any other waters within the jurisdiction of the Commonwealth. Except where specifically otherwise indicated, waters and bodies of water shall have the same meaning.

b. Atmospheric Waters.- All waters in aqueous steam suspended in the air in the form of clouds.

c. Coasted Waters.- Those of the sea within the jurisdiction of the Commonwealth of Puerto Rico and all such interior waters where the flow and ebb of the sea is sensible.

d. Subterranean Waters.- Those which are under the surface of the earth, under the bed of a river, stream or brook, or under the bottom of the sea, lake, dam or other body o

water, irrespective of its origin or state, or of the geological formation or unit in which they happen to be, flow, percolate or move. It includes water that form part of which exists in the interior of animal and vegetal.

e. Surface Waters.- Those which flow continuously or discontinuously through natural or artificial channels or which emerge continuous or discontinuously in public or private lands or which are contained in lakes, lagoons, dams or any other body of water on land surface in Puerto Rico.

f. To Pollute, Pollution.- To alter the natural properties of a body of water so that it causes damage or is prejudicial to human health, or to animal and plant life, or causes bad odors or impurities, or alters adversely its physical, chemical, microbiological or radioactive properties, in such a way that harm the enjoyment of life or property or violates the criteria about the standards of purity established by the regulation to that effect of the Environmental Quality Board.

g. Department.- The Department of Natural Resources.

h. Franchise.- Written authorization of the Secretary for the use or utilization of surface or subterranean waters.

i. Governor.- The Governor of Puerto Rico.

j. Act.- The Act for the Conservation, Development and Use of the Water Resources of Puerto Rico.

k. Permit.- Written authorization of the Secretary for the drilling of wells for the purpose of using subterranean waters.

l. Person.- Any individual or juridical entity, groups organized under one firm, partnerships, public and private corporations including municipalities, agencies and instrumentalities of the Government of the Commonwealth of Puerto Rico.

m. Well.- Any system, process, method, device or combination thereof used by man for the main or incidental purpose of extracting subterranean waters.

n. Puerto Rico.- Embraces the whole area within the geographical or territorial boundaries under the jurisdiction of the Commonwealth of Puerto Rico.

o. Secretary .- The Secretary of the Department.

p. Water Connection or Water Connection System.- Any natural or artificial method to use or utilize a body of water

Section 4.- Assignment of Dominion.- All waters and bodies of water of Puerto Rico are hereby declared to be the property and wealth of the People of Puerto Rico. Their use, utilization and development shall be subject to the provision of this act and of the regulations prescribed thereunder.

Section 5.- Assignment of functions to the Secretary.- The Secretary shall have the following duties and powers in connection

with the water resources in Puerto Rico:

a. To prepare, adopt and maintain an integral plan of conservation, development and use of the water resources of Puerto Rico in consultation with the Water Resources Committee established hereinafter. This plan shall determine with precision the present uses of the bodies of water of the Island and shall project future uses. In preparing said plan, the Secretary shall bear in mind the hydrological cycle, as well as the requirements of the natural, social and economic systems which depend on the resource for their subsistence and development.

b. To establish a classification system of the water resources based on the utilizations and uses; on the consumption needs, the priorities of present and future use, the state and condition of the resource, as well as on the quality of the supply required for human consumption and for the economic and social development foreseen for Puerto Rico. This system, like the integral plan for the use, conservation and development of the waters, shall constitute the basis for implementing and administering the permit and franchise system hereby established.

c. To adopt the regulations he may deem necessary on uses and areas of use of the bodies of water, the quantity which may be used of each body, formulation of riparian areas, lakes, lagoons and dams, recovery of land, reclaiming of flooded areas, and other aspects relating to the waters. The decisions that the Secretary may adopt under this provision shall be based on considerations of public interest and shall take into account the hydrological cycle, the versatility of the bodies of water, the variety of possible utilizations, and the projections relative to quantity and quality of supply that the Island requires to meet its needs.

d. To establish water areas or districts in a critical status and to adopt, in reference thereto, the special rules and system of priorities necessary to guarantee their best conservation, use and utilization. The decisions of the Secretary to this effect shall be based on specific criteria of public interest and on criteria about the best, most beneficial and most reasonable use of the resources. In the exercise of this power, the Secretary shall take into account the different phases of the hydrological cycle and shall pay special attention to the rythm of extraction of subterranean waters, the rythm of supply of the sources,

the permissible reduction of the subterranean water-mark, and the possible pollution of aquifers.

e. To promulgate the criteria about the best beneficial and most reasonable use of the waters and to establish the consumption priorities which shall be followed in the administration of the permit and franchise system prescribed by this act. In connection with this function the Secretary shall bear in mind the hydrological differences registered in the regions of Puerto Rico, the quantity and quality of the waters in each region, the demand that new consumption sources would represent, the social need and economic potential of those new sources, the reasonability of the existing uses and utilizations, the possibility of producing fresh water or of reusing water already utilized, the social and economic cost of meeting the present and future needs of Puerto Rico, and the ways that may be found to satisfy public interest to the optimum.

f. To carry out the technical researches he may deem convenient in order to determine with precision the adequacy for certain uses of the waters of Puerto Rico, as well as to identify the means of protecting, conserving and using efficiently the aquifers.

g. To recommend to the Planning Board the adoption of standards and regulations relative to the development and use of lands, that affect the water resources.

h. To recommend to the Governor, upon consultation with the agencies and instrumentalities of the Commonwealth interested in each particular case that he declare an emergency situation with respect to the use of waters throughout Puerto Rico or in certain specific areas when the shortage of the supply so warrants, or when the quality of the water jeopardizes the health, welfare or safety of the people, or whenever any such situation is foreseen.

For the purposes of a declaration of emergency, not provoked by an unforeseeable act requiring immediate action, the Secretary shall hold public hearings before submitting his recommendation to the Governor. These hearings shall be announced in two newspapers of general circulation in Puerto Rico at least ten days prior to the date of the hearings. The recommendation of the Secretary to the Governor shall be for the purpose of suspending the granting of new permits and licenses or to render ineffective, in whole or in part, for not more than six (6) months, the existing permits or licenses, or both. The emergency period may be extended by the Governor for an additional term of six months. The Governor may render ineffective a declaration of emergency for reasons of

public interest or when the causes which originated it have disappeared.

Nothing contained herein shall be understood as a limitation of the powers of the Aqueduct and Power Authority of Puerto Rico or of the Water Resources Authority of Puerto Rico to impose a water rationing on their users when there are reasons to warrant it, or of the powers granted to the Environmental Quality Board by Act No. 9 of June 18, 1970, as amended, to order any person or juridical entity to cease such acts as cause or may cause damage to the environment or which may jeopardize the public health and safety.

i. To carry out surveys, researches and scientific experiments in connection with the water resources, in coordination with other agencies and instrumentalities of the Commonwealth and of the United States Government, or with persons and organizations interested in the hydrological problems of Puerto Rico. The knowledge acquired through these means shall be kept in a hydrological information center and shall be at the disposal of the different government agencies concerned with the waters of Puerto Rico and of persons interested therein.

j. To establish a permit and franchise system for the use and utilization of the waters and bodies of water of Puerto Rico

and to fix the fees to be charged in each case. The Aqueduct and Sewer Authority and the Water Resources Authority are exempt from the payment of such fees.

k. To regulate the design, construction, operation and everything pertinent to the closing of installations, structures or devices used to extract or to surface subterranean waters, in coordination with other agencies concerned with these matters.

l. To make the inventories and to establish the registries necessary to achieve the purposes of this act, including those referring to surface and subterranean waters, wells, vested rights under prior legislation and to permits and franchises granted. The information contained in the registries, as well as in the inventories, shall be of a public nature and shall be made available to any person requesting it.

m. To perform inspections and exercise surveillance over the bodies of water of Puerto Rico.

n. To disclose information and promote the knowledge about the water problems and resources of Puerto Rico.

o. To promulgate rules of a substantial and processal nature for the adjudication of controversies between private persons on the utilization of waters.

p. To adopt the necessary regulations for the implementation of this act in keeping with the provisions of Act No. 112 of June 30, 1957. In the promulgation of these regulations the Secretary

shall consult the Aqueduct and Sewer Authority and the Water Resources Authority, so as not to affect the normal operation of these instrumentalities.

Section 6.- Water Resources Committee.- The Secretary shall appoint a Water Resources Committee to advise him in the preparation of the integral plan for the use, conservation and development of the water resources and to assist him in any other function entrusted to him by this act. The Committee shall be composed of representatives of the Planning Board, the Economic Development Administration, the Environmental Quality Board, the Aqueduct and Sewer Authority, the Water Resources Authority, the Department of Agriculture, the Department of Health, the Department of Transportation and Public Works and the University of Puerto Rico. The Secretary may, when he deems it convenient, enlarge the Committee by appointing representatives of other agencies of the Commonwealth and of the United States Government, and private persons concerned with the water resources of Puerto Rico. The operating costs of the Committee shall be defrayed by the Department of Natural Resources.

Section 7.- Functions of the Environmental Quality Board, the Department of Health and the Planning Board.- In the preparation and implementation of the integral plan for the use, conservation and development of the water resources, the Secretary shall strictly follow the rules and findings which as regards the quality and

potableness of the waters may adopt the Environmental Quality Board and the Department of Health, respectively. It is further provided that such integral plan for the use, conservatio and development of the water resources shall be considered as a sectorial plan, as provided in Act No. 75 of June 24, 1975.

Section 8.- Prohibition.- No person may construct, establish or operate a water-connection system, or use or utilize the waters and bodies of water of Puerto Rico without the corresponding permit or franchise issued by the Secretary. These rights shall not be acquired by prescription.

Section 9.- Permits and Franchises.-

a. The Secretary shall establish a system of permits for drilling wells and another system of franchises for the utilization of superficial waters or surfaced waters. The permits shall fix the specifications of the works and installations they authorize and the franchises shall establish, among other conditions, those relating to the quantity, the rythm of extraction, the use and the fees to be paid for the volume of water whose utilization or surfacing they permit. The Secretary shall establish the standards he may deem useful and necessary for using artificial means to provoke rainfall and for utilizing in any other form the atmospheric waters.

b. The permits and franchises shall be granted on petition of the interesting party. The Secretary shall ask the petitioner for such information and surveys as he, may deam necessary for the permit and franchise system to operate in keeping with the purposes of this act.

c. In the cases of petitions involving a volume of water in excess of a limit previously fixed by the Secretary, or which refer to certain specific bodies of water or to certain specific locations, areas, districts or regions, the Secretary shall not issue any permit without having first determined the impact that the proposed utilization might have on those existing. On the other hand, when the case deals with utilizations to satisfy the needs of domestic or agricultural consumption not involving a considerable or substantial volume of water, the Secretary may relieve the interested party from the administrative process required for the issuance of the permit or license, as well as from the corresponding payment. The Secretary shall prepare model plans of minor works for the collection of rainwater which may fall within the limits of a property, such as ponds, reservoirs and tanks, which would be devoted to domestic or agricultural use. The model plans shall be distributed, free of charge, to interested persons requesting them.

d. The permits and franchises shall have the duration that the Secretary may establish by regulation, but they shall never be issued for periods over two (2) and ten (10) years, respectively. This limitation shall not be applicable to permits and franchises of government instrumentalities. Renewal thereof shall follow the procedure corresponding to their original issuance, except that when the renewal plus previous permits granted hereunder do not exceed ten (10) years in all, the Secretary shall not be bound to follow said procedure.

e. The Secretary may issue the permits and franchises prescribed herein, provided they are of public interest, the petitioners or applicants comply with the prevailing legal and regulatory requirements, the use for which the waters are requested be optimum, beneficial and reasonable, the resource be not wasted, its utilization be in conformance with the priorities established herein and do not impair vested rights under previous legislation.

f. In the evaluation of the public interest attached to a use or utilization, the Secretary shall bear in mind, among others, the following factors:

1. Its compatibility with the plan of use, conservation and development of the waters of Puerto Rico.

2. Its impact on the economy of the Island.
3. The use to which the water would be devoted.
4. The volume of water that would be used.
5. Its effect on potential uses or utilizations which could become effective within a reasonable limit of time if the waters were not committed under the permit or franchise sought.
6. Its impact on other resources.
7. Potential damages to persons and to the community.
8. Its effect on the public health and safety.
9. Possible impairment of existing rights, including the right of ownership over the tract where the waters are.
10. Its impact on the integrity of the natural systems and, in general, on the ecosystem.

g. Permits and franchises may be transferred by their holders only when the public interest warrants the transfer and the Secretary approves it. Every permit or license shall establish the conditions for its transfer. Transfers shall not entail any payment for the value represented by the permits or franchises, but only such payment as corresponds to the assessment of the structures and equipment used in the utilization of the surfacing. For the purposes of authorising the transfer of a permit or franchise, the Secretary shall hold public hearings if he thinks there is controversy.

Section 10.- Accidental or Illegal Surfacing.-

a. The provisions of this act relating to permits and franchises shall not apply to surfacing resulting from activities carried out for other purposes. The Secretary shall provide by regulation the procedure to be followed in such cases.

b. Waters surfaced in violation of this act shall not legally benefit the person who surfaced them.

Section 11.- Substitution of Sources.-

a. Permits and franchises for the use of waters constitute authorizations to utilize and extract certain specific quantities of water and not a right over a source. The Secretary may substitute the source of supply of a user provided he guarantees to the latter waters of quality and in quantity comparable to those he is using. Likewise, and in order to protect bodies of water which at the time this act is approved require special attention, the Secretary may satisfy water rights acquired under the previous law by the utilization of other sources that provide the supply needed by their possessors. The costs corresponding to the substitution of sources shall be determined by the Secretary, or on his petition, by the Superior Court and shall be paid by the Commonwealth of Puerto Rico. The Secretary may transfer, in whole or in part, to the party benefited by the substitution the costs corresponding thereto.

b. For the purposes of substituting sources, the Secretary may establish time limits and other reasonable conditions that may permit the enjoyment of vested rights and protect the public interest.

c. Nothing provided herein imposes on the Government of the Commonwealth an obligation to guarantee the quality or quantity of waters whose utilization it authorizes.

Section 12.- Fees to be Paid.- The Secretary shall establish by regulation the fees to be paid for each permit or franchise this act authorizes him to grant. In establishing the regulation to that effect, the Secretary shall bear in mind the nature of the permits and franchises, the duration thereof, the capital investment required to render effective the permit or franchise, the quantity and quality of the waters the use of which he would authorize, the use to which they would be put, the impact of the utilization on the natural systems and on other rights, and any other factors he may deem necessary for fixing a reasonable fee.

No fee shall be required to be paid by the municipalities, public agencies or instrumentalities and persons who by reason of rights acquired under prior legislation may be exempted from such payment.

The funds deriving from these fees shall be covered into a special account which the Secretary of the Treasury shall establish in behalf of the Department of Natural Resources. Said fund shall be used by the Secretary to cover the expenses of the administration of this act.

Section 13.- Grounds for Revocation of Permits and Franchises.- The Secretary may, upon notice and hearing to that effect, modify, suspend temporarily, or cancel a permit or franchise for any of the following reasons:

1. Intentional violations of this act, of Act No. 9 of June 18, 1970, of Act No. 23 of June 20, 1972, as amended, or of the standards, decisions and regulations adopted thereunder.
2. Violation of any of the conditions established in the permit or franchise and, particularly, those referring to the volume, form, rythm, place, time and purpose of the utilization.
3. The nonusing, without good cause, of the permit or franchise for the time fixed therein, or if none is fixed, for the period of one year.
4. Where the holder refuses to furnish the information requested by the Environmental Quality Board and the Secretary, or furnishes false information.

The Environmental Quality Board may request the Secretary to revoke a permit or franchise when it realizes that, as a result of the corresponding utilization, damage or significant adverse effect is being caused or may be caused to the environment or to any natural system.

Section 14.- Dispensations.- In furtherance of the public interest, the Secretary may grant dispensations within his plan and regulation for the use, conservation and development of the waters and bodies of water of Puerto Rico. Said dispensations shall be preceded by public hearings which shall be announced as provided in Section 19 of this act. The applicant for the dispensation shall bear the burden of proof and must show clearly and conclusively that he would utilize the waters he seeks in the best and most beneficial and reasonable way; that the dispensation would not entail a significant adverse effect on the environment or natural systems; that it would not impair vested rights or the enjoyment of another's property, and that it would not jeopardize the health, safety and welfare of the community. After hearing the evidence, the Secretary shall enter an order based on findings of fact and issues of law. The decision of the Secretary may be reviewed by the Superior Court of Puerto Rico upon the filing of a petition to that effect by any interested party within thirty (30) days after its official notice.

Any use, dispensed in whole or in part, shall be subject to the emergency powers which Section 5 (h) of this act grants to the Governor, and to the regulatory requirements that may be established by the Environmental Quality Board and the Secretary.

Section 15.- Priorities of Use.- Where several petitions are presented for the purpose of utilizing beneficially and reasonably a body of water and it lacks the sufficient volume to meet them all, or when there is sought the beneficial and reasonable utilization of a body of water that is incompatible with another foreseeable use also beneficial and reasonable, or when there is sought the utilization of a source for a purpose more beneficial and reasonable than any of the existing ones, the Secretary shall grant the petitions which represent the most beneficial and reasonable utilization and best satisfy the public interest and the purposes of this act. The adjudication of an insufficient volume of water shall be based on an analysis of costs and social benefits, The utilization of waters for domestic consumption and particularly for human consumption shall have priority over any others.

The Secretary shall establish the regulatory procedures necessary to enforce this section. The compensation or payment corresponding to holders of permits or franchises which may be affected by decisions which the Secretary may adopt by virtue of the powers granted to him by this section shall be determined pursuant to the procedure established in Section 11 a. of this act.

Section 16.- Vested Rights.- Every beneficial and reasonable use and utilization of waters existing on the date this act takes effect, including those acquired under grants from the government of Spain, or which existed within the preceding year, or was to commence at the termination of works in progress on the effective date of this act shall be considered as a vested right under the previous legislation and shall be protected by this act. The Secretary may recognize a vested right of a lesser amount than that claimed by the holder.

This provision does not limit the powers which Section 5 of this act grants to the Secretary, and in no way reduces his authority to establish the true existence of the rights claimed, or to require the inscription and registration thereof, or to require information on existing wells and water connections, or to inspect those wells or water connections, or to require, in accord with reasonable terms and conditions, the conformation of existing installations or those under construction to the regulations that may be established, or to order the installation of water meters or systems that gauge the volume of water used, or to require the repair of installations or the introduction of improvements that may reduce water waste.

Section 17.- Registry of Rights of Use.- The Secretary shall establish special procedures for the registration of the rights of use and utilization of waters acquired under the previous legislation. To this effect the Secretary may set dates for the filing of the corresponding statements and require the information he may consider useful to establish the true existance and exact amount of the rights claimed. Likewise, he may, motu proprio, adopt such decisions as may be pertinent regarding the right of those who, having such right, have not claimed it or have not met the requirements established to that effect.

Within a period of not more than thirty (30) days after the approval of this act, the Secretary shall begin to prepare an inventory of the wells existing in Puerto Rico. This inventory may be prepared according to a procedure different from the one used to determine vested rights under the previous legislation.

Section 18.- Orders of the Secretary, Administrative Fines and Aid of Jurisdiction.-

a. The Secretary or his authorized representatives shall have power to receive testimony, administer oaths, issue summons requiring the appearance of witnesses or the introduction of documentary evidence or of any other kind. The Secretary may issue orders to do or not to

do, to cease and desist and, after a hearing, to impose sanctions or administrative fines up to a maximum of fifty thousand (50,000) dollars for violations of this act, its regulations or the orders issued thereunder. The Secretary may appear before the Superior Court to pray the latter to order compliance with any summons or order issued by him.

b. No person may refuse to comply with a summons of the Secretary or of his duly authorized representatives, or with a judicial order issued to that effect, alleging that the testimony or evidence which he is required to give, might incriminate him or give rise to the imposition of a penalty. Such testimony or evidence may not be presented against that person in any other proceeding.

Section 19.- Right to a Hearings.-

a. The Secretary shall hold public hearings when the matters on which he must pass refer to:

   1. Adoption of rules and regulations or amendments thereto.
   2. Adoption of the integral plan for the conservation, use and development of the water resources or modifications thereto.
   3. Establishment of priorities for consumption.

4. Granting of dispensations as authorized by Section 14 of this act.
5. Substitution of supply sources.
6. Determination of vested rights.
7. Denial of petition for a permit or franchise or the limitation or revocation of existing permits and franchises when there is controversy.
8. Declaration of an emergency in accordance with provisions of Section 5 (h) of this act.
9. Imposition of administrative fines and penalties.

b. The parties concerned with any of the matters listed in the preceding clause may waive their right to a hearing.

c. The hearings that the Secretary may hold on the adoption of rules and regulations or amendments thereto, or on the adoption of the integral plan for the conservation, use and development of water resources or modifications thereto, or on the establishment of priorities for consumption, or on the granting of dispensations as authorized by Section 14 of this act, or on the substitution of supply sources; or on the determination of vested rights shall be announced by publication in two newspapers of general circulation at least two (2) weeks in advance of the date fixed for their holding.

d. In the quasi-judicial hearings listed in clause "a" of this section the persons affected or concerned shall be entitled:

1. To be notified, personally or by registered mail with return receipt requested, of the proceeding to be held, and to be informed of the facts on which it is based at least fourteen (14) days prior to the date fixed for the hearing.
2. To appear personally or through counsel and with the technical assistance they deem necessary.
3. To testify and to present oral and documentary evidence.
4. To examine and cross examine witnesses.
5. To request that the appearance of witnesses and the presentation of evidence be ordered.
6. To request the preparation of a stenographic record of the hearing or an equivalent record.
7. That the decision be adopted solely on the basis of the evidence presented at the hearing.
8. That the hearing be public unless this right be waived.
9. That persons involved in the investigation giving rise to the proceeding do not preside over the hearing.

e. The Secretary may order the parties requesting the hearings to pay for the expenses and professional and consultant service fees incurred by the Department of Natural Resources in the hearings and corresponding investigations. The Secretary shall

determine the form in which and the time when the payments shall be made, upon the approval of the bills presented by the persons who rendered the services, and these payments shall be covered into a special fund to defray the expenses had by reason of the hearings.

f. At the quasi-legislative hearings listed in clause (a) of this Section, the persons affected or concerned shall be entitled to appear personally or through counsel and to present the evidence they may deem necessary.

Section 20.- Procedure at the Hearings and Review Thereof.- At every administrative hearing of a quasi-judicial nature required by this act the following procedures shall be observed:

1. The Secretary or a representative shall preside over the hearing.
2. The appearing parties shall be entitled to offer all the evidence and to argue their case.
3. Insofar as applicable, the fundamental principles of the Law of Evidence shall prevail, without being subject to technicalities and said law shall be construed as liberally as possible.
4. The Secretary shall issue his order or decision within thirty (30) days following the date when the hearing is terminated and he shall notify it to the party or parties affected, except that in cases of prolonged hearings and lengthy

records or of complicated cases, the period of thirty (30) days may be extended to a maximum of ninety (90) days.

5. The order or decision of the Secretary shall be final unless, within thirty (30) days following the date of notice, a review is sought before the Superior Court.

Section 21.- Public Information.- The information related to the supplies and bodies of water of Puerto Rico, including the coastal waters, shall be held as information of a public character and shall be available for inspection by the public in general. Studies on the quality of waters and the deposits of effluents in bodies of water shall partake of the same character.

b. Documents and information brought before the Secretary by owners or managers of commercial or industrial enterprises and which refer to the production or production processes, or to the volume of sales, or which if known could injure the competitive position of the entity, shall be of a confidential nature except where the person presenting them expressly consents otherwise. This provision shall not preclude the Secretary from using the confidential documents and information submitted to him in analyses or summaries related to the general condition of the waters or of the air, provided he does not disclose the sources presenting the information.

Section 22.- Actions of Citizens.- Any citizen domiciled in Puerto Rico may bring a civil action under this act in the following cases:

1. Against any person, instrumentality, agency, municipality, or public or quasi-public corporation of the Commonwealth who is found to be in violation of this act or of any regulation, standard or order issued thereunder by the Secretary.
2. Against the Secretary of Natural Resources when it is alleged that he has failed to comply with a non-descretionary duty imposed by this act.
3. Against the Secretary of Natural Resources when it is alleged that he has committed an abuse or excess of discretion, or an arbitrary act, in enforcing any limitation or standard of effluents established hereunder.

The Superior Court of Puerto Rico shall have jurisdiction over these actions irrespectively of the amount in issue.

In issuing any final order on actions instituted under this section, the Court may levy such costs as it may deem proper on any of the parties in the action.

Section 23.- Penal Sanctions.- Any person who personally or through his agents, representatives or employees, engages in constructing, establishing or operating a water connection system, or who uses or utilizes the waters and bodies of water in Puerto Rico without the corresponding permit or franchise issued by the Secretary shall be guilty of a misdemeanor and, upon conviction, shall be punished by a fine of not more than five hundred (500.00)

dollars or by imprisonment for not to exceed six (6) months, or both, in the discretion of the Court.

It shall also be a misdemeanor, punishable by the aforesaid penalties, to violate any order, decision or decree issued by the Secretary, or any condition or requirement established in a permit or franchise, or any of the provisions of this act or of the regulations promulgated thereunder.

Each day during which there persists the violation of any provision, requirement, determination, order or regulation of the Secretary, or of any of the provisions of this act, or of a final decree issued by the Superior Court of Puerto Rico shall constitute a separate and distinct violation.

Exclusive jurisdiction is granted to the Superior Court of Puerto Rico to hear the offenses established in this section.

Section 24.- Separability.- If any clause, paragraph, section, article or part of this act is declared unconstitutional by a court of competent jurisdiction, the judgment rendered to that effect shall not affect, prejudice, or invalidate the rest of this act, its effects being limited to the clause, paragraph, section, article or part of this act so declared unconstitutional.

Section 25.- Repeals.- The following sections of the Civil Code of Puerto Rico, 1930 Edition, are hereby repealed: Sections 342, (except clause 5), 343, 344, 346, 348, 349, 351, 352, 353, 358. The Law of Waters of March 12, 1903 is likewise repealed, excepting the following sections: 4, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104,

105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 127, 128, 129, 130, 131, 132, 151, 154, 158, 176, 179, 226.

Section 26.- Effectiveness.- This act shall take effect immediately after its approval.

COMMONWEALTH OF PUERTO RICO

PUERTO RICO AQUEDUCT AND SEWER AUTHORITY

TYPICAL DETAILS

TYPICAL DETAILS

FIGURE

1. Fence and Gate Detail
2. Pier Details
3. Tank (Fuel) and Foundation Details
4. Discharge in Cement Pipes
5. Discharge in Circular w/Smooth Slopes
6. Discharge in Circular w/Steep Slopes
7. Hydraulic Elements for Small Pipe (K.F.)
8. Multiples Connections to Avoid Dead ends
9. Multiples Connections to Avoid Dead ends
10. Subdivided House Connection
11. House Connection with Ford Meter box
12. House Connection (Typical Inst.)
13. 2" Dia. Water Meter Box
14. 4" Dia. Water Meter Box
15. Public Fountain
16. Vent and Pipe Installation
17. Air Release Valve and Basin
18. Butterfly Valve 16" or 20"
19. Back Flow Preventer Valve
20. Fire Hydrant (P.R. Type)
21. Drain Detail
22. C.I. Telescopic Valve Box

23. Horizontal Centrifugal Booster Pump (line)

24. Horizontal Centrifugal Booster Pump (pit)

25. Pumping Station

25A Pumping Station Wheather Proof Inst.

26. Aluminium Frame and Cover - Flockhart

27. Hook for Tank Access Cover

28. Pump House Hook Detail

29. Vertical Turbine Pump to Wet Pit

30. Deep Well Pump

31. Sanitary Sewer House Connection w/Saddle

32. House Connection and Rungs

33. Sanitary House Connection Complete

34. House Connection - Sewer Pipe Plus 2.0 m

35. Concrete Protection for House Connection

36. Frame and Cover (C.I.)

37. Inspection M.H.

38. Inspection M.H.

39. Drop M.H.

40. Drop M.H.

41A Elevated M.H.

41B Precast M.H.

41C Precast M.H.

42. Typical Siphon

43. Water/Sewer Mains Separation

44. Sludge Drying Beds

45. Waste Burner

46. Spiral Stairs

47. Laboratory Arrangement #1

48. Laboratory Arrangement #1

49. Laboratory Arrangement #2

50. Laboratory Arrangement #2

51. Laboratory Arrangement #3

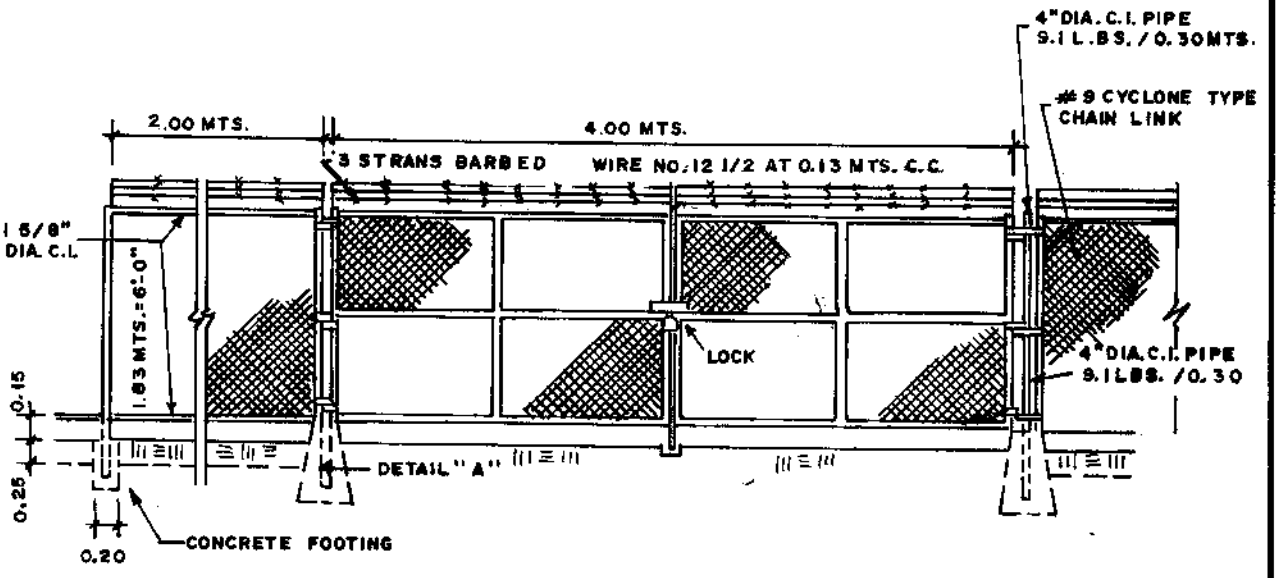
52. Time Required for Sewer Pumps Stops

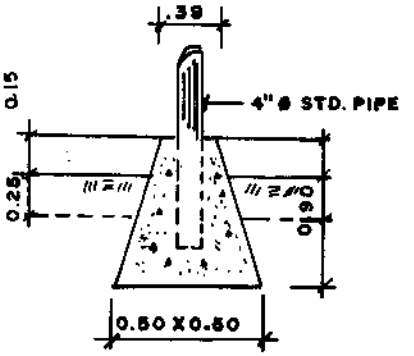
53. Variation in Daily Sewer Flow

54. Apartments Water Supply Alt.

55. Loading Platform Bumper

57. Exhaust Fan (17" unit)



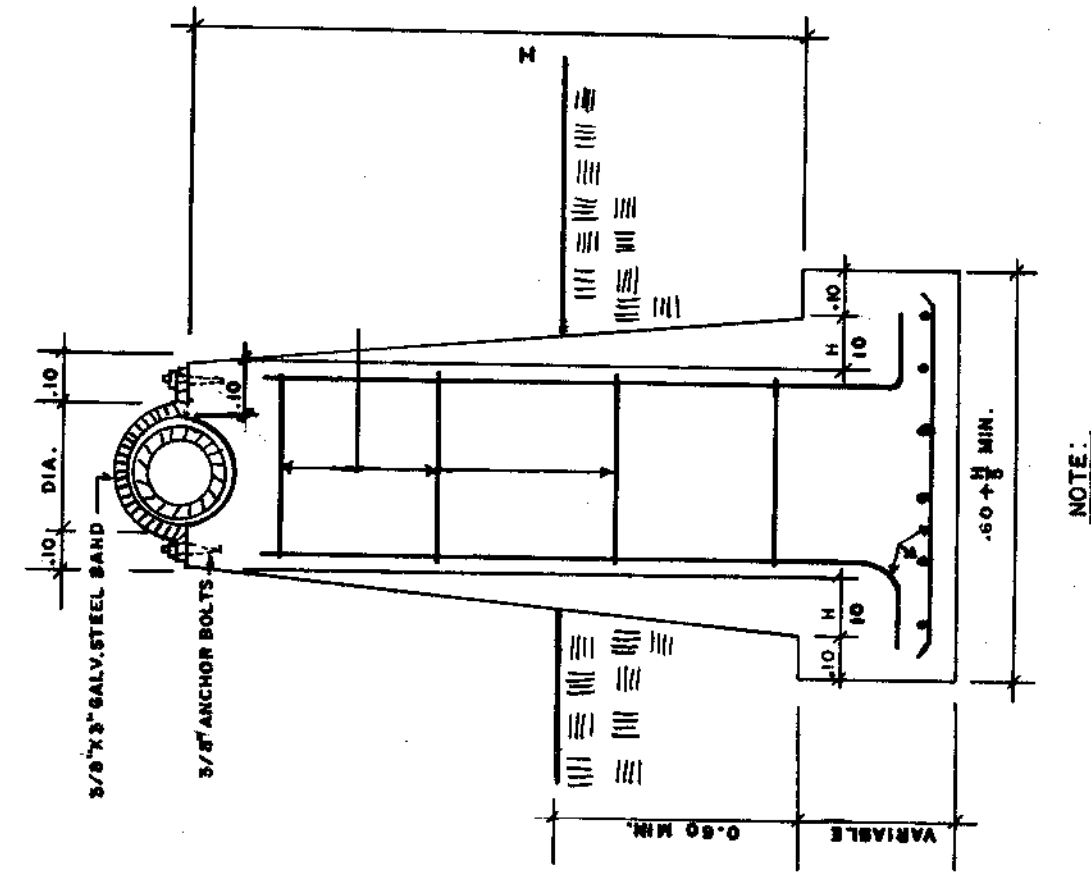


DETAIL "A"

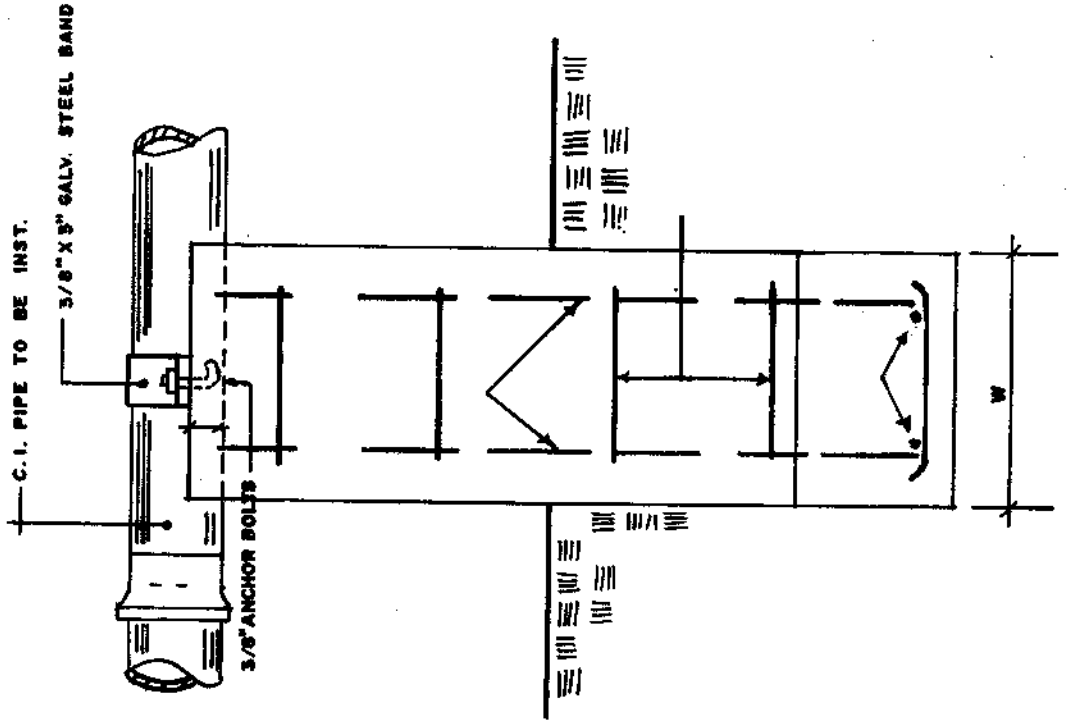
FENCE & GATE DETAIL

FIG. NUM. 1

DATE 8/08/80



NOTE:
THIS DETAIL IS TO SHOW THE TYPE AND FORM OF THE PIERS, THE DEVELOPER SHOULD PERFORM THE STRUCTURAL DESIGN FOR THE PIERS.

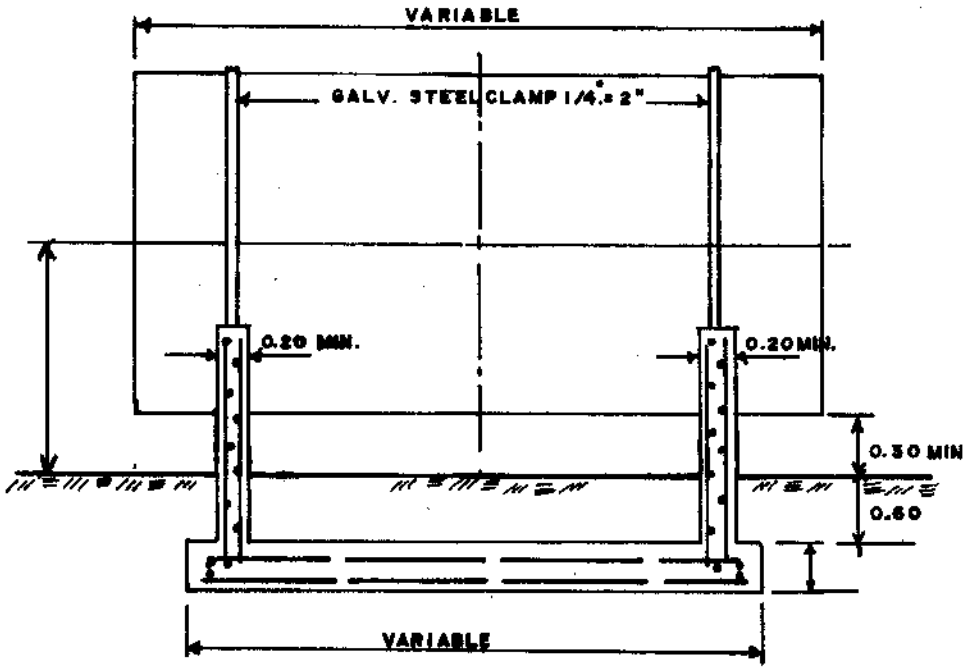


* DIMENSIONS IN METER

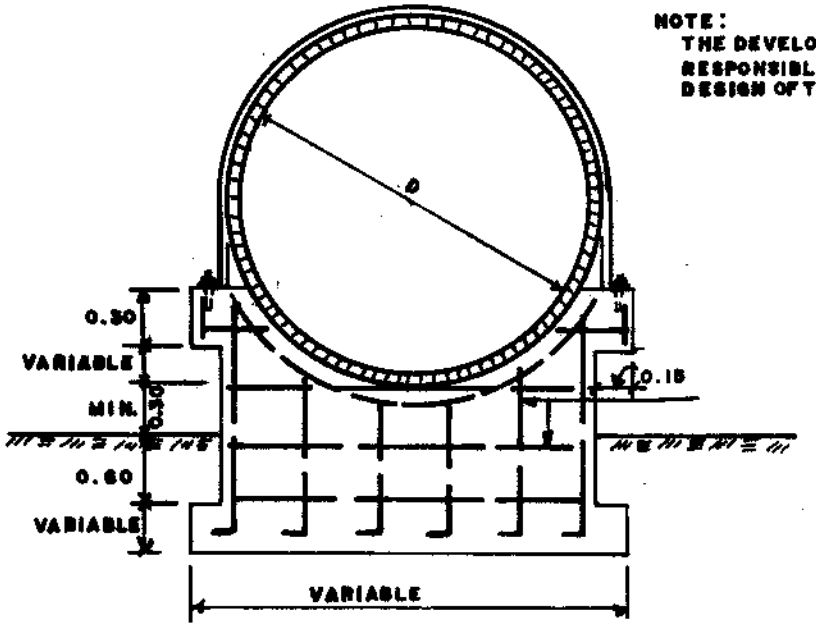
PIER DETAIL

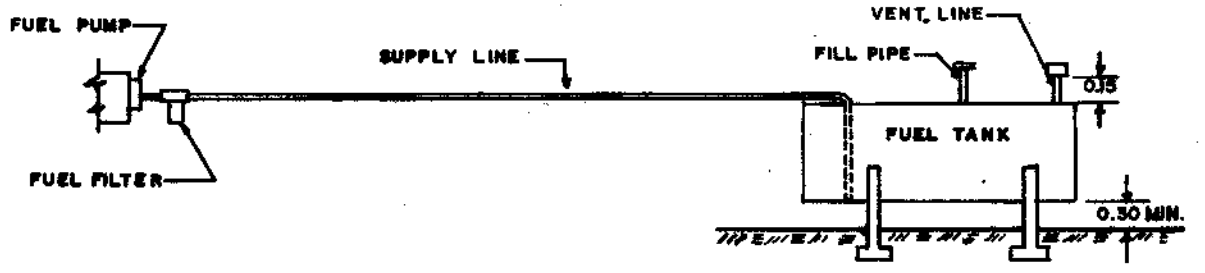
FIG. NUM. 2

DATE 8/08/80



NOTE:
THE DEVELOPER SHALL BE RESPONSIBLE FOR THE STRUCTURAL DESIGN OF THE FOUNDATIONS.



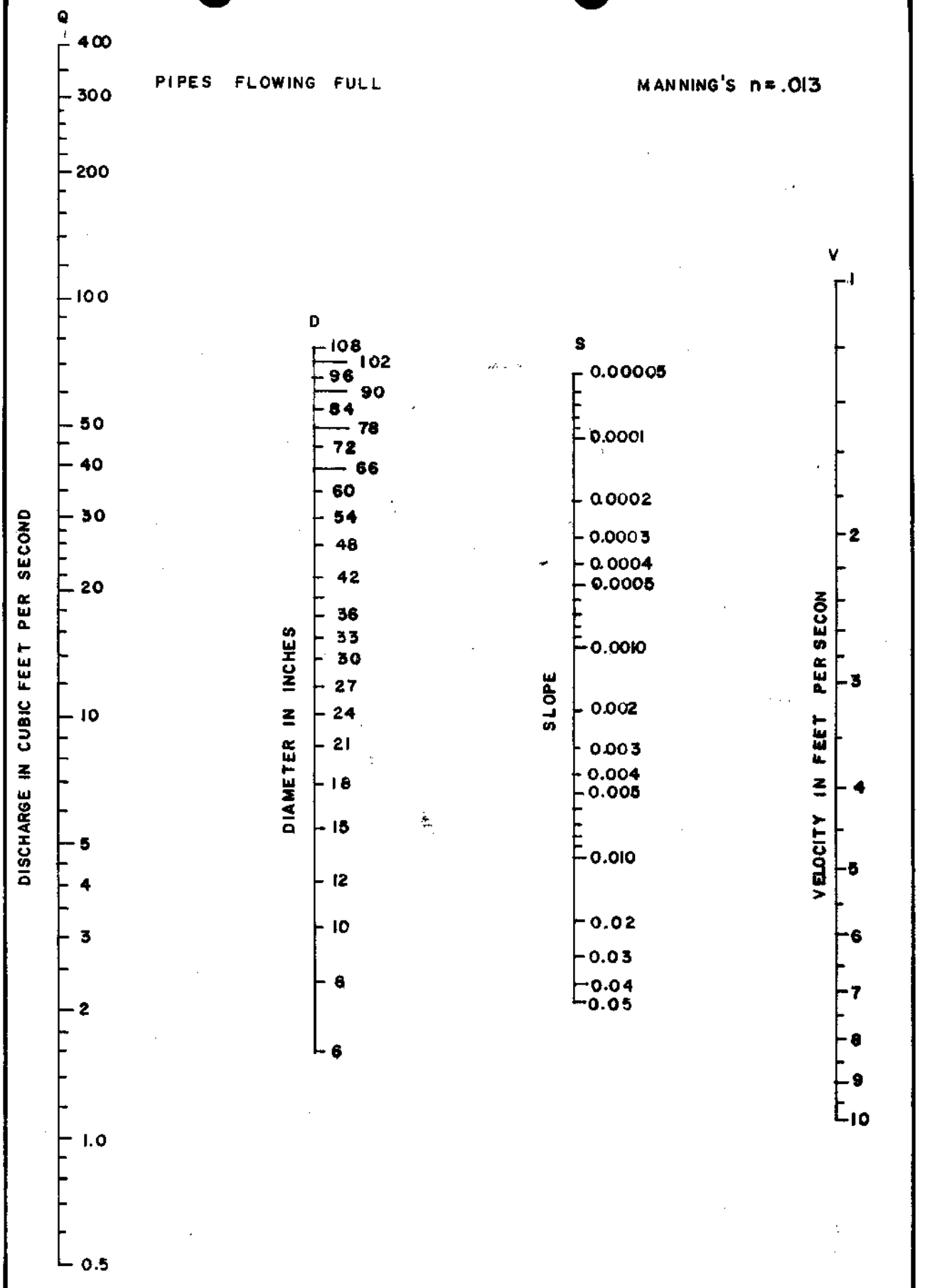


NOT TO SCALE

FUEL TANK AND FOUNDATION DETAIL

FIG. NUM. 3

DATE 8/5/80

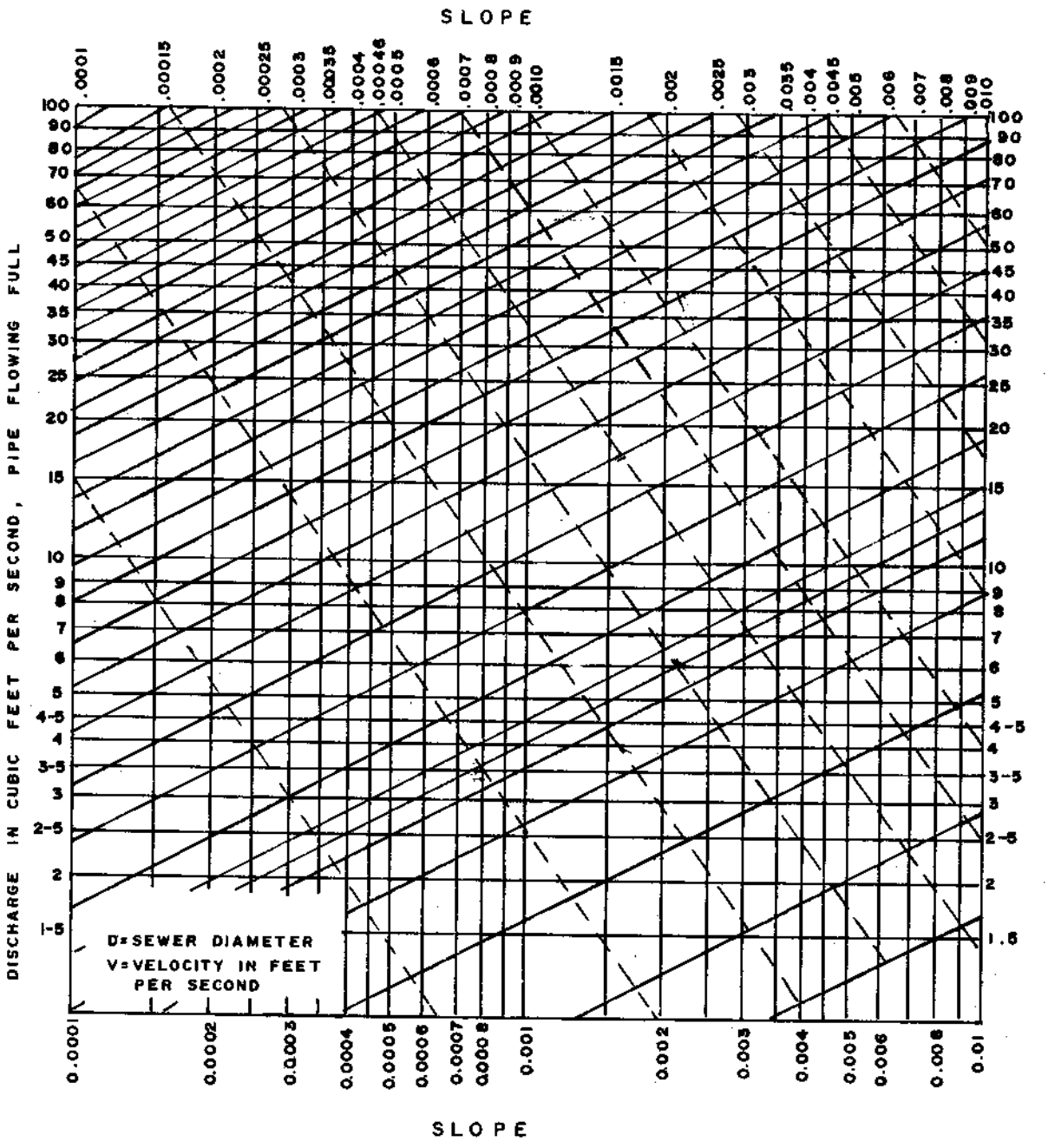


DISCHARGE IN CEMENT PIPES

FIG. NO. 4

DATE: 8/08/80

WATER FLOW IN CEMENT PIPES

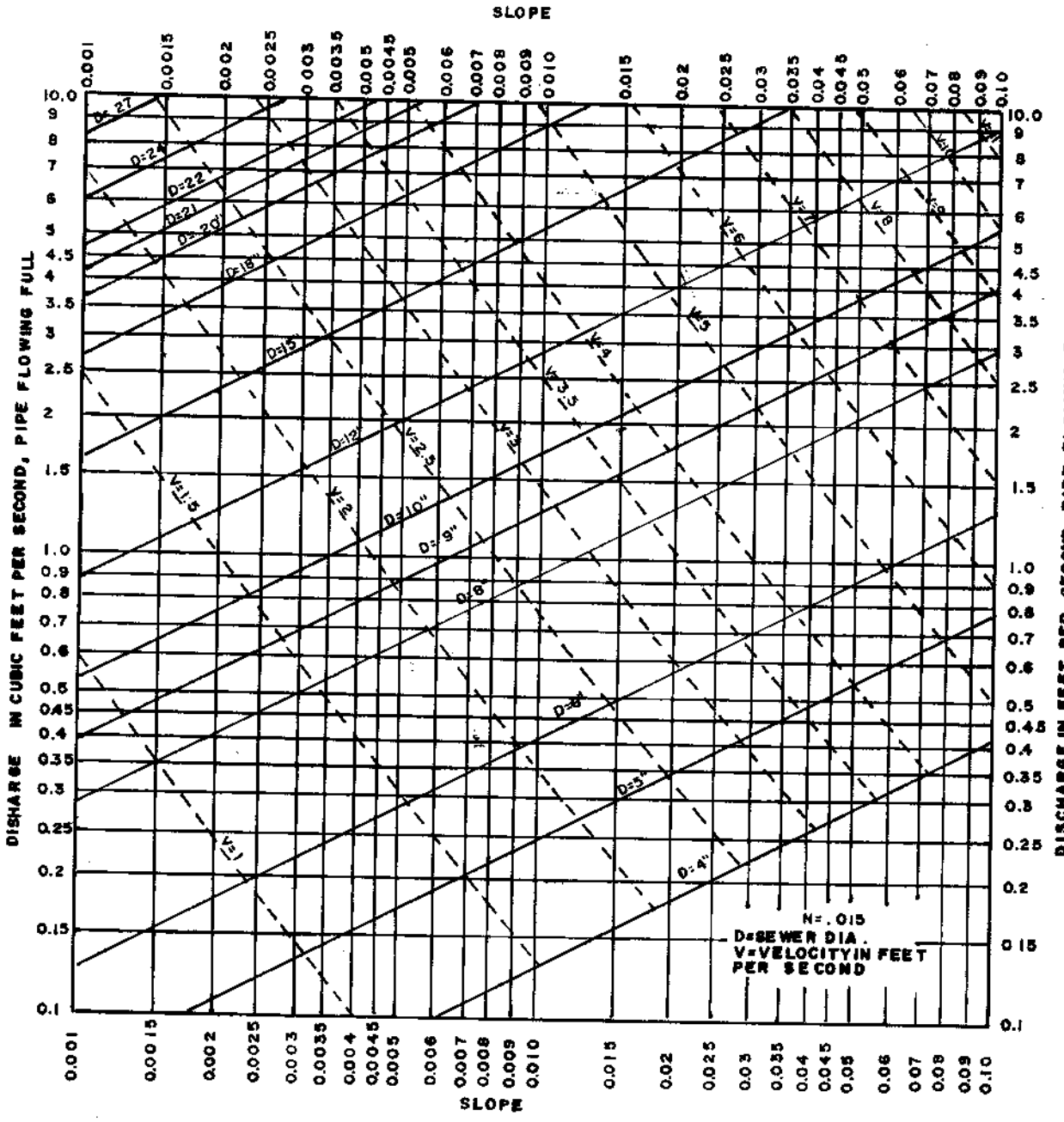


DISCHARGE IN CIRCULAR PIPES WITH SMOOTH SLOPES

FIG. NO. 5

DATE 8/08/80

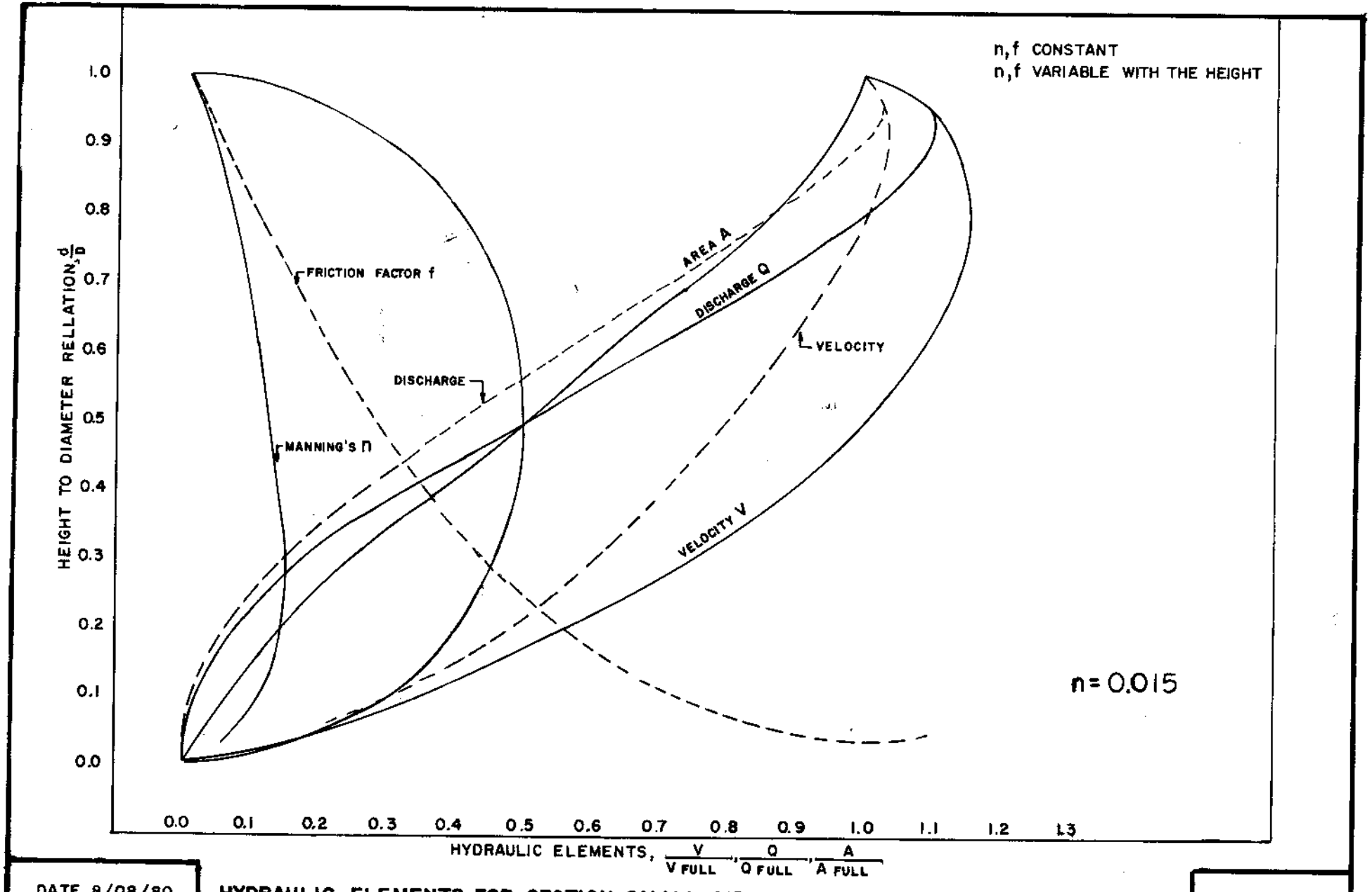
WATER FLOW IN CEMENT PIPES



DISCHARGE IN CIRCULAR PIPES WITH STEEP SLOPES

FIG. NO. 6

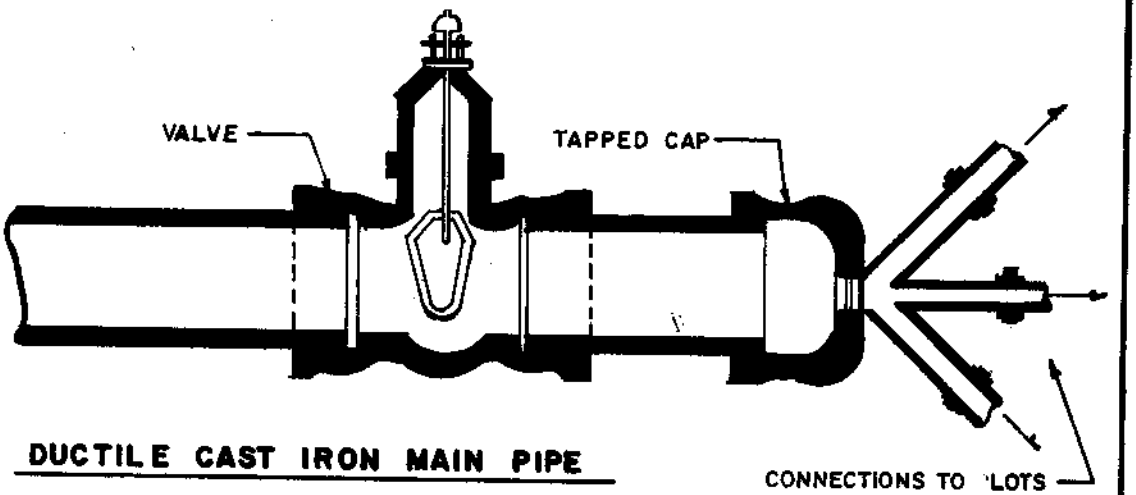
DATE: 8/08/80



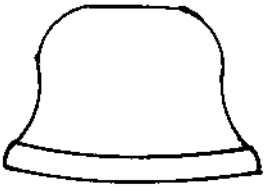
DATE 8/08/80

HYDRAULIC ELEMENTS FOR SECTION SMALL CIRCULAR PIPE BY THE KUTTER FORMULA

FIG. NUM. 7

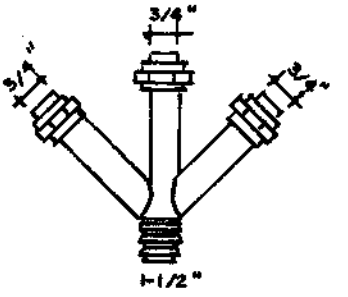


DUCTILE CAST IRON MAIN PIPE



TAPPED CAP

SIMILAR OR EQUAL TO F-1390
"JAMES B CLOW & SONS, INC."



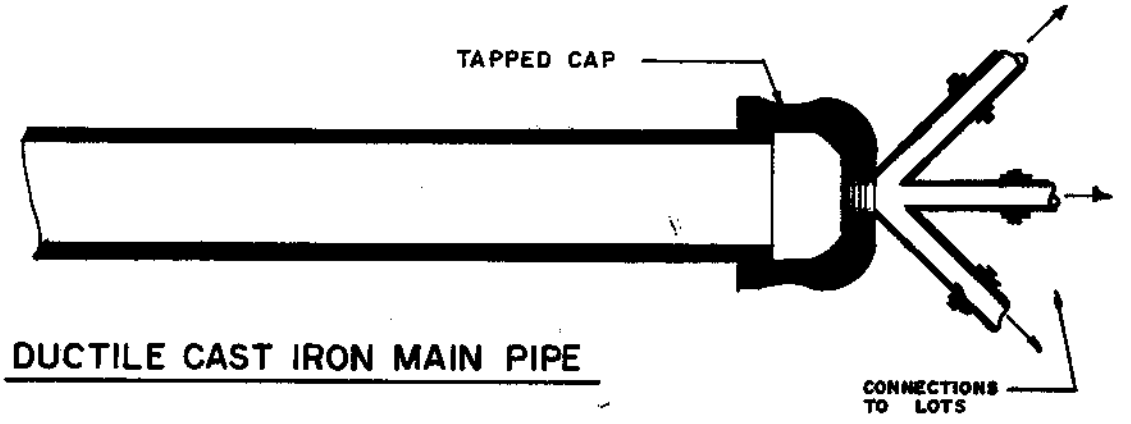
MULTIPLE CONNECTION BRONZE PLUG

SIMILAR OR EQUAL TO F-4435
"JAMES B CLOW & SONS, INC."

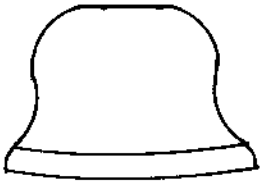
DETAILS OF MULTIPLES CONNECTIONS TO AVOID DEAD ENDS WHERE POSSIBLE EXTENSION EXISTS

FIG. NUM. 8

DATE: 8/08/80

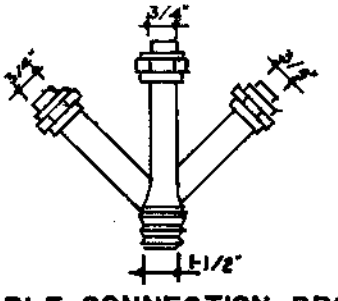


DUCTILE CAST IRON MAIN PIPE



TAPPED CAP

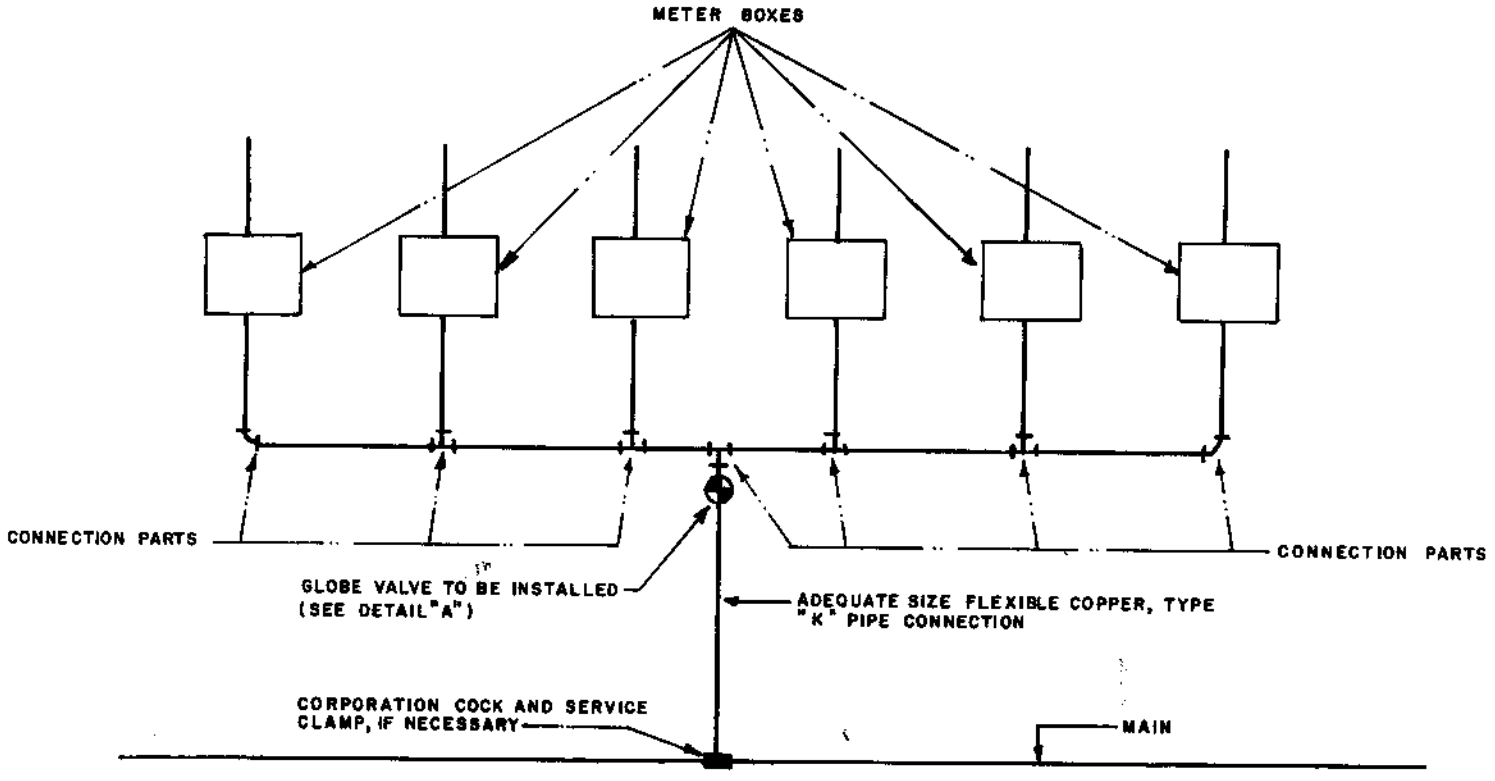
SIMILAR TO F-1390 DE
"JAMES B. CLOW & SONS, INC."

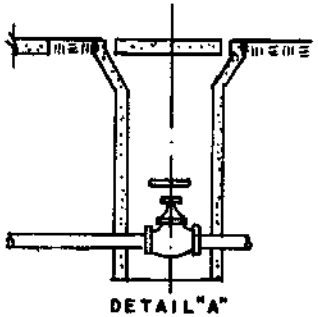


MULTIPLE CONNECTION BRONZE

SIMILAR TO F-4435
"JAMES B. CLOW & SONS, INC.

DETAILS OF MULTIPLES CONNECTIONS TO AVOID DEAD ENDS WHERE POSSIBLE EXTENSION EXISTS	FIG. NUM. 9
	DATE : 8/08/80





DETAIL "A"

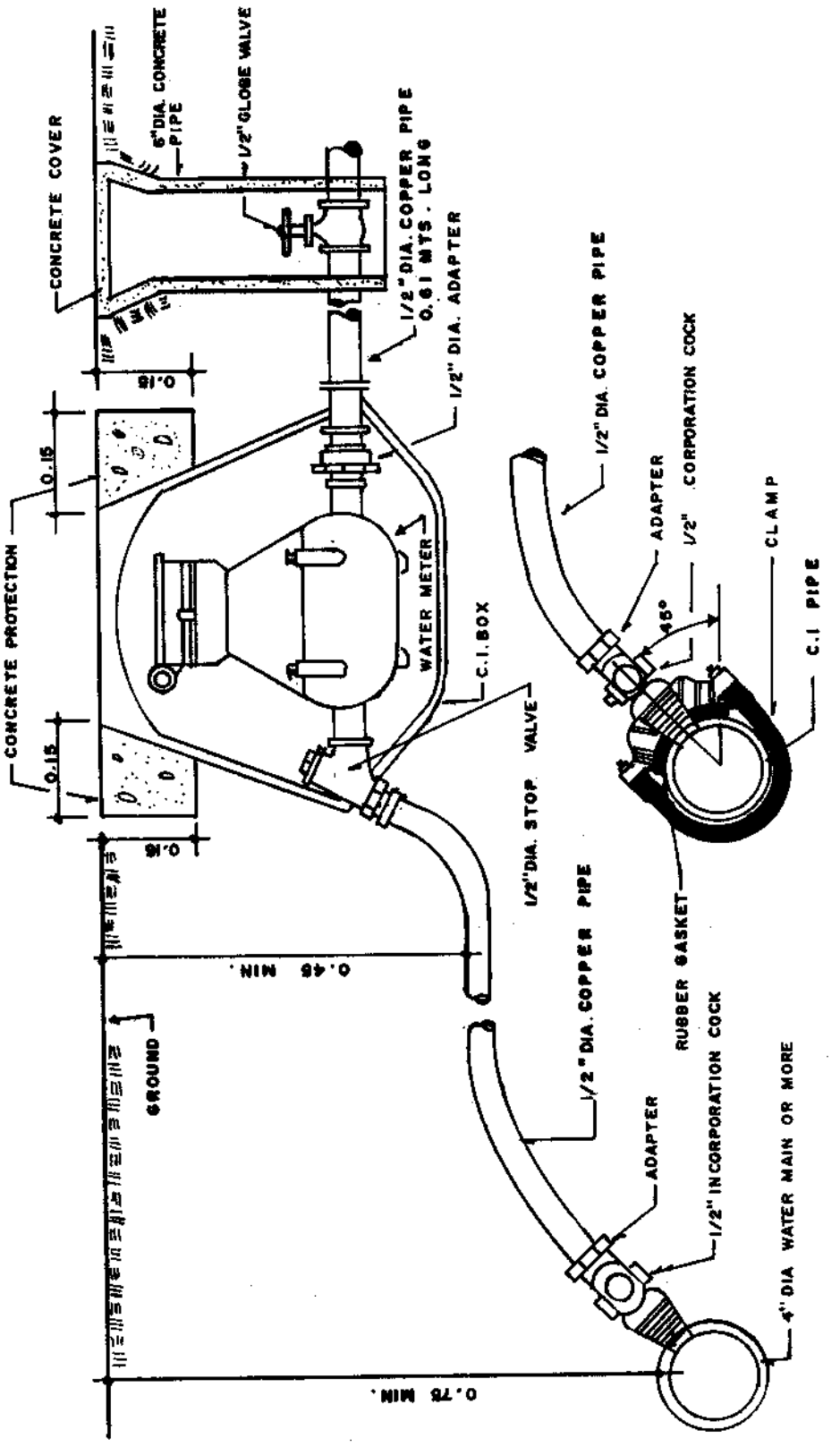
NOTES:

1-FOR 3/4" TO 2" DIA. CONNECTION.
2-FOR FLEXIBLE COPPER PIPE CONNECTION USE FLARE END FILLINGS.
3-THE CONNECTION AND BRANCHES SHALL BE DETERMINED IN ACCORDANCE WITH THE NUMBER OF METERS AND ITS SIZE.
4-SERVICE CLAMP SHALL BE USED WHEN THE RATIO BETWEEN THE CONNECTION AND THE MAIN IS MORE THAN 1/6.
5-ALL FITTINGS SHALL BE THREAD TYPE WHEN BRONZE PIPE IS USED.

DATE 8/08/80

SUBDIVIDED HOUSE CONNECTION DETAIL

FIG. NUM. 10

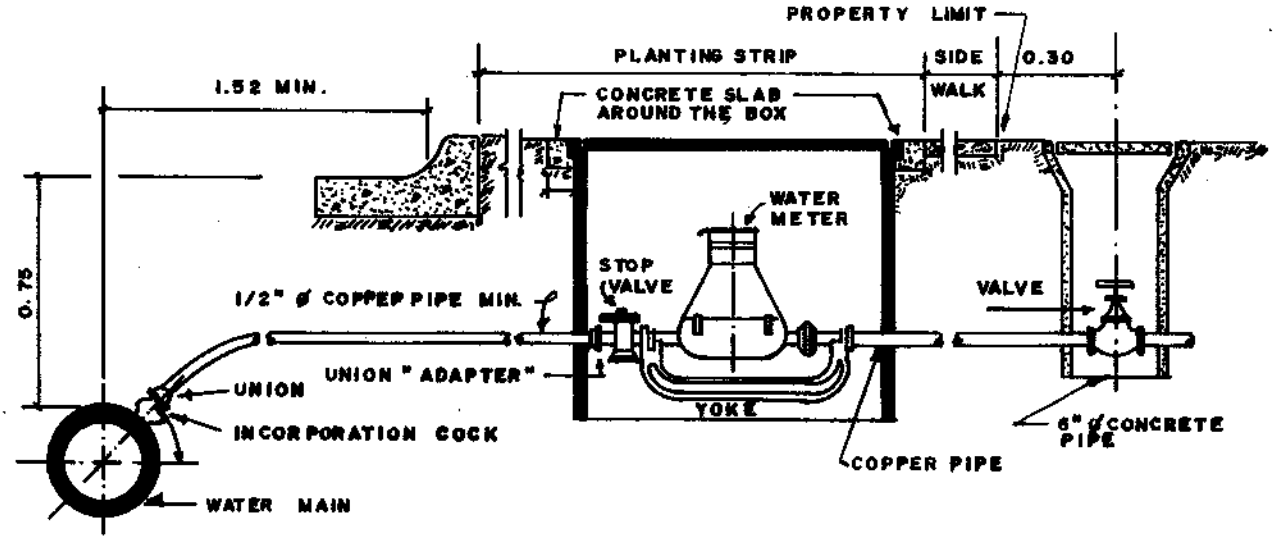


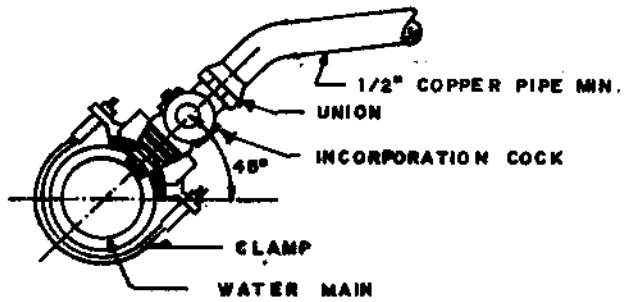
CONNECTION TO MAIN PIPE AND WATER METER INSTALLATION

CONNECTION TO MAIN PIPE

FIG. NUM. 11

DATE 8/08/80





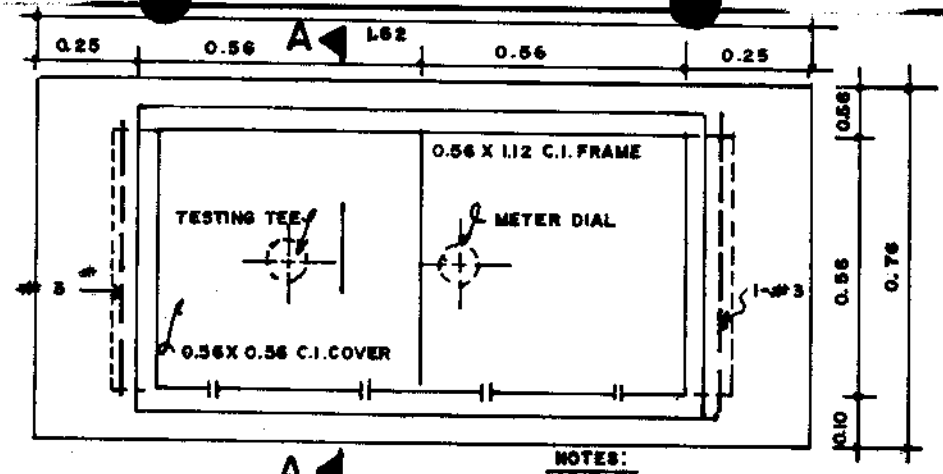
NOTE:

ALL HOUSE CONNECTIONS TO BE MADE AT CENTER OF PROPERTY

HOUSE CONNECTION AND METER INSTALATION TYPICAL DETAIL

FIG. NUM. 12

DATE: 8/08/80

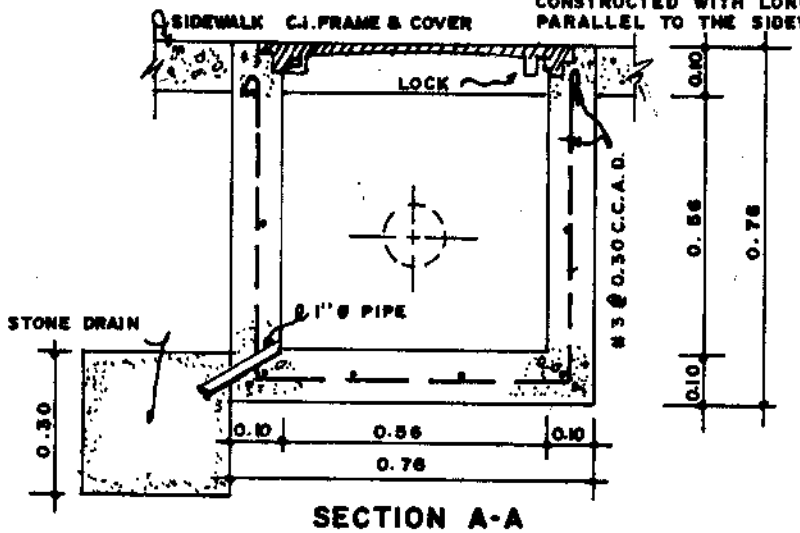


PLAN

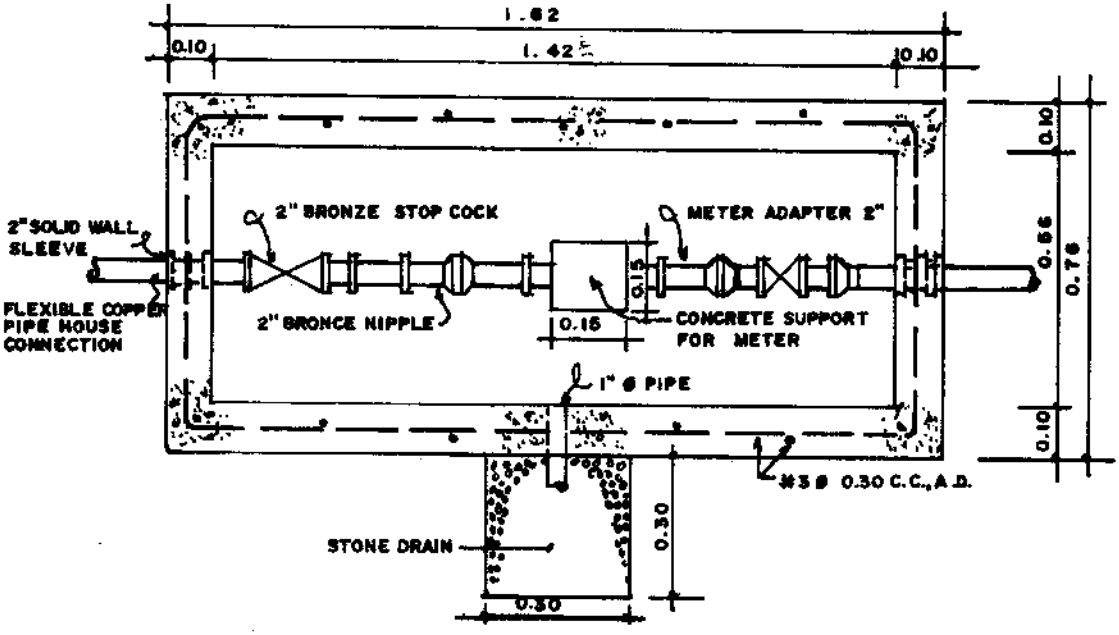
NOTES:

1- BOX TO BE CONSTRUCTED IN THE SIDEWALK OR PLANTING STRIP.

2- IN NARROW SIDEWALK THE BOX SHALL BE CONSTRUCTED WITH LONGITUDINAL AXIS PARALLEL TO THE SIDEWALK AXIS



SECTION A-A



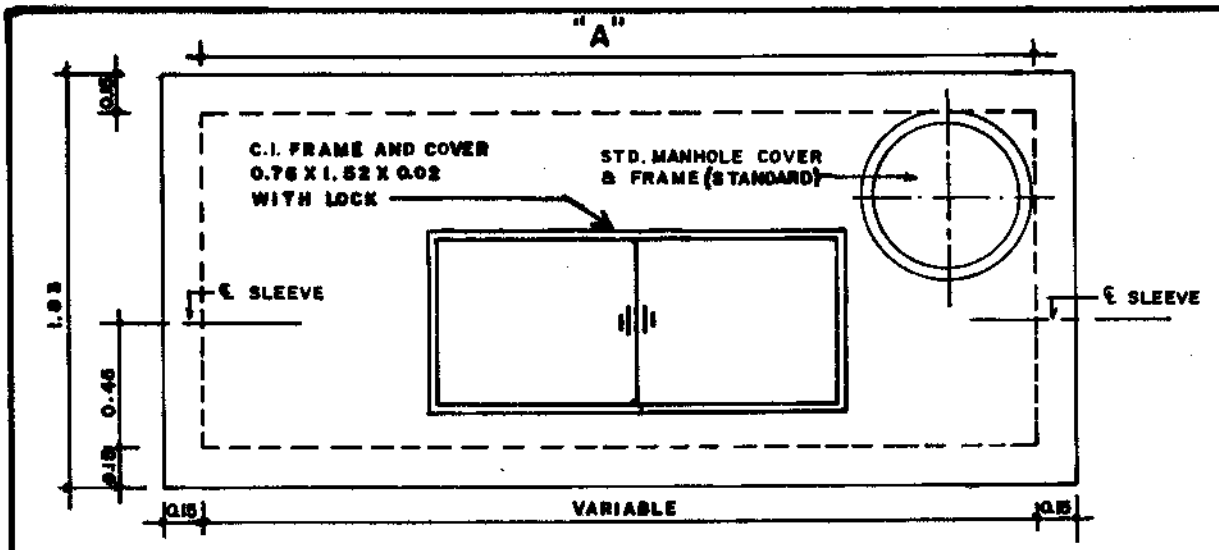
NOT TO SCALE

SECTION PLAN

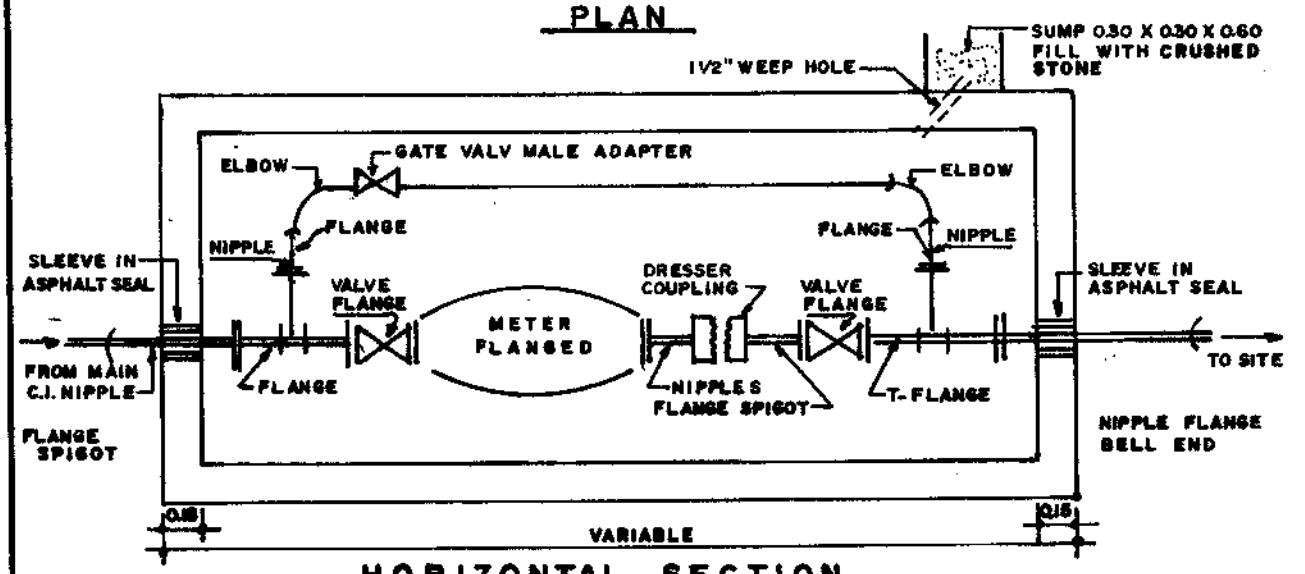
DETAILS FOR 2" DIA. WATER METER BOX

FIG. NUM. 13

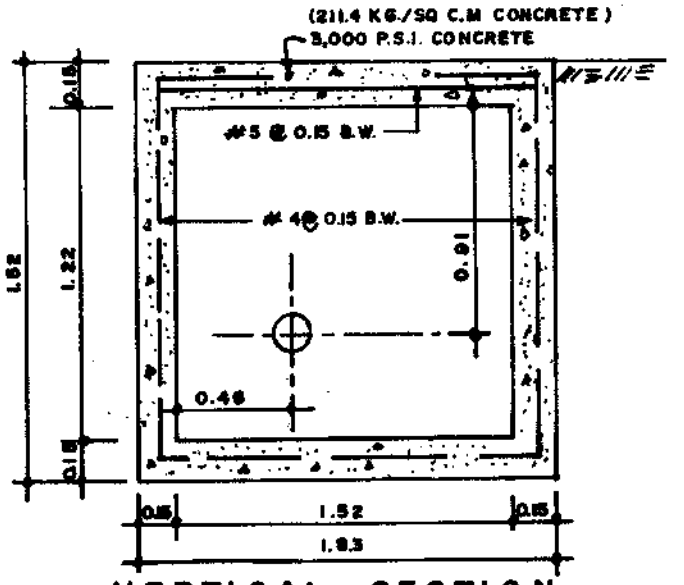
DATE 8/08/80



PLAN



HORIZONTAL SECTION



VERTICAL SECTION

INSIDE DIMENSIONS "A"

3" DIAMETER - 2.74 M.
6" DIAMETER - 3.12 M.
8" DIAMETER - 3.58 M.

BY PASS. DIMENSIONS

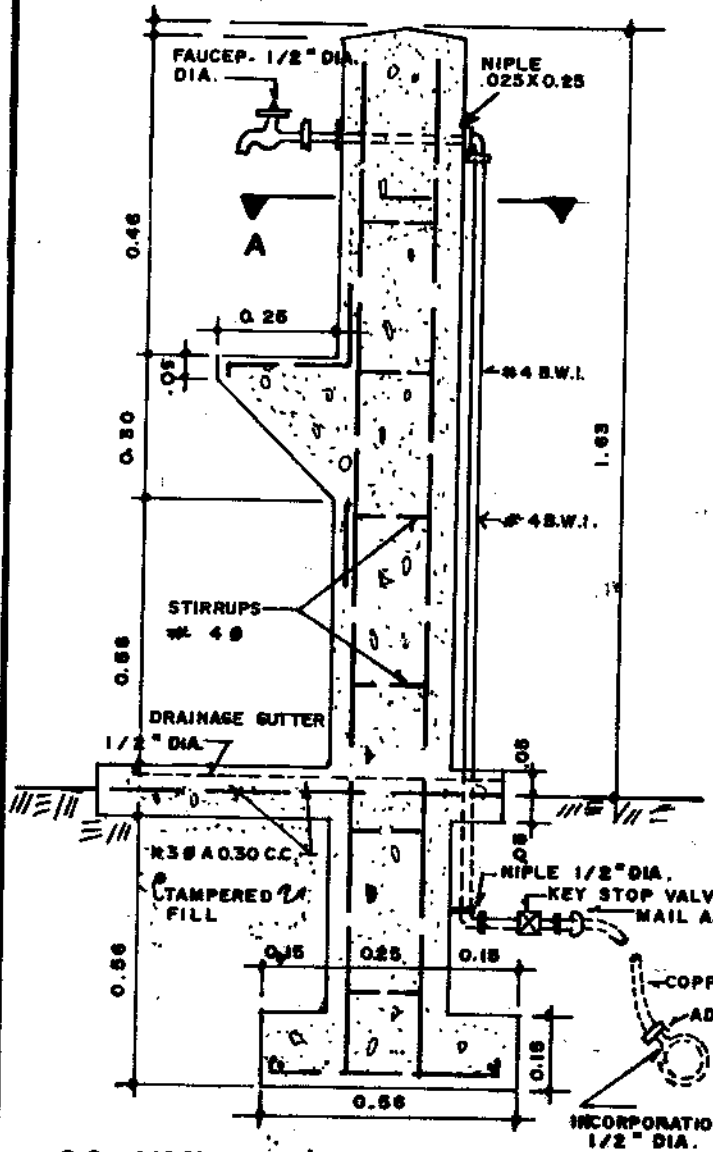
3" DIAMETER = 2"
4" DIAMETER = 2"
6" DIAMETER = 4"
8" DIAMETER = 4"

NOT TO SCALE

3" TO 8" WATER METER

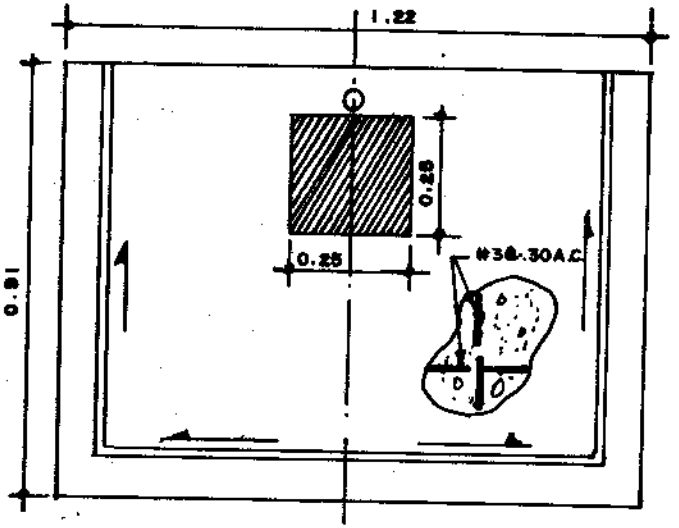
FIG. NUM. 14
DATE 8/08/80

PUBLIC FOUNTAIN



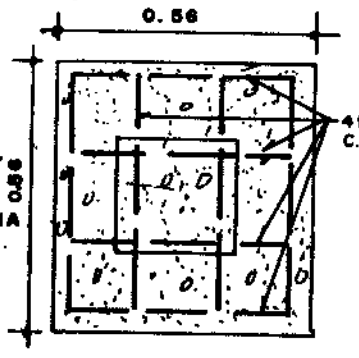
COLUMN TYPE PUBLIC FOUTAIN DETAIL

NOT TO SCALE



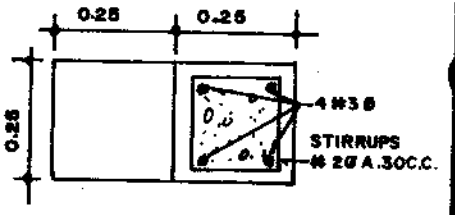
CONCRETE PLATFORM AT PUBLIC FOUNTAIN

NOT TO SCALE



FOOTING DETAIL

NOT TO SCALE

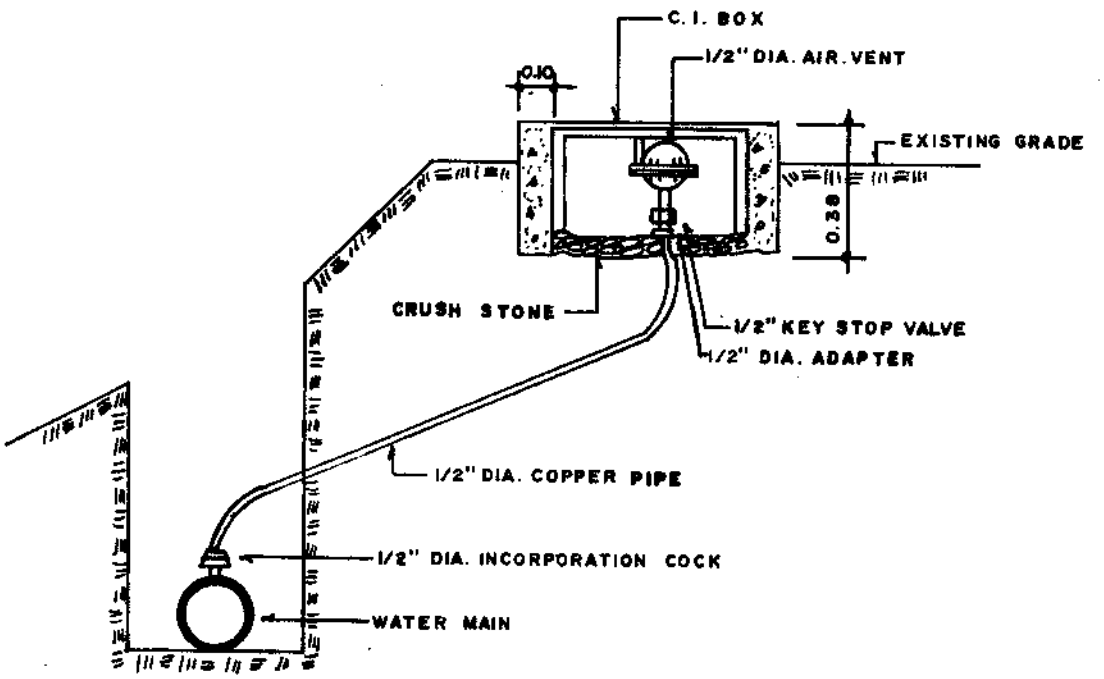


SECTION-"A-A"

NOT TO SCALE

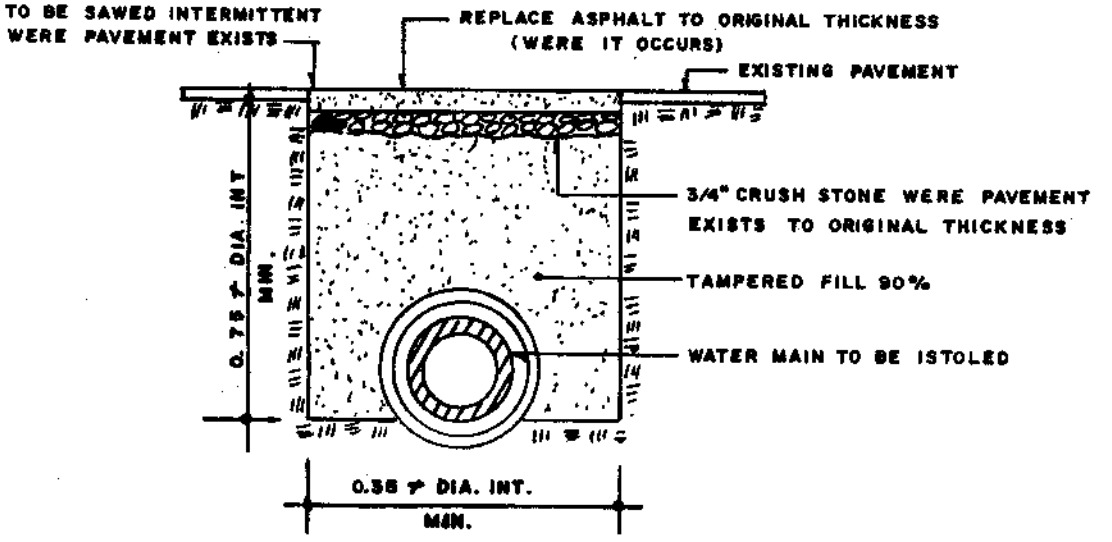
FIG. NO. 15

DATE 8/08/80



1/2" VENT & CONCRETE BOX DETAIL

NOT TO SCALE



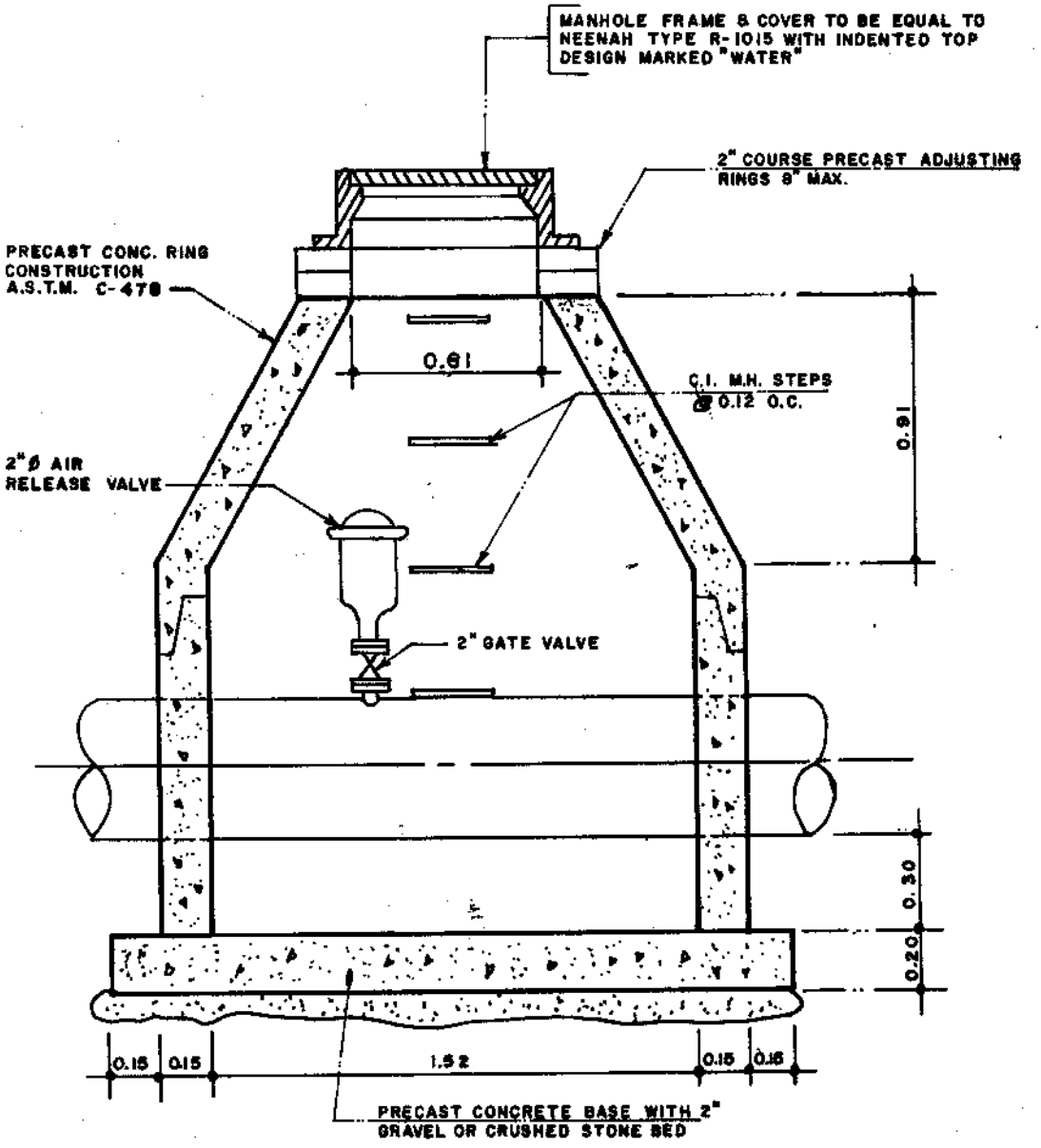
EXCAVATION & FILL FOR PIPE INSTALLATION

NOT TO SCALE

VENT & PIPE INTALLATION DETAILS

FIG. NUM. 16

DATE. 8/08/80

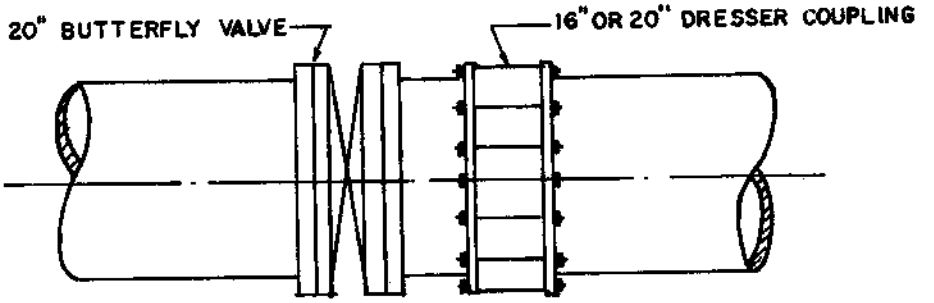


NOT TO SCALE

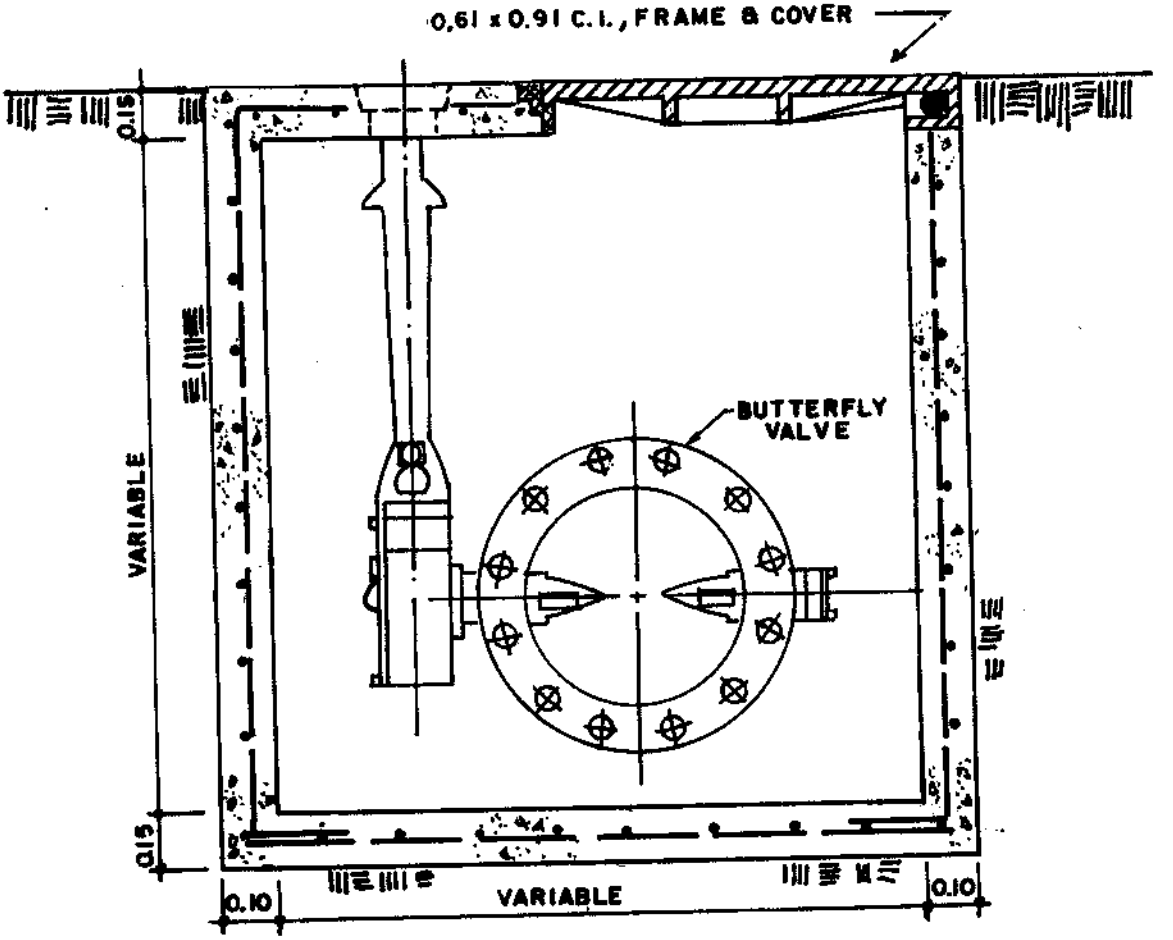
AIR RELEASE VALVE & BASIN DETAIL

FIG. NO.17

DATE 8/08/80



PLAN



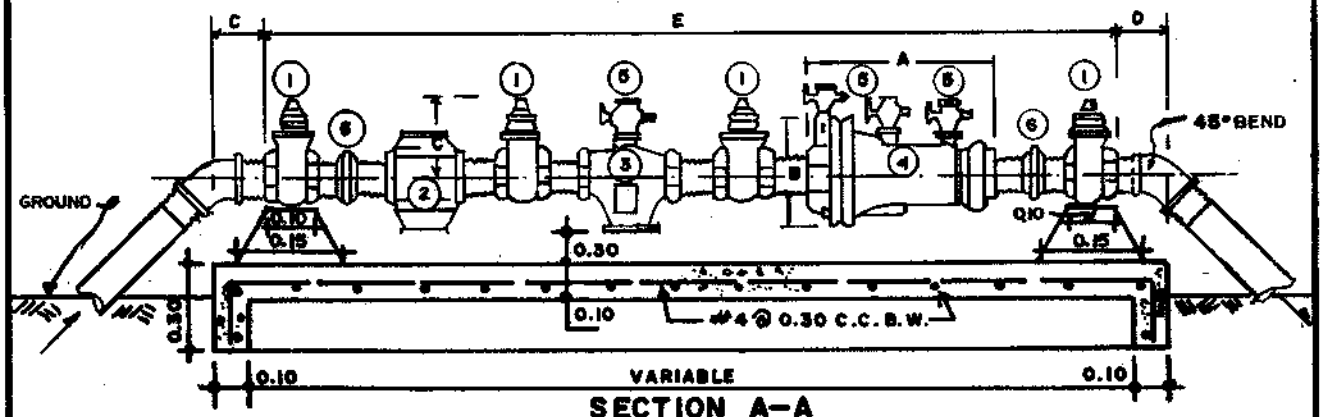
SECTION

NOTE:
THE DEVELOPER SHALL BE RESPONSIBLE FOR THE STRUCTURAL DESIGN

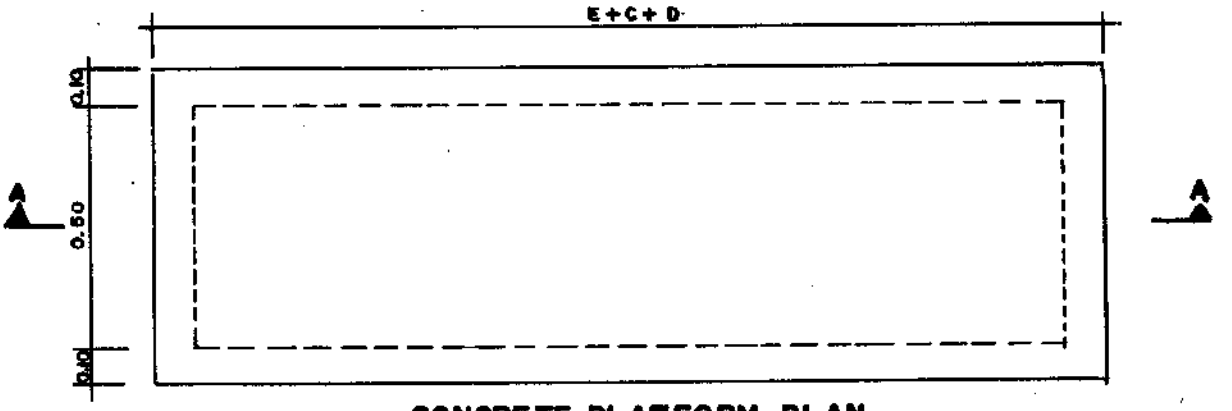
16" OR 20" DIA. BUTTERFLY VALVE DETAIL

FIG. NUM. 18

FECHA : 8/06/80



SECTION A-A



CONCRETE PLATFORM PLAN

SIZES (IN)	DIMENSIONS (INCHES)				
	A	B	C	D	E
3/4	7 1/4	4 1/4	4	4	15 1/4
1	7 1/4	4 1/4	6	6	17 1/2
1 1/4	7 3/8	4 1/4	8	8	19 1/2
1 1/2	12 5/8	7 1/2	10	10	25 7/8
2	12 5/8	7 1/2	12	12	27 7/8

NOTES :

(1) ALL FITTINGS SHALL BE MADE OF BRONZE

(2) THIS EQUIPMENT SHALL BE INSTALLED INSIDE THE LOT

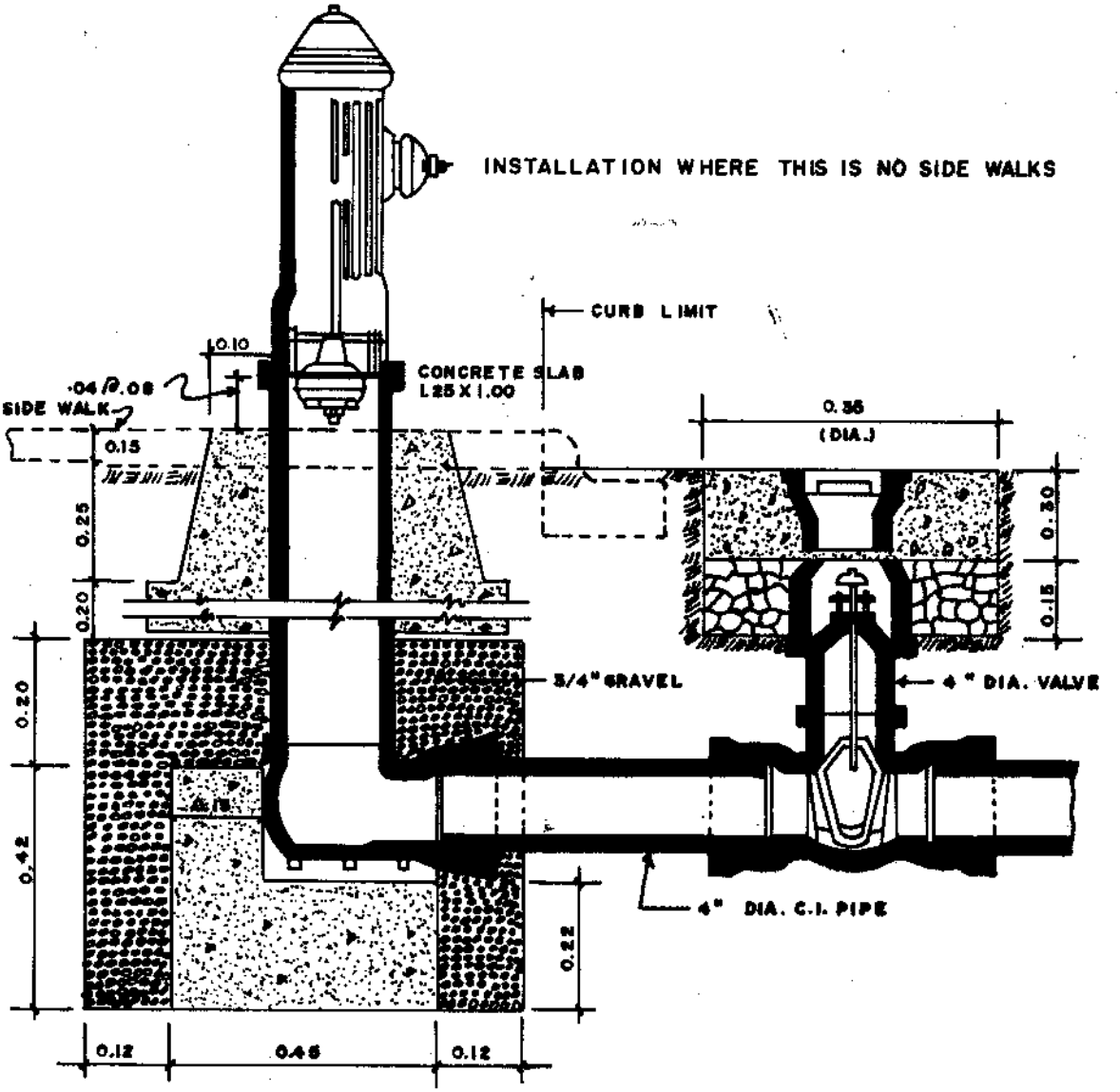
LEGEND

(1) GATE VALVE
(2) WATER METER WITH LOCK CAP
(3) STRAINER
(4) BACKFLOW PREVENTER VALVE
(5) TEST COCK
(6) UNIVERSAL UNION

BACKFLOW PREVENTER VALVE DETAIL
EQUAL OR APROVED EQUAL TO WATTS SERIES 900

FIG. NO. 19

DATE 8/08/80



NOTE:

FOR SIDEWALK PLANTING STRIP THE FIRE HYDRANT MUST BY INSTALLED IN SUSH PLANTING STRIP AS SHOWN IN THE DOTTED LINES.

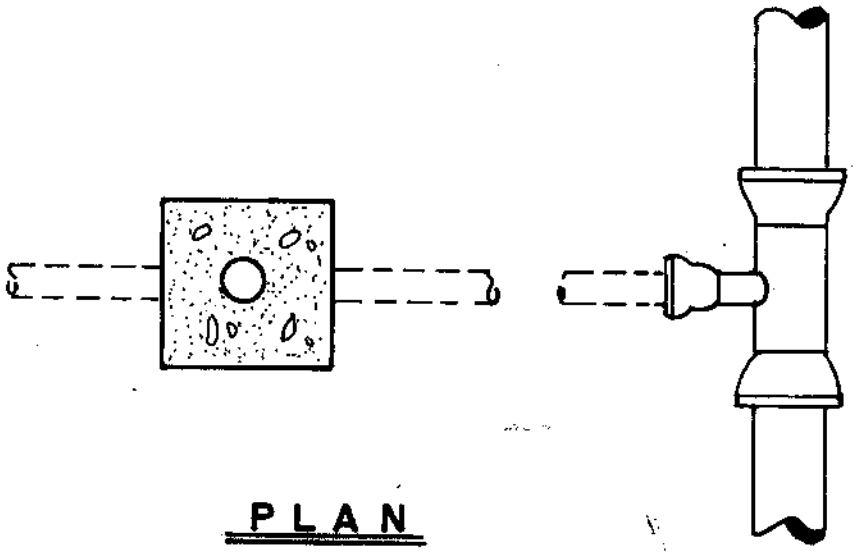
NOT TO SCALE

FIRE HYDRANT

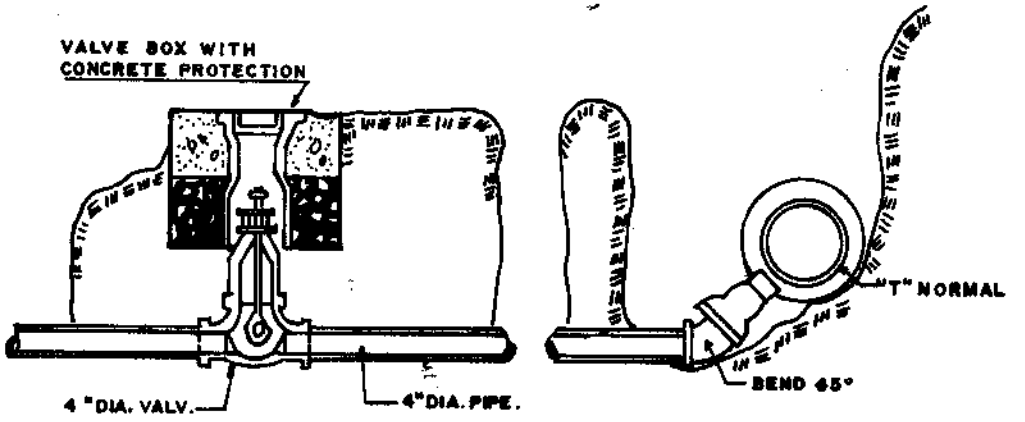
(PUERTO RICO)

FIG. NO. 20

DATE 8/.06/80



PLAN



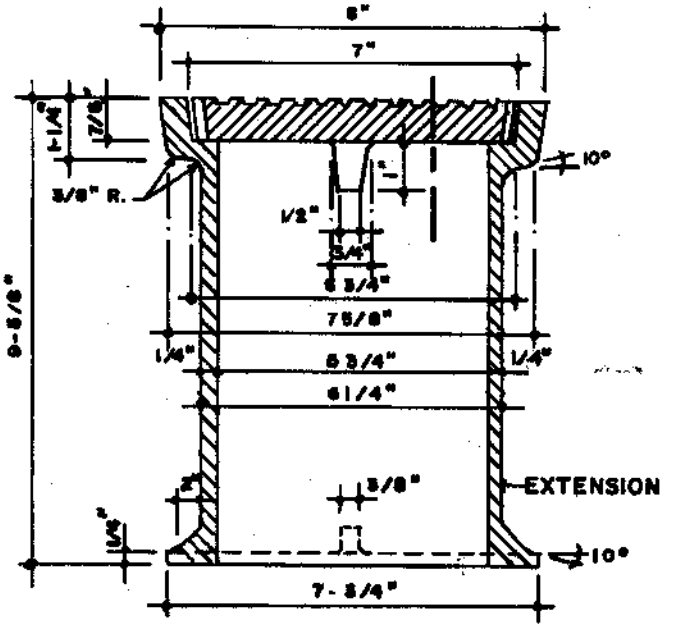
SECTION

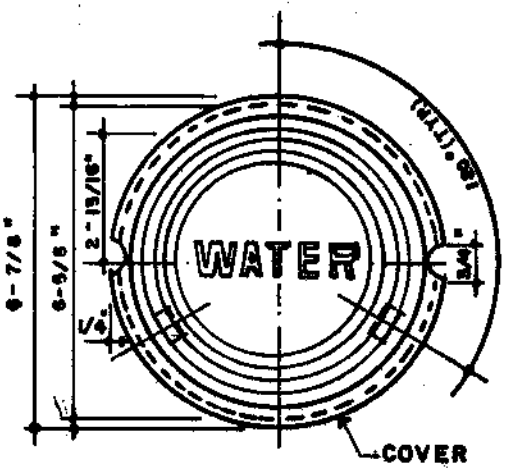
DRAIN DETAIL

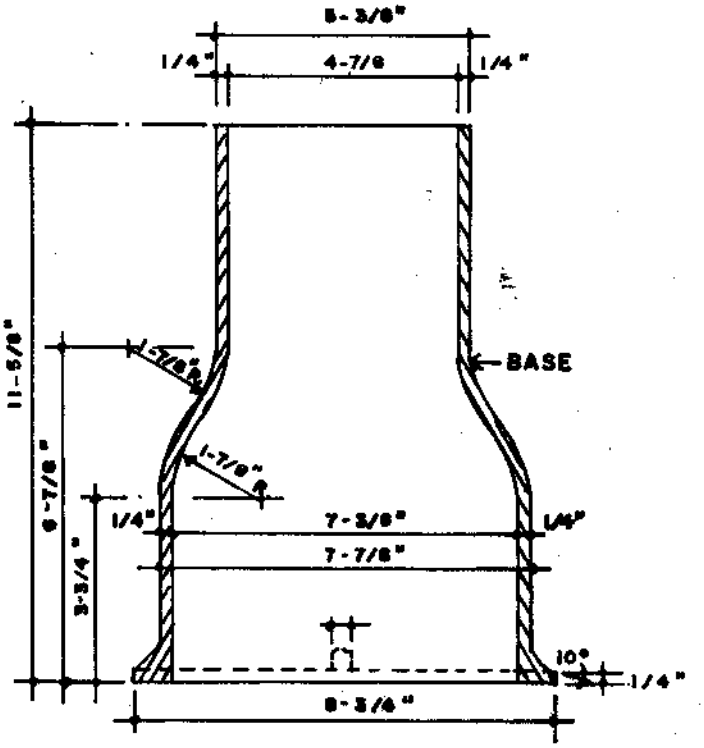
C.I. VALV BOX FOR VALVE PROTECTION

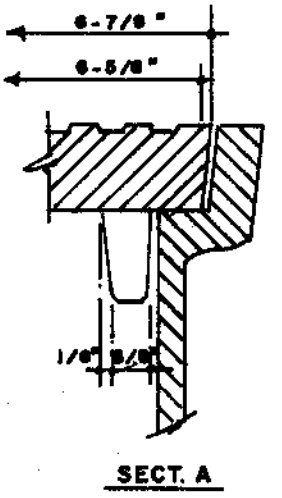
FIG. NO. 21

DATE: 8/08/80









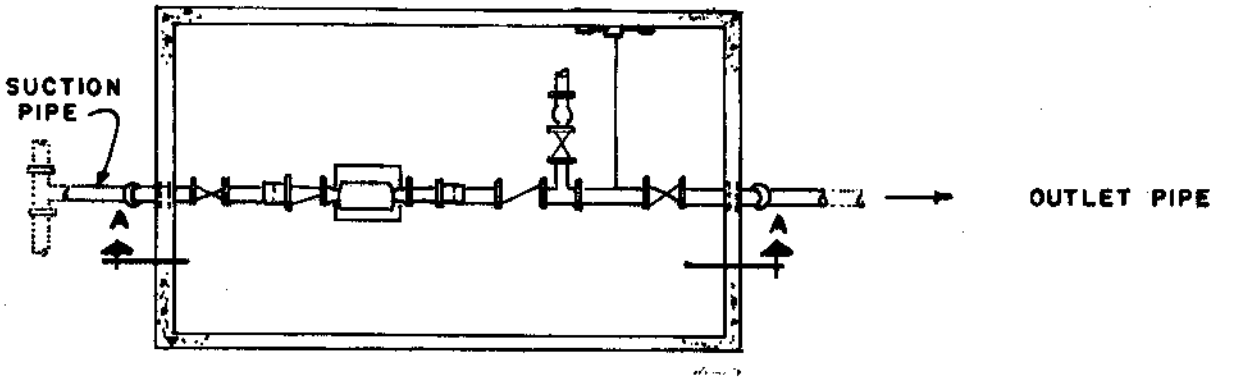
SECT. A

NOT TO SCALE

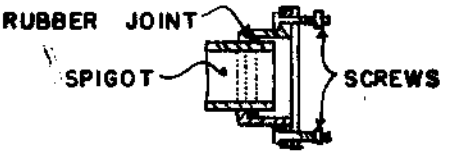
CAST IRON TELESCOPIC VALVE BOX INCLUDING EXTENSION AND COVER

FIG. NO .22

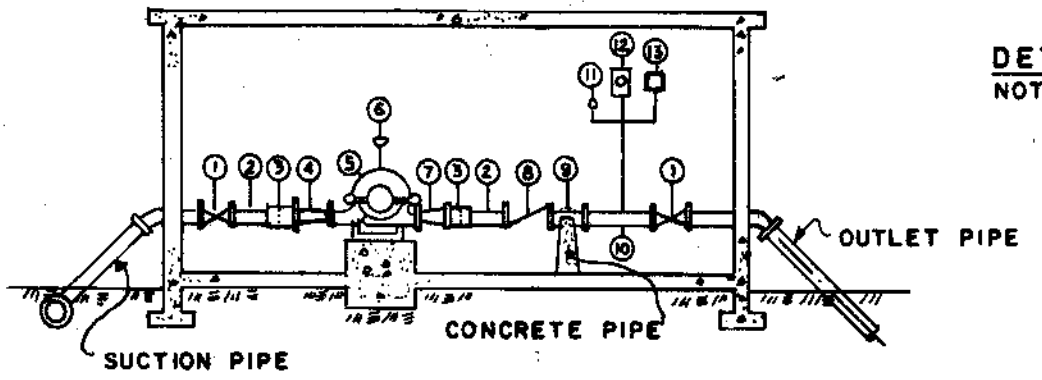
DATE 8/08/80



PLAN
NOT TO SCALE



DETAIL "D"
NOT TO SCALE



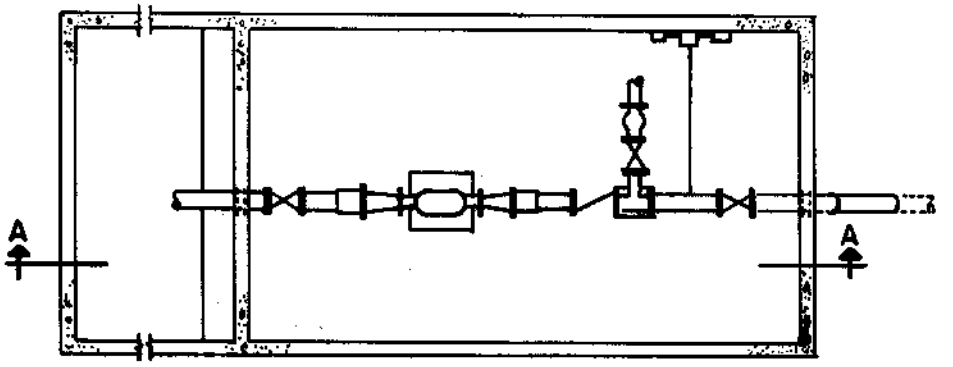
NOT TO SCALE

LEGEND

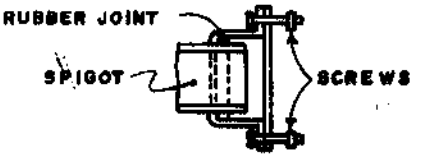
① GATE VALVE , HANDWHEEL OPERATED
② C.I. NIPPLE ,FLANGED & SPIGOT
③ DRESSER COUPLING
④ C.I. REDUCER
⑤ HORIZONTAL CENTRIFUGAL BOOSTER PUMP
⑥ AIR VENT
⑦ C.I. CONCENTRIC PUMP REDUCER
⑧ COMBINATION BACK PRESSURE & CHECK VALVE
⑨ TEE , PRESSURE RELIEF VALVE
⑩ C.I. FLANGED NIPPLE
⑪ PRESSURE GAUGE
⑫ PRESSURE RECORDER
⑬ AUTOMATIC PRESSURE SWITCH

NOTE:
ALL FLANGED FITTINGS

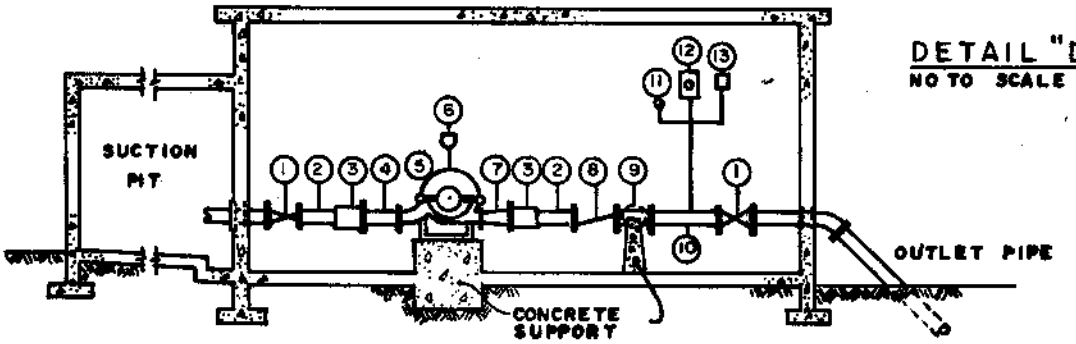
TYPICAL CONNECTION DETAIL OF A HORIZONTAL CENTRIFUGAL BOOSTER PUMP TO A WATER MAIN	FIG. NO. 23
	DATE 8/08/80



PLAN
NOT TO SCALE



DETAIL "D"
NO TO SCALE



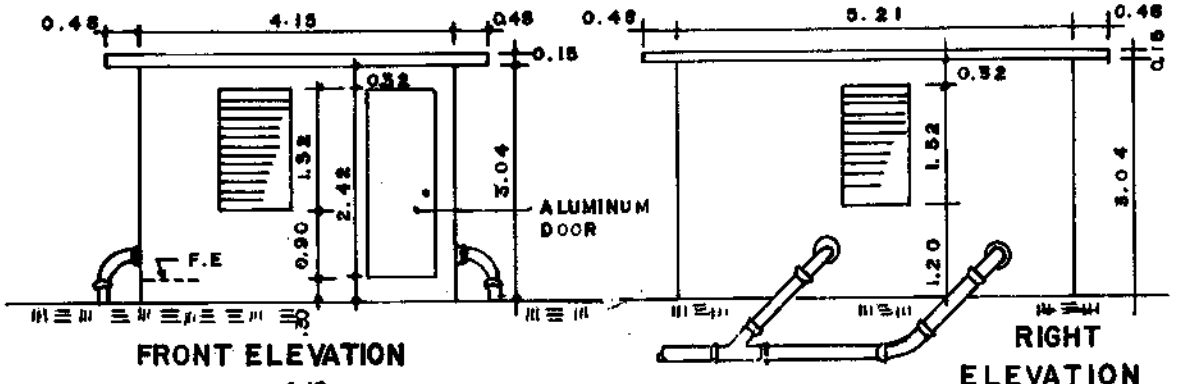
SECTION "A-A"
NOT TO SCALE

LEGEND

1. GATE VALVE, HAND WHEEL OPERATED
2. C.I. NIPPLE, FLANGED & SPIGOT
3. DRESSER COUPLING
4. REDUCER
5. HORIZONTAL CENTRIFAL BOOSTER PUMP
6. AIR VENT
7. PUMP CONCENTRIC REDUCER
8. COMBINATION BACK PRESSURE & CHECK VALVE
9. TEE, PRESSURE RELIEF VALVE
10. C.I. FLANGED NIPPLE
11. PRESSURE GAUGE
12. PRESSURE RECORDER
13. AUTOMATIC PRESSURE SWITH

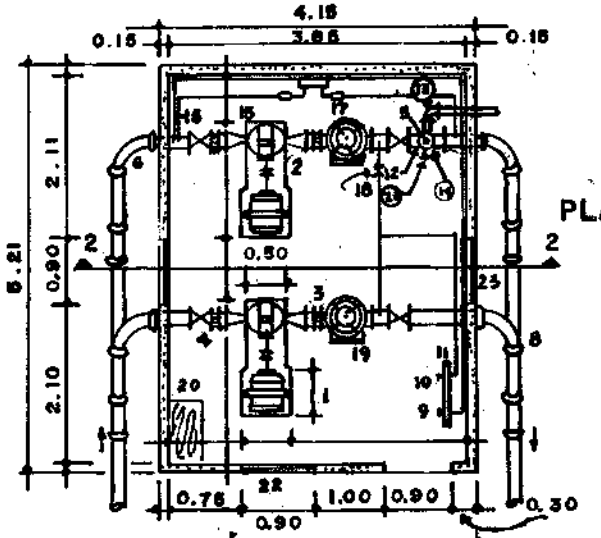
NOTE:
ALL FLANGED FITTINGS

TYPICAL DETAIL OF HORIZONTAL CENTRIFUGAL BOOSTER PUMP CONNECTED TO A SUCTION PIT	FIG NO. 24
	DATE 6/08/80

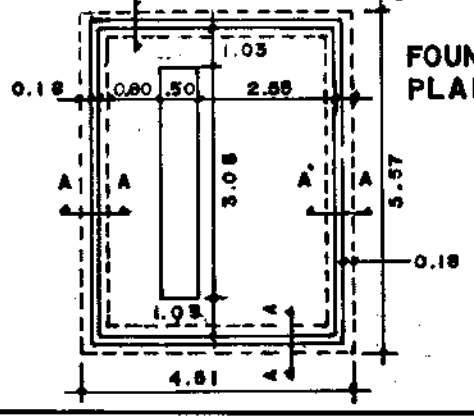


FRONT ELEVATION

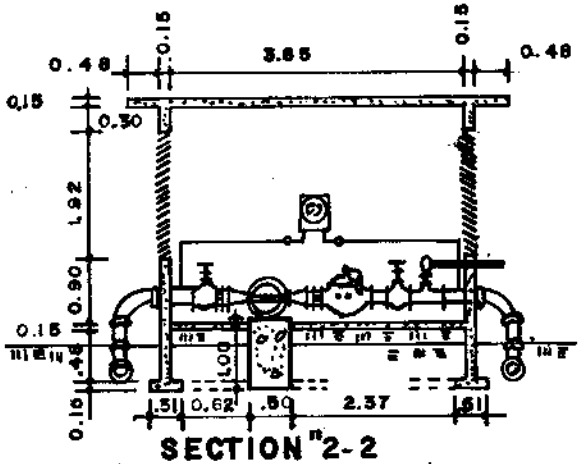
RIGHT ELEVATION



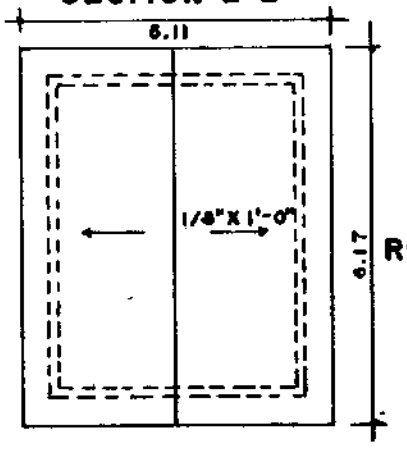
PLANT



FOUNDATION PLANT



SECTION "2-2



ROOF PLAN

LEGEND

1. HORIZONTAL, CENTRIFUCAL PUMP "TURBINE TYPE WITH CAPACITY FOR ____ G.P.M., AGAINT A TOTAL HEAD OF ____ FT., ATTACHED TO A ____ H.P. ELECTRIC MOTOR. ____ R.P.M. ____ PHASES ____ CYCLES AND ____ VOLTS.
2. EXCENTRIC REDUCER, F.L.; ____ X ____
3. FLANGED COUPLING ADAPTER ____ H.P.
4. GATE VALVE ____ DIA. H.F., F.L.
5. PRESSURE SUSTAINING AND CHECK VALVE 2" DIA. SIMILAR OR EQUAL TO CLA-VAL CO. SERIE 91 WITH ADJUSTABLE PILOT FROM ____ P.S.F TO ____ P.S.F. (BRONCE AND THREADED.
6. 90° ELBOW ____ DIA. H.F., B&S 150#.
7. 45° BEND ____ DIA. H.F., B&S 150#.
8. "Y" ____ X ____ X ____ H.F., B&S 150#.
9. MERCOID SUCTION CONTROL.
10. TANK TROL
11. MOTOR CENTRAL CENTER
12. "T" ____ X ____ X ____ H.F., F.L.
13. 90° ELBOW ____ DIA. H.F., H.G.
14. ____ DIA. RING AND THREADED, H.F., F.L.
15. CONCENTRIC REDUCER ____ TO ____ H.F.
16. DUPLEX PRESSURE RECORDING GAUGE FOR 7 DAYS RECORDER.
17. PRESSURE SNUBBER.
18. 1/4" DIA. GATE VALVE
19. PRESSURE SUSTAINING AND CHECK VALVE; IQUAL OR SIMILAR TO MODEL NO. 51 CLA-VAL CO.
20. WOOD CABINET 2'-0" X 1'-0" X 4'-0"
21. VALVE ____ H.F., F.L.
22. ALUMINUM WINDOW
23. ALUMINUM WINDOW.

PUMPING STATION

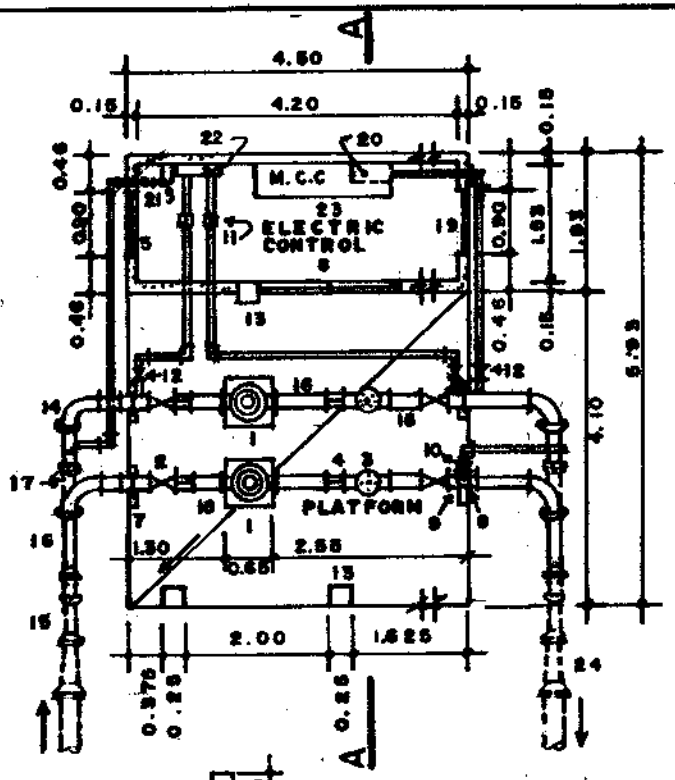
NOT TO SCALE

FIG. NO. 25

DATE 8/08/80

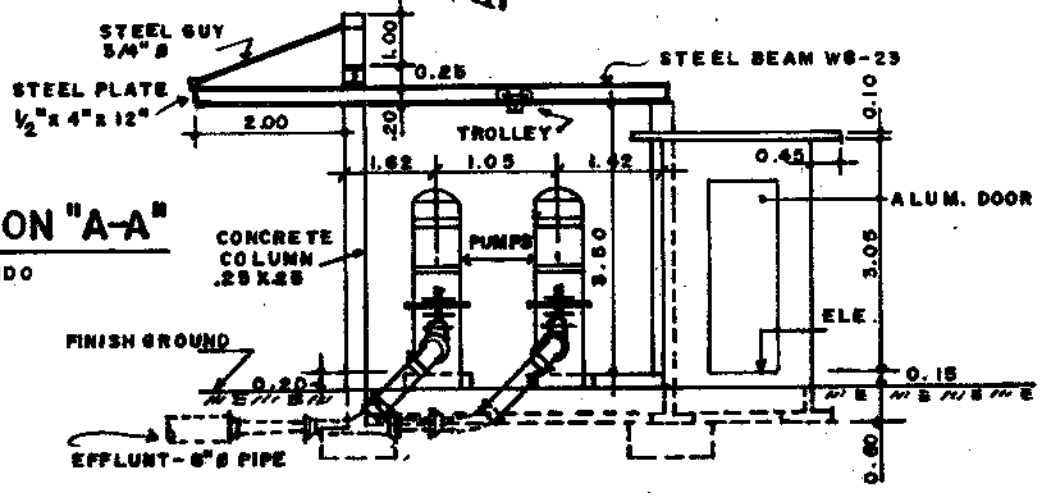
PLAN VIEW

SCALE : 1: 100



SECTION "A-A"

SCALE : 1: 100



LEGEND

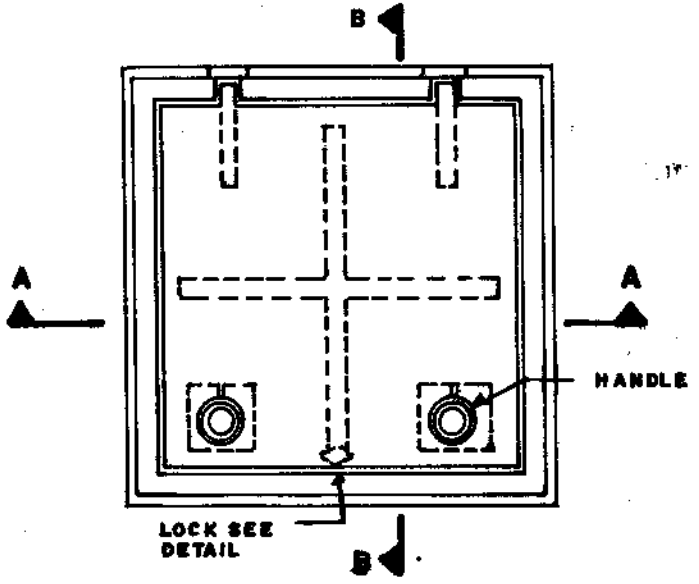
1. VERTICA, CENTRIFUCAL PUMP WHEATHER PROOF WITH CAPACITY FOR ____ G.P.M., AGAINST A TOTAL HEAD OF ____ F.T. EQUAL OR SIMILAR TO MODEL ____ JOHNSTON PUMP CO., ATTACHED TO ____ H.P. ELECTRIC MOTOR ____ R.P.M. ____ PHASES ____ CYCLES AND ____ VOLTS.
2. 6"ø VALVE, 150#, F.F.
3. PRESSURE SUSTAINING AND CHECK VALVE, IQUAL OR SIMILAR TO MODEL NO. 81CLA-VAL CO., WITH ADJUSTABLE PILOT.
4. 6"ø FLANGED COUPLING ADAPTER
5. 3'-0"X5'-0" ALUMINUM WINDOW (MIAMI)
6. 3'-0" X5'-0" ALUMINUM WINDOW (MIAMI)
7. CONCRETE SUPPORT AND STEEL BRACKET
8. 90° ELBOW - 2" DIA.
9. "T" 6"X6"X2" H.F., F.F., 150#
10. PRESSURE SUSTAINING AND CHECK VALVE 2" DIA. SIMILAR OR EQUAL TO CLA-VAL CO. SERIE 81 WITH ADJUSTABLE PILOT FROM ____ P.S.F. TO ____ P.S.F. (BRONZE AND THREADED.
11. PRESSURE SNUBBER 1/4" DIA.
12. 1/4" DIA. GATE VALVE
13. CONCRETE COLUMN 0.25 X 0.25
14. 6"DIA 90° ELBOW, H.F., F.F., 150#
15. "Y" 6"X6"X6", H.F., B.B.B., 150#
16. NIPPLE 6" DIA. H.F., F&S, 150#
17. 45° BEND 6" DIA., H.F. B&B, 150#
18. ALUMINUM DOOR 3'-0" X8'-0"
19. NIPPLE 6" DIA. H.F., F.F. 150#
20. TANK TROL
21. ELECTRODE HOLDER
22. DUPLEX PRESSURE RECORDING GAUGE FOR 7 DAY RECORDER.
23. MOTOR CONTROL CENTER
24. 6"X 4" REDUCER

PUMPING STATION

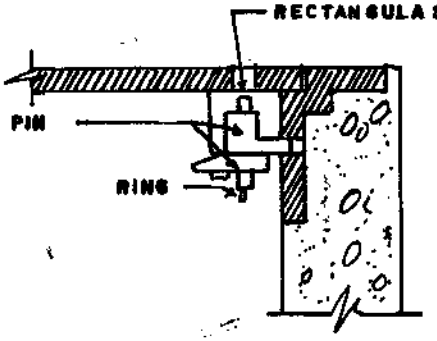
WEATHER PROOF INSTALLATION

FIG. NO. 25-A
DATE 6/06/80

DESCRIPTION	NUMBER	A	B	C	D
FLOAT VALVE FRAME AND COVER	16225	1.07 MT.	0.97 MT.	0.95 MT.	0.90 M.T.
CHECK VALVE FRAME AND COVER	15181	1.22 MT.	1.12 MT.	1.11 MT.	1.07 MT.
FRAME AND COVER FOR INSPECTION MANHOLE	16213	0.76 MT.	0.66 MT.	0.65 MT.	0.60 MT.



PLANT



NOTE:
ALL PARTS TO BE BRONCE

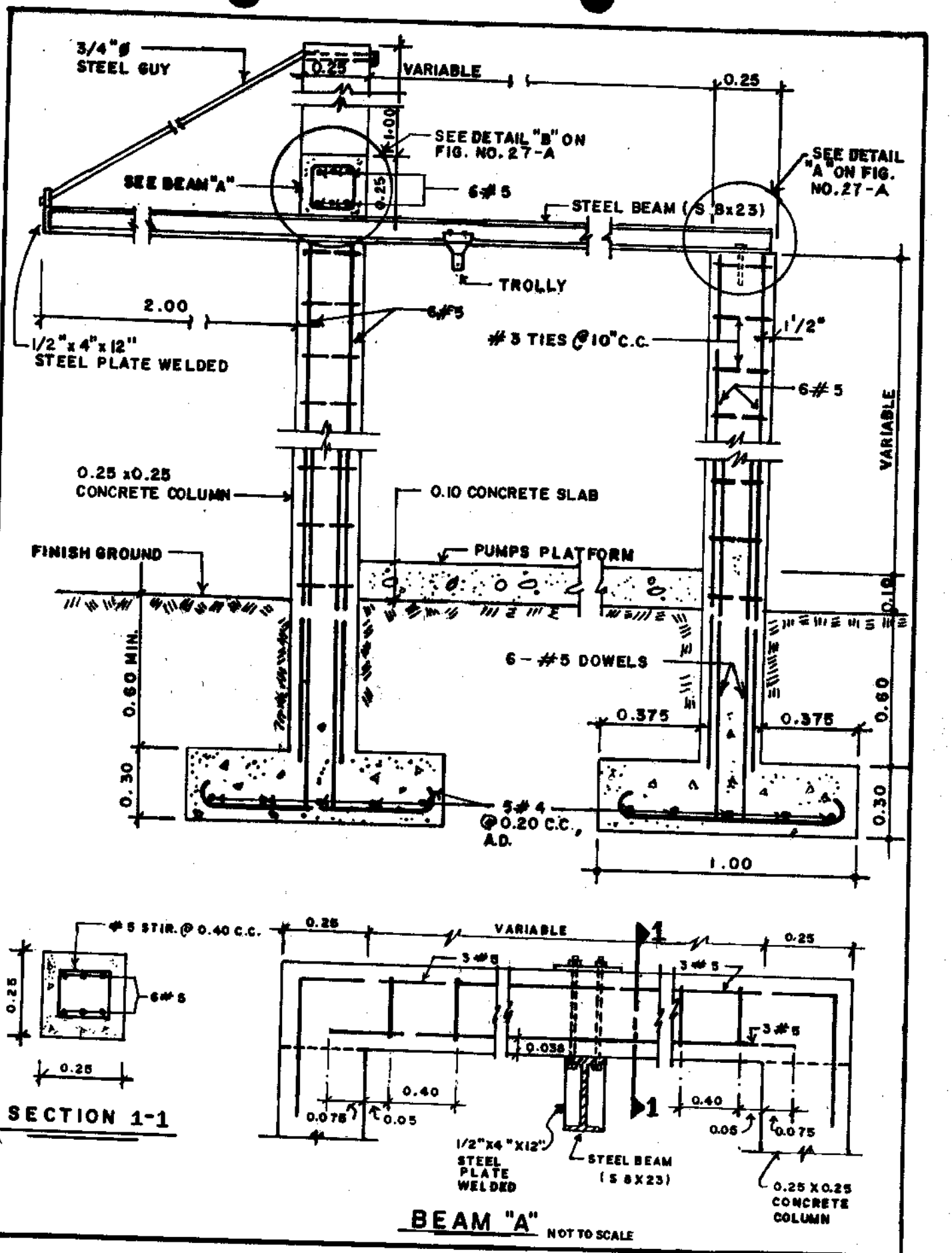
LOCK DETAIL

NOT TO SCALE

ALUMINUM FRAME AND COVER
TIPE FLOCKHART 678 WITH LOCK

DATE 8/08/80

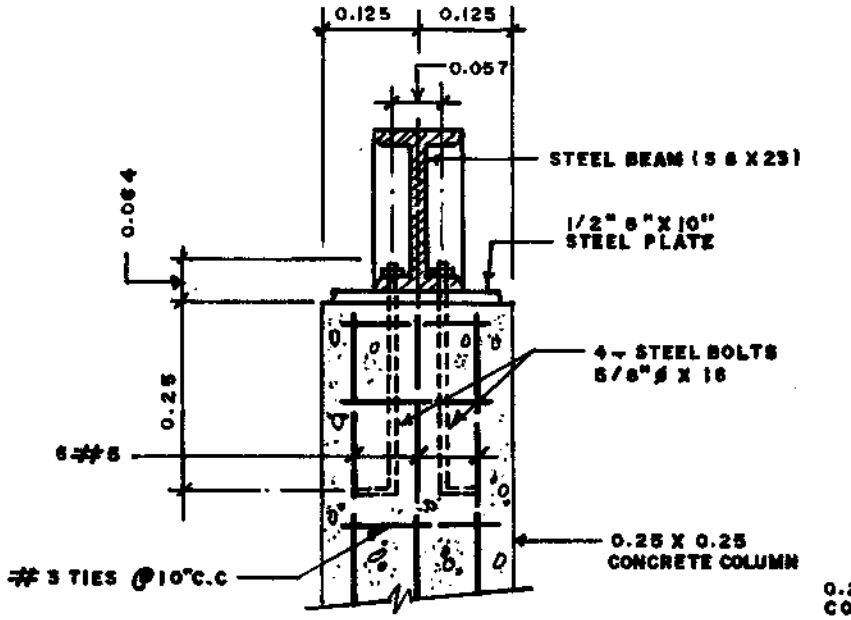
FIG. NO. 26

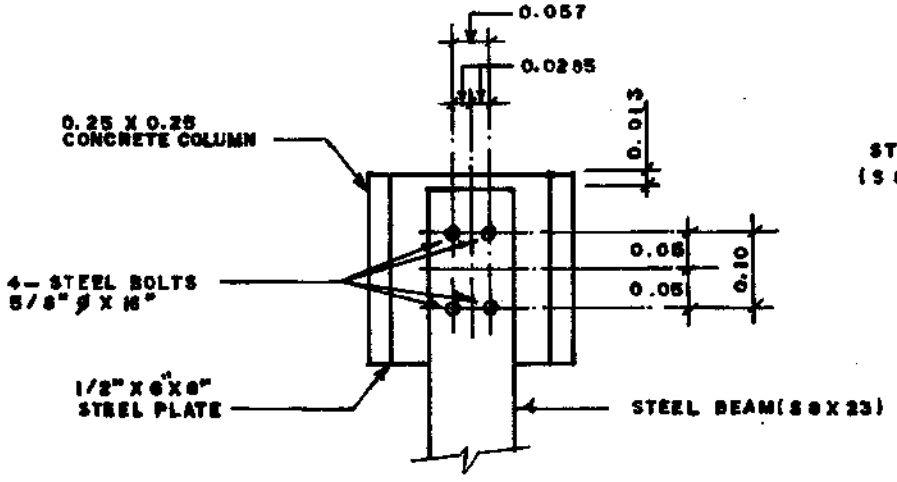


PUMPING STATION INSTALLATION

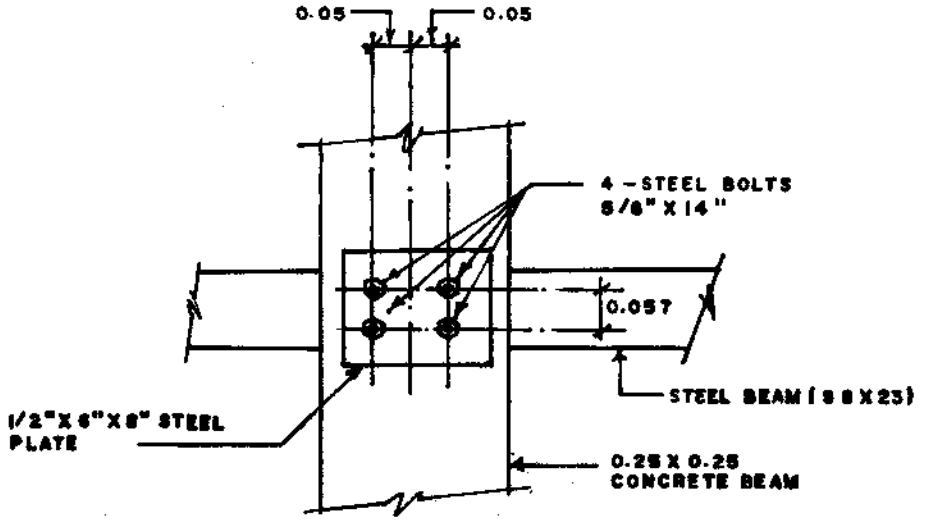
FIG. NO. 27

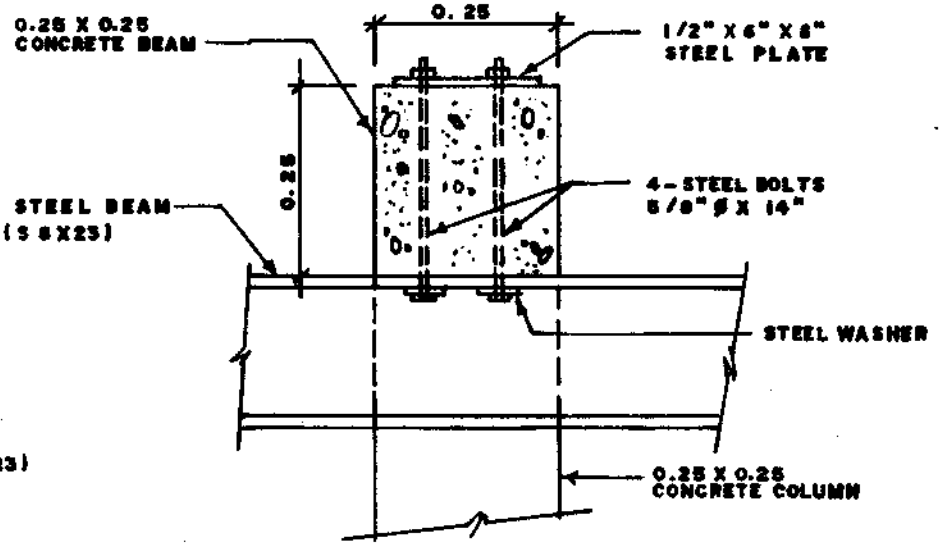
DATE 7/11/80





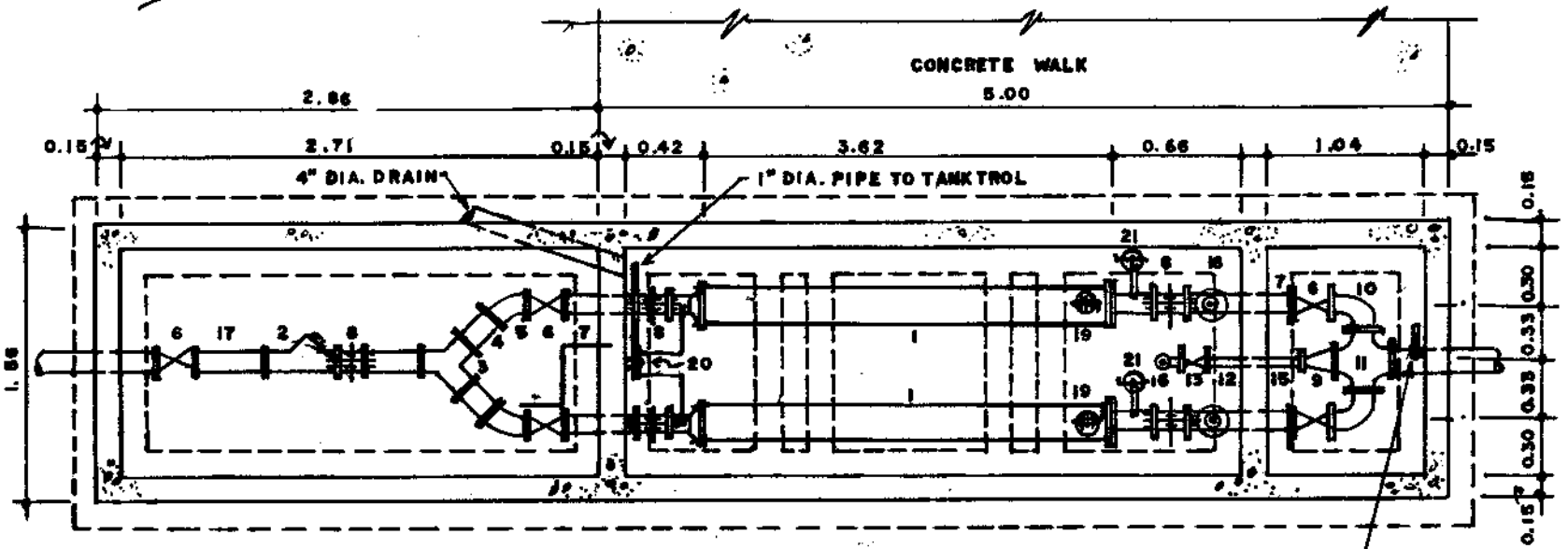
DETAIL "A"





DETAIL "B"

FIG. NO. 27-A	PUMPING STATION INSTALLATION DETAILS	DATE: 7/11/80



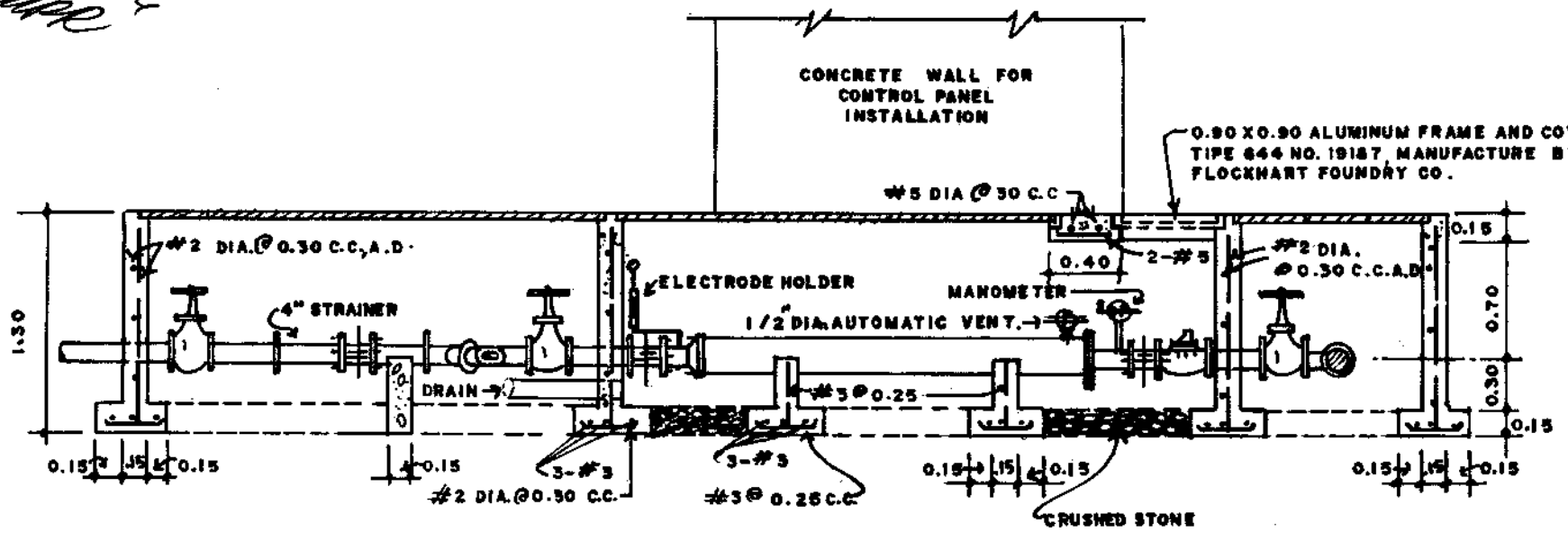
PLANT SCALE =1:40

LEGEND

1- UNDER GROUND PUMP. WITH CAPACITY FOR ____ G.P.M., AGAINST A TOTAL HEAD OF ____ FT. EQUAL OR SIMILAR TO MODEL ____ ATTACHED TO A ____ H.P. ELECTRIC MOTOR ____ R.P.M. ____ PHASES ____ CICLES AND ____ VOLTS.
2- 4" DIA. STRAINER H.F., F.L.
3- 4" DIA. TRUE "Y" H.F., F.L.
4- 4" DIA. NIPPLE H.F., F.L. (6" LENGHT)
5- 45° BEND 4" DIA. H.F., F.L. (SHORT BODY)
6- 4" DIA. VALVE H.F., F.L.
7- 4" DIA. NIPPLE H.F., F.L. (15" LENGHT)
8- FLANGED COUPLING ADAPTER 4" DIA. H.F.
9- 4" X 2" REDUCER H.F., F.L.
10- 90° ELBOW, 4" DIA. H.F. (SHORT BODY)
11- 4" DIA. CROSS H.F., F.L. (SHORT BODY)
12- 2" DIA. NIPPLE H.G. (20" LENGHT)
13- 2" DIA. VALVE BRONZE AND THREADED
14- PRESSURE SUSTAINING VALVE 2" DIA. SIMILAR OR EQUAL TO MODEL 20 W.R FROM ROSS VALVE MFG. CO.
15- FLANGED ADAPTER
16- 90° ELBOW 2" DIA. H.G., WITH THREADED
17- 4" DIA. NIPPLE H.F., F.L. (16" LENGHT)
18- PRESSURE SUSTAINING AND CHECK VALVE IQUAL OR SIMILAR TO MODEL NO. 51 FROM CLA-VAL CO.
19- 1/2" DIA. AUTOMATIC VENT.
20- ELECTRODE HOLDER, VENT. AND MANOMETER
21- MANOMETER.

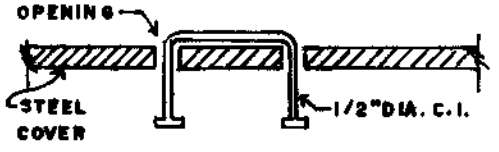
NOTE:
FOR SECTION "A-A" SEE FIG. NO. 28-A

DATE : 7/11/80	UNDER GROUND PUMPS STATION	FIG. NO. 28



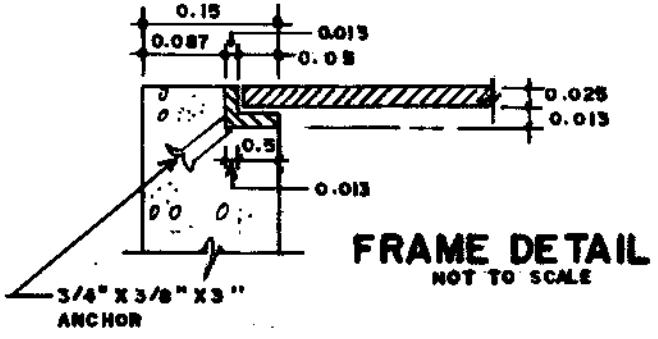
SECTION A-A

SCALE = 1:40



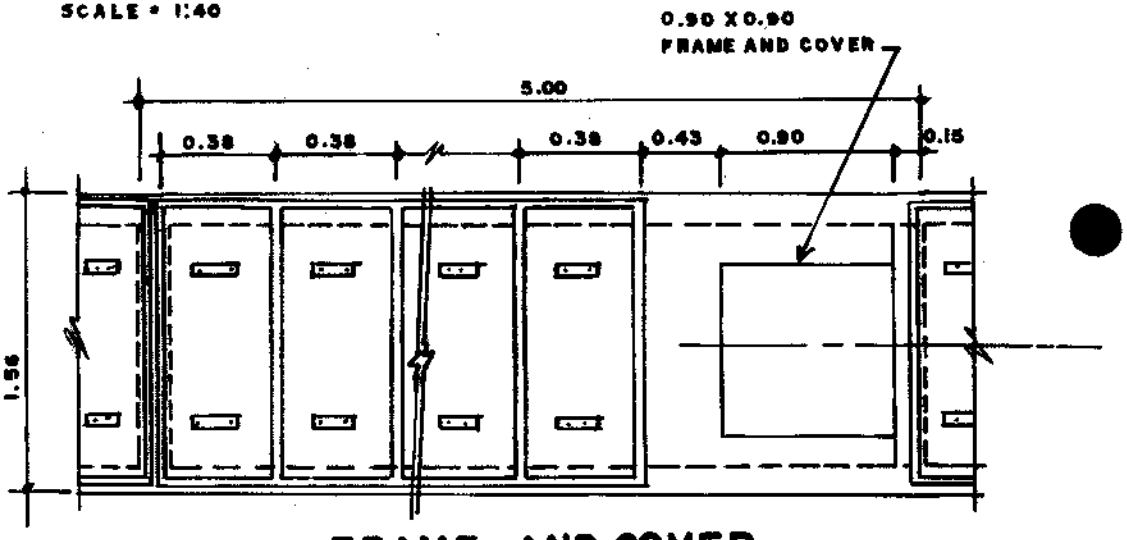
HANDLE DETAIL

SCALE = 1:20



FRAME DETAIL

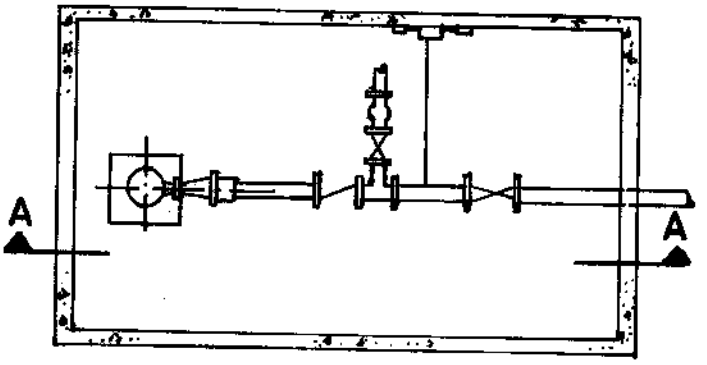
NOT TO SCALE



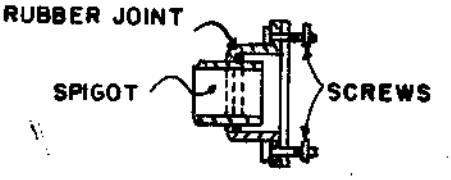
FRAME AND COVER

SCALE = 1:40

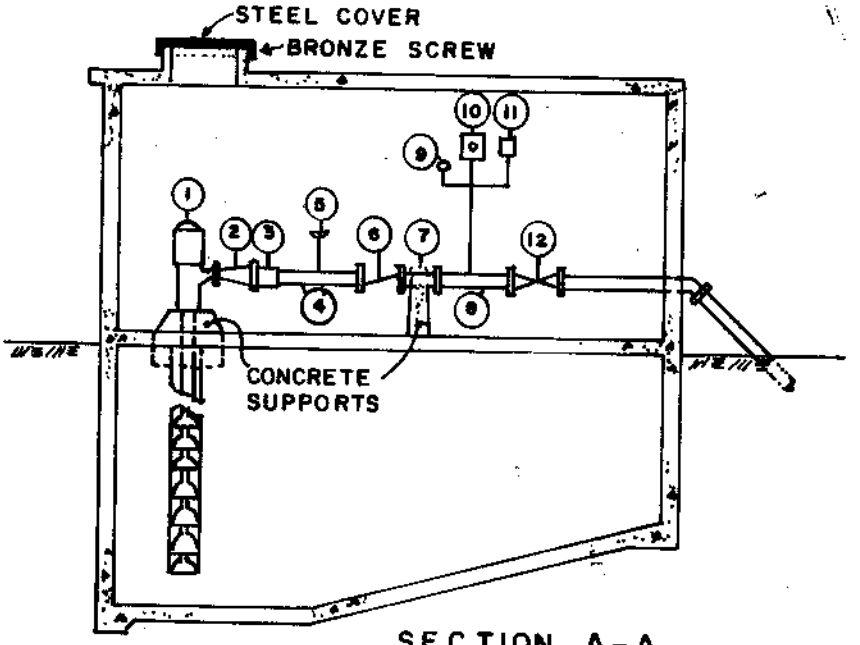
DATE: 7/11/80	UNDER GROUND PUMPS SECTION AND DETAIL	FIG. NO. 28-A



PLAN
NOT TO SCALE



DETAIL "D"
NOT TO SCALE



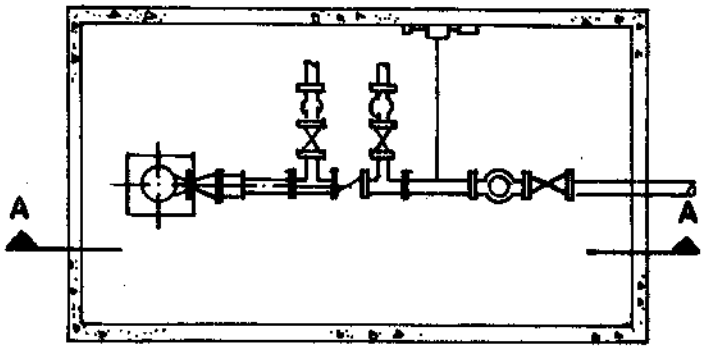
SECTION A-A
NOT TO SCALE

NOTE:
ALL FLANGED FITTINGS

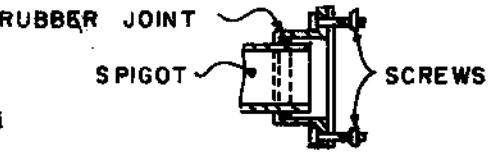
LEGEND:

1. VERTICAL TURBINE PUMP
2. REDUCER
3. DRESSER COUPLING (SEE DETAIL "D")
4. FLANGED SPIGOT C.I. FLANGED NIPPLE
5. AIR VENT
6. COMBINATION BALK PRESSURE AND CHECK VALVE
7. TEE PRESSURE RELIE VALVE
8. C.I. FLANGED NIPPLE
9. PRESSURE GAUGE
10. PRESSURE RECORDER
11. AUTOMATIC PRESSURE SWITCH
12. GATE VALVE, HAND WHEEL OPERATED

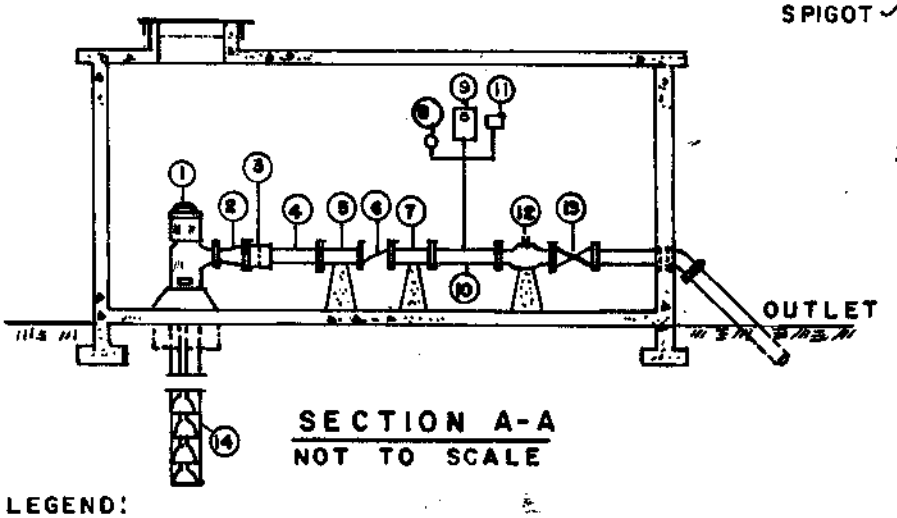
INSTALLATION DETAIL OF A VERTICAL TURBINE PUMP TO A WET PIT	FIG. NUM. 29
	DATE 8/5/80



PLAN
NOT TO SCALE



DETAIL "D"
NOT TO SCALE



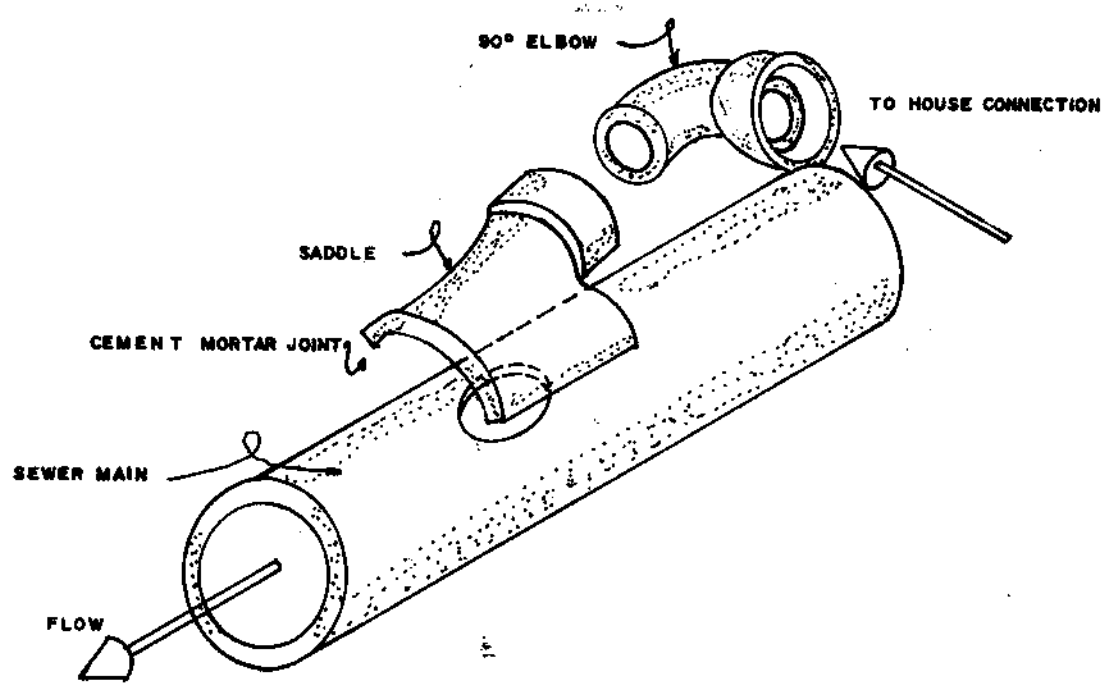
SECTION A-A
NOT TO SCALE

LEGEND:

1 VERTICAL TURBINE DEEP WELL PUMP
2 REDUCER
3 FLEXIBLE VOINT (SEE DETAIL)
4 NIPPLES FLANGE SPIGOT
5 TEE AND PRESSURE RELIEF VALVE
6 RETENTION VALVE AND OR CONTROLER OF AUTOMATIC FLOW
7 TEE, GATE VALVE, DRAIN PIPE
8 PRESSURE GAUGE
9 GRAPHIC PRESSURE RECORDER
10 PUMP NIPPLE
11 GRAPHIC PRESSURE SWITCH
12 TURBINE METER OR VENTURI TYPE
13 GATEVALVE HANDER HOOK OPERATED
14 PUMP COLUMN

NOTE:
ALL FLANGED FITTINGS

DETAIL OF A DEEP WELL PUMP	FIG. NUM. 30
	DATE 8/5/80

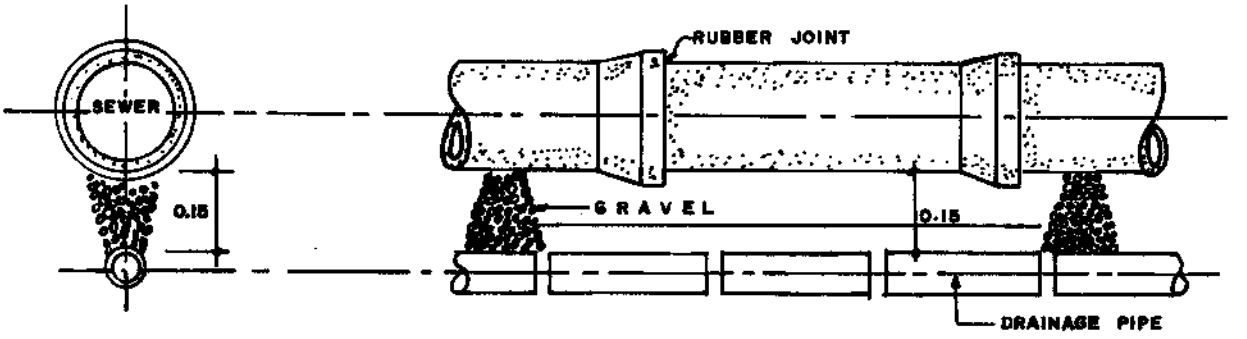


NOT TO SCALE

SADDLE HOUSE CONNECTION TO EXISTING SANITARY SEWER

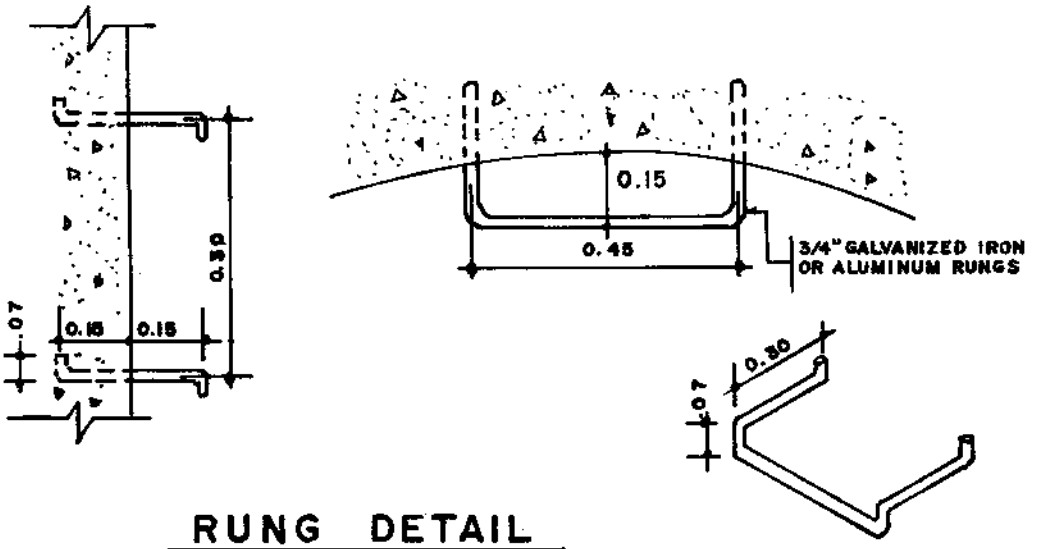
FIG. NUM. 31

DATE : 8/08/80



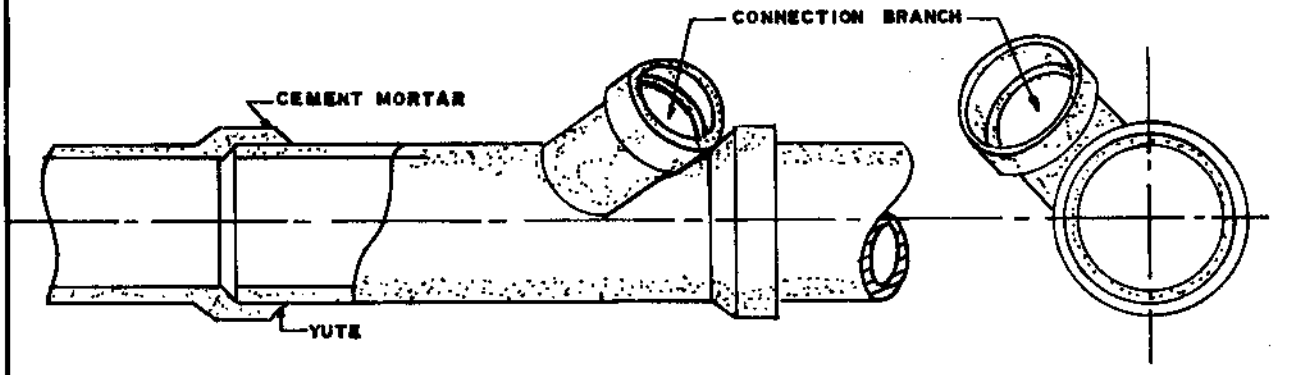
DRAIN DETAIL

SCALE : 1:10



RUNG DETAIL

SCALE: 1:10



HOUSE CONNECTION DETAIL

SCALE : 1-1/2"=1'-0"

NOT TO SCALE

HOUSE CONNECTION & RUNGS DETAILS

FIG. NUM. 32

DATE 8/08/80

SANITARY HOUSE CONNECTION DETAIL

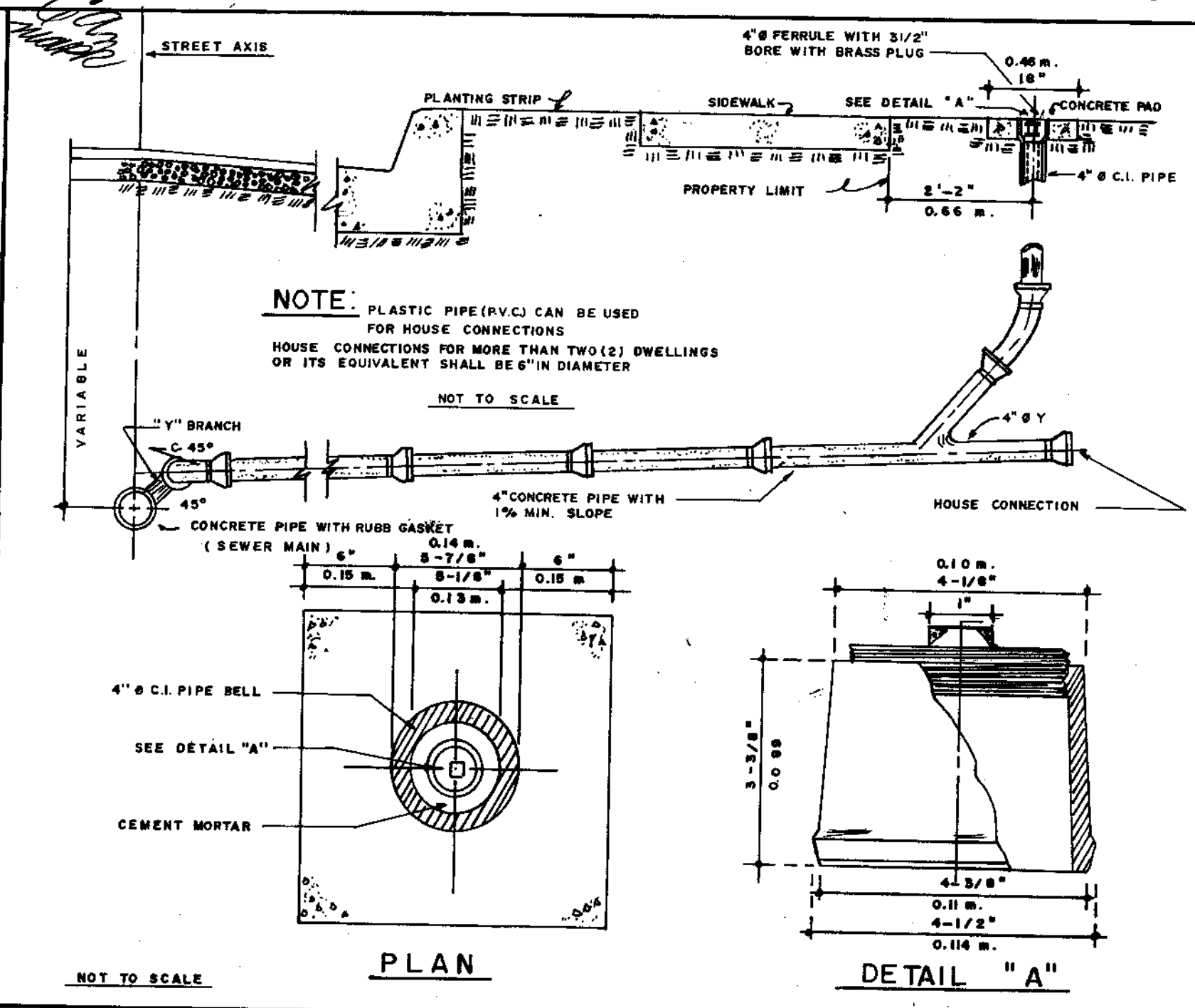
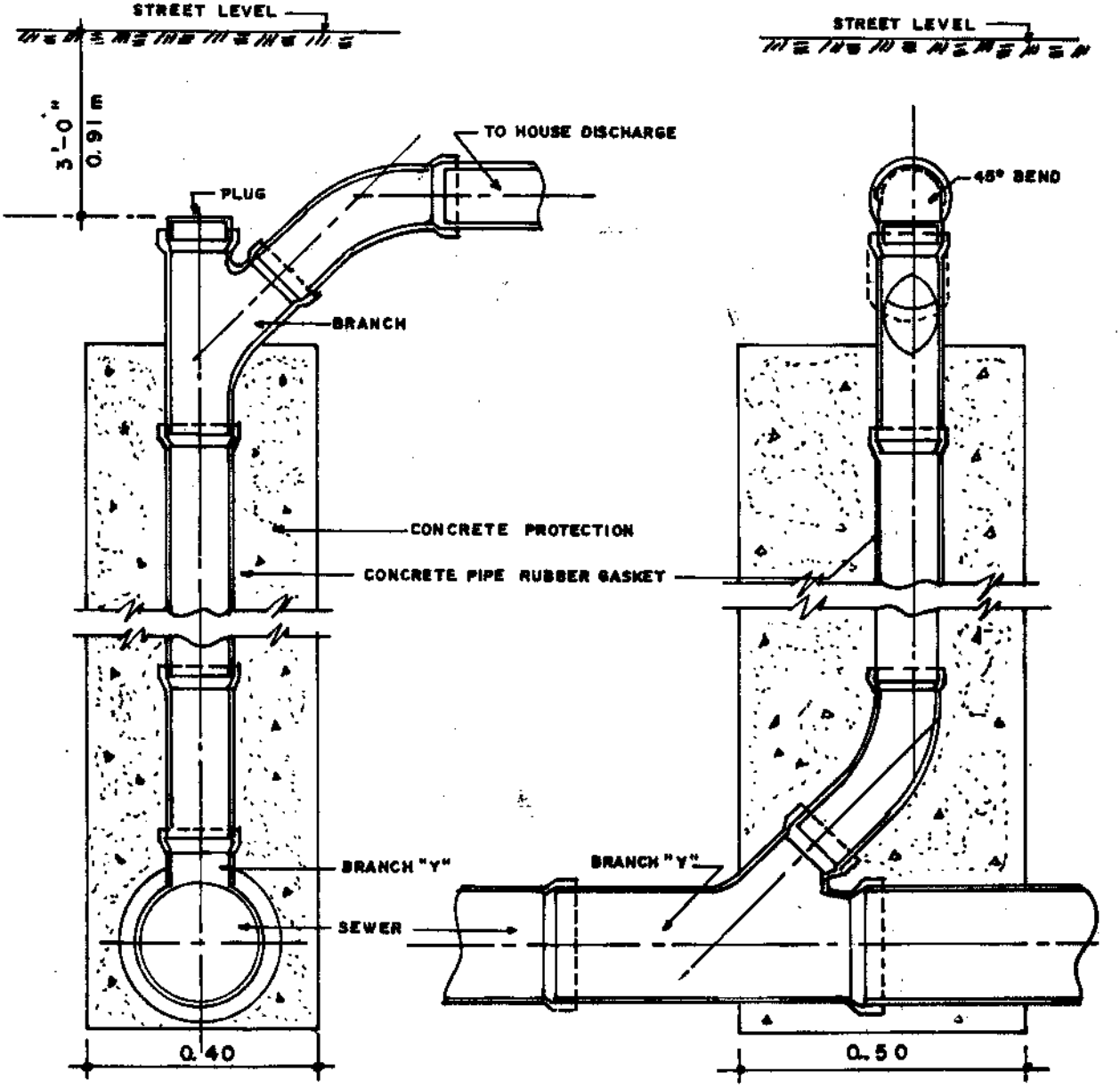


FIG. NUM. 33

DATE: 8/08/80

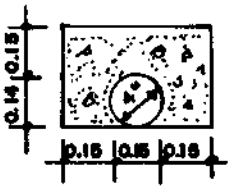


NOT TO SCALE

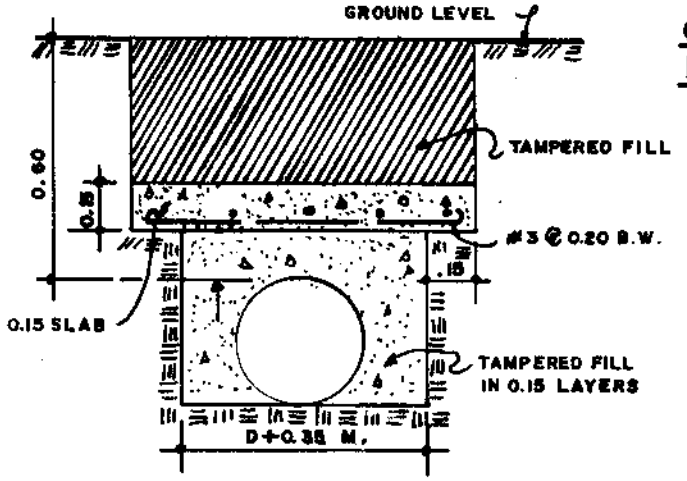
DETAIL OF HOUSE CONNECTION WHEN SEWER IS 2.0 M. DEEP OR MORE

FIG NUM. 54

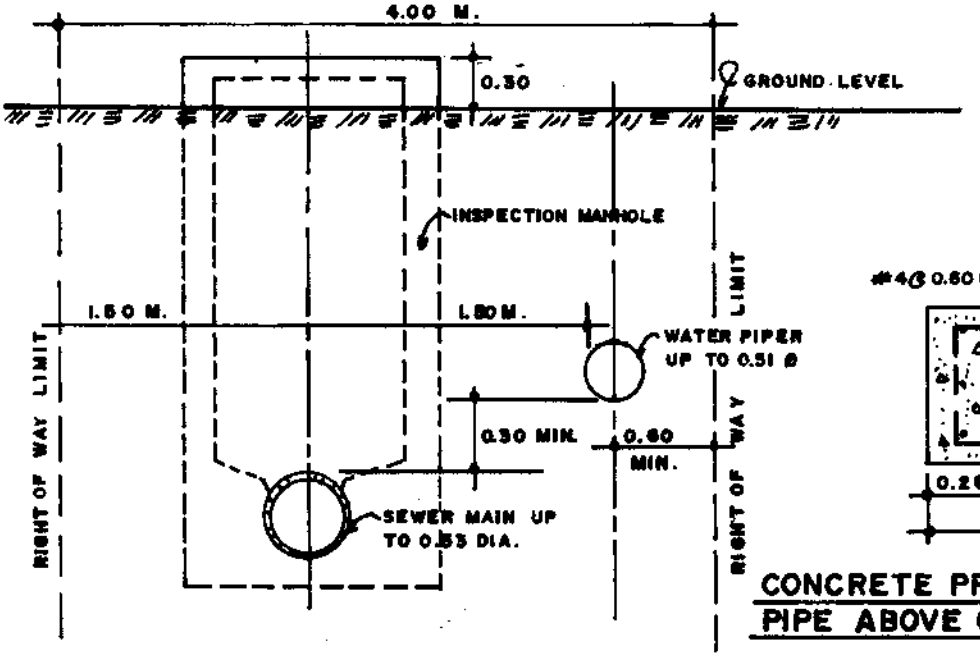
DATE 8/08/80

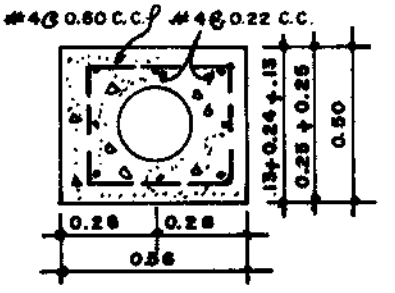


CONCRETE PROTECTION FOR HOUSE CONNECTION DETAIL



CONCRETE PROTECTION DETAIL FOR PIPES AT DEPTHS LESS THAN 0.60 M

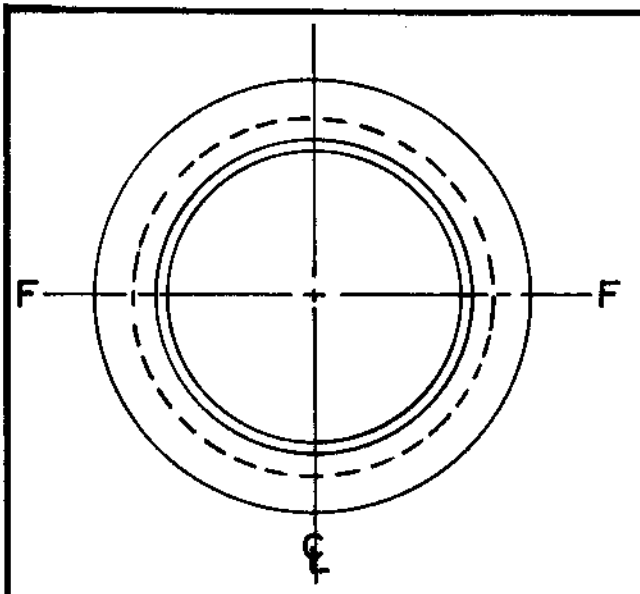




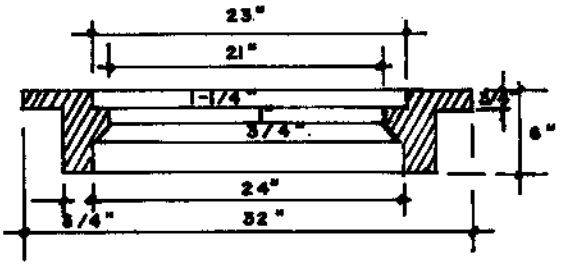
CONCRETE PROTECTION FOR PIPE ABOVE GRAUND DETAIL

RIGHT OF WAY WIDTH FOR PARARELL RUNNING SEWER & WATER PIPERS DETAIL

PROTECTION DETAILS AND RIGHT OF WAY	FIG. NUM. 35
	DATE 8/08/80

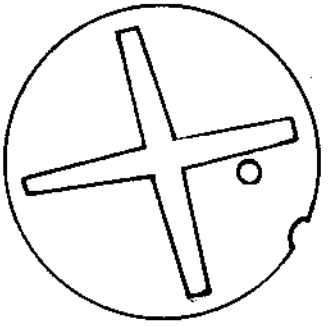


PLAN

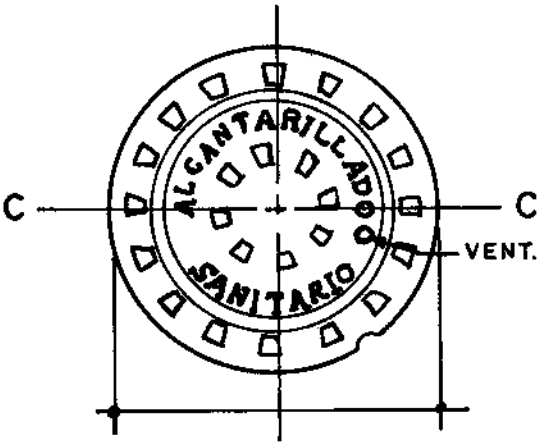


SECTION F-F

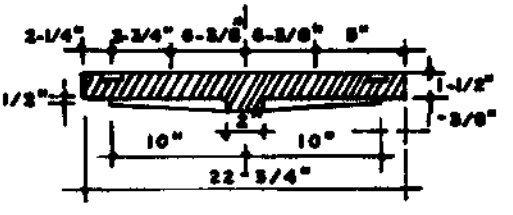
C. I. FRAME DETAIL



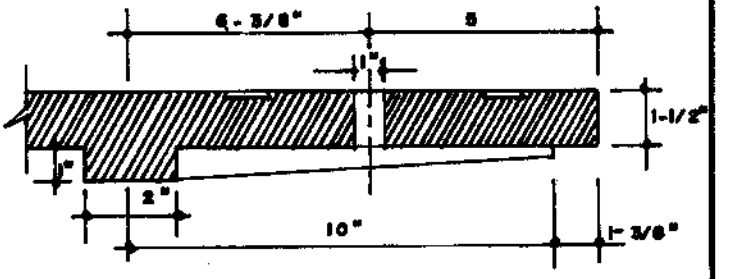
COVER BOTTOM VIEW



COVER TOP VIEW



SECTION C-C



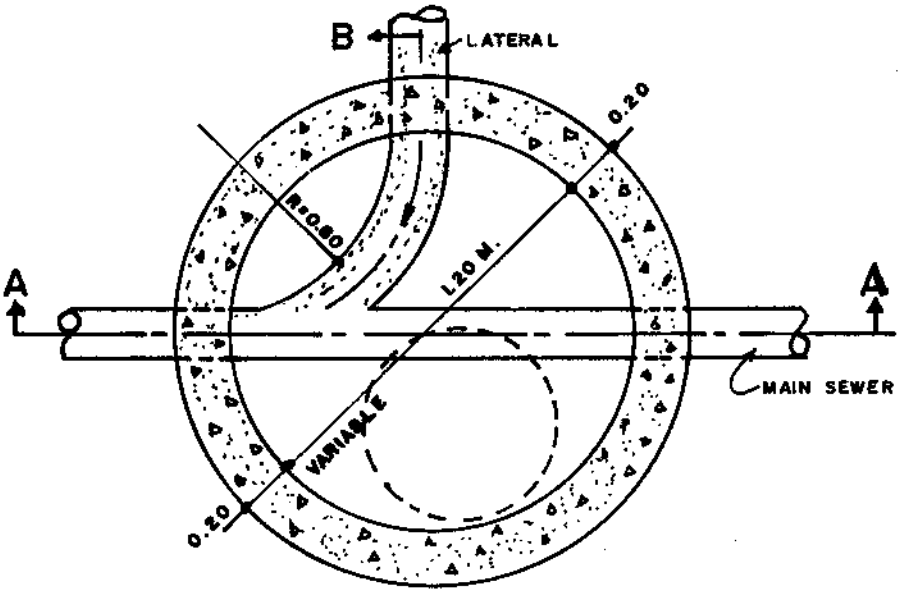
VENTILATION HOLE SECTION

NOT TO SCALE

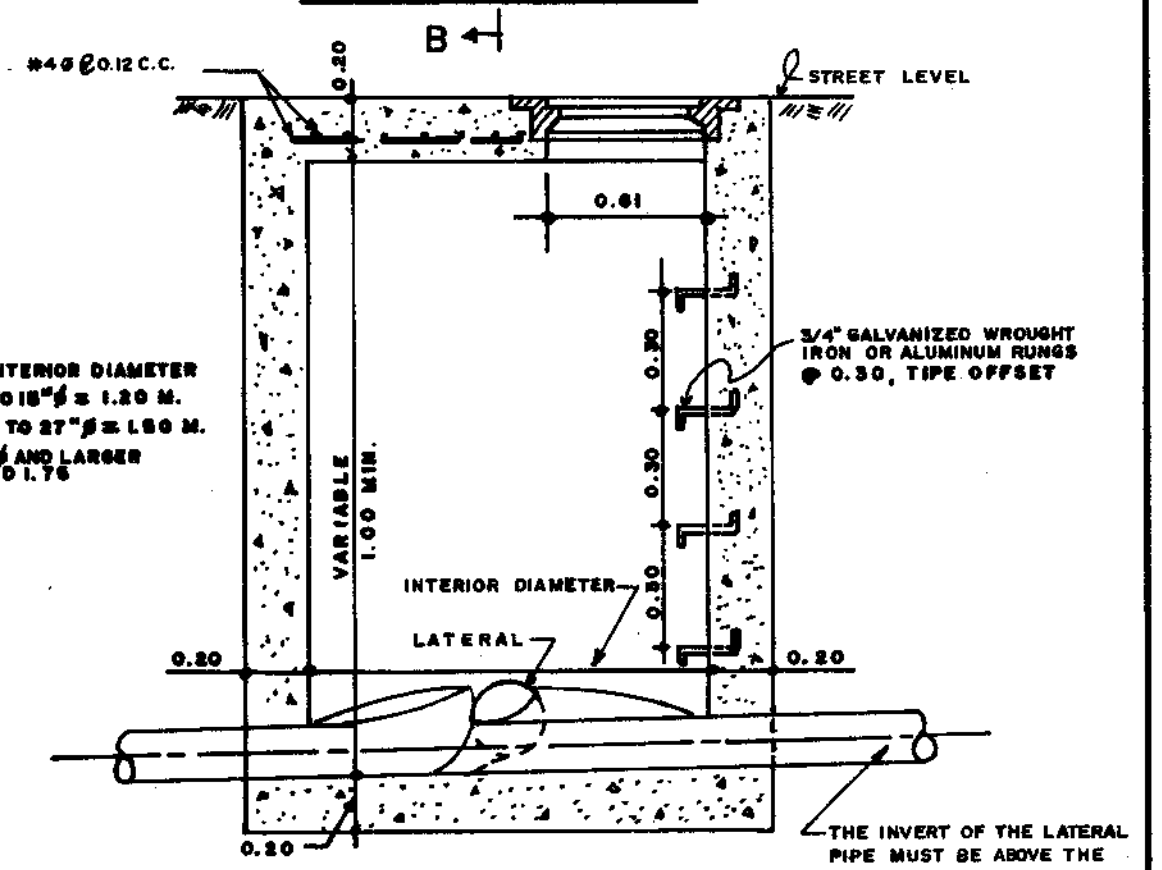
C.I. FRAME & COVER MANHOLE DETAIL (MODEL-A)

FIG. NO. 36

DATE 8./08/80



SECTIONAL PLAN



NOTE:
MANHOLE INTERIOR DIAMETER
FROM 8"ϕ TO 15"ϕ = 1.20 M.
FROM 16"ϕ TO 27"ϕ = 1.50 M.
FROM 30"ϕ AND LARGER
= 1.00 M. + Ø 1.75

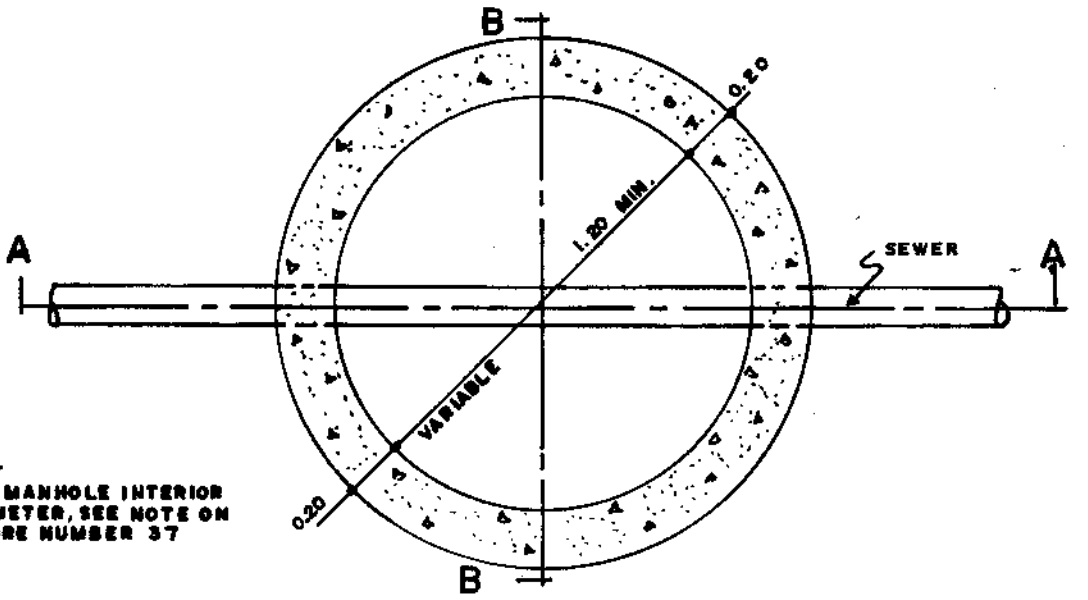
SECTION- A-A

NOT TO SCALE

INSPECTION MANHOLE DETAIL

FIG. NO. 37

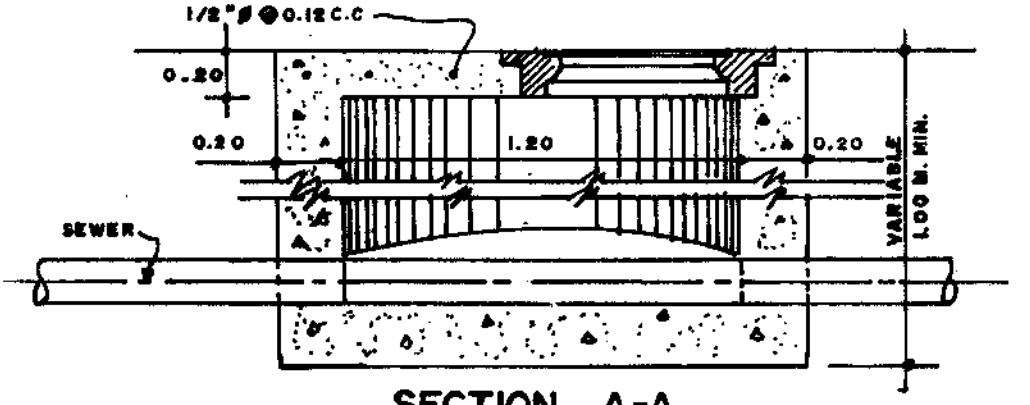
DATE 8/08/80



NOTE :

FOR MANHOLE INTERIOR DIAMETER, SEE NOTE ON FIGURE NUMBER 37

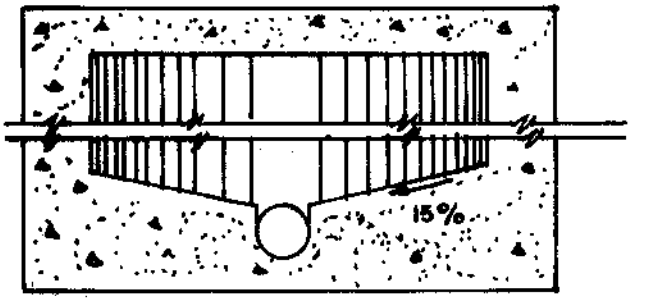
SECTIONAL PLAN



SECTION A-A

TRANSITION PIPE SHALL HAVE THE SAME SLOP AS INLET PIPE.

RUNGS MUST BE PLACED WHEN DEPTH EXEDEDS 0.91M.(3'-0")

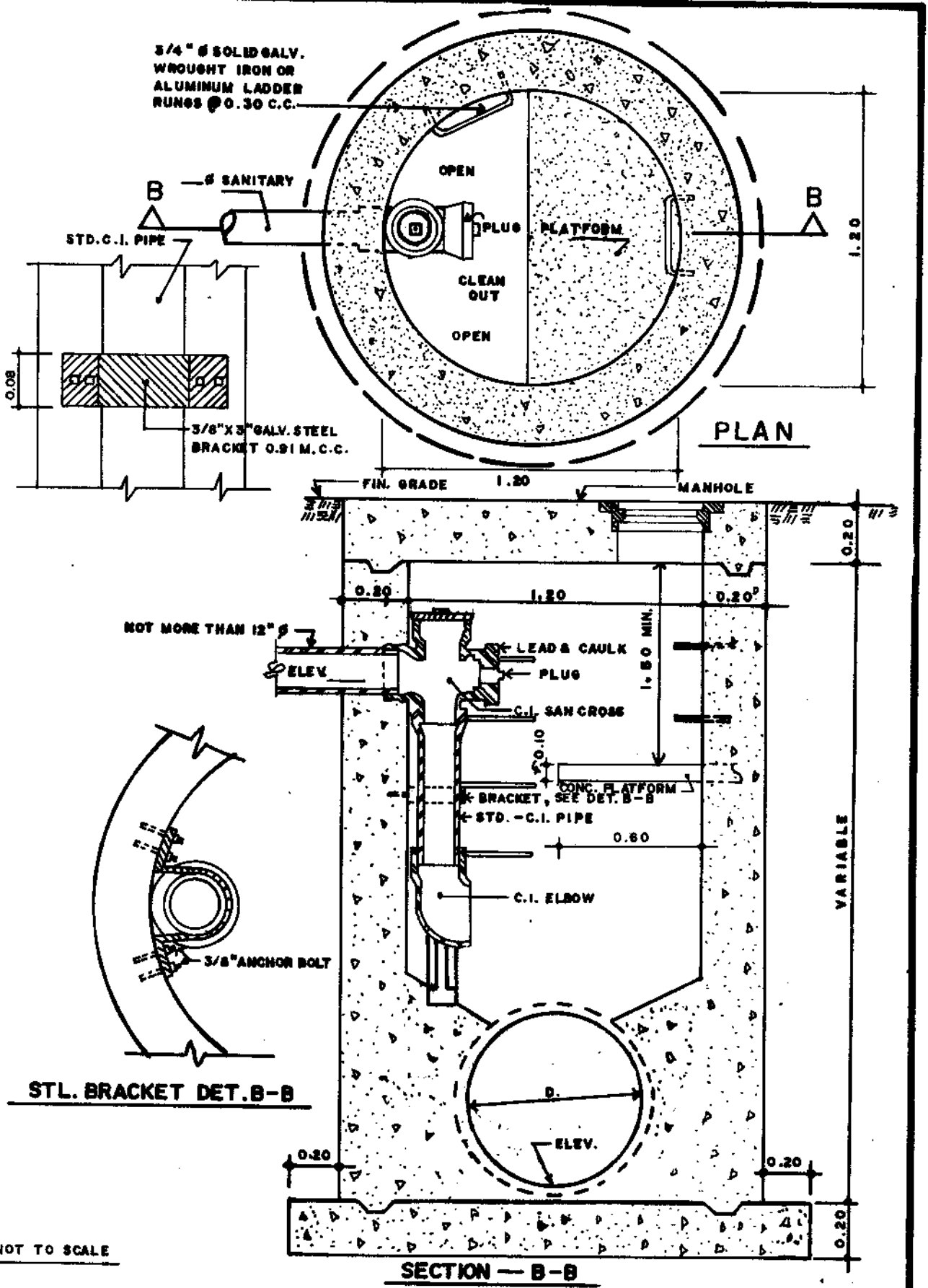


SECTION B-B

INSPECTION MANHOLE DETAIL

FIG. NO. 38

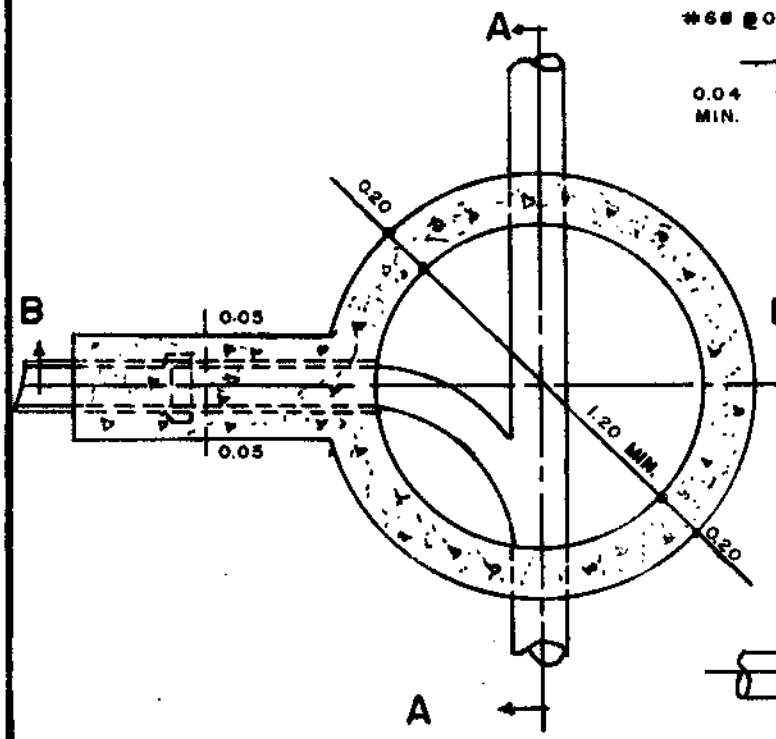
DATE : 6/06/80



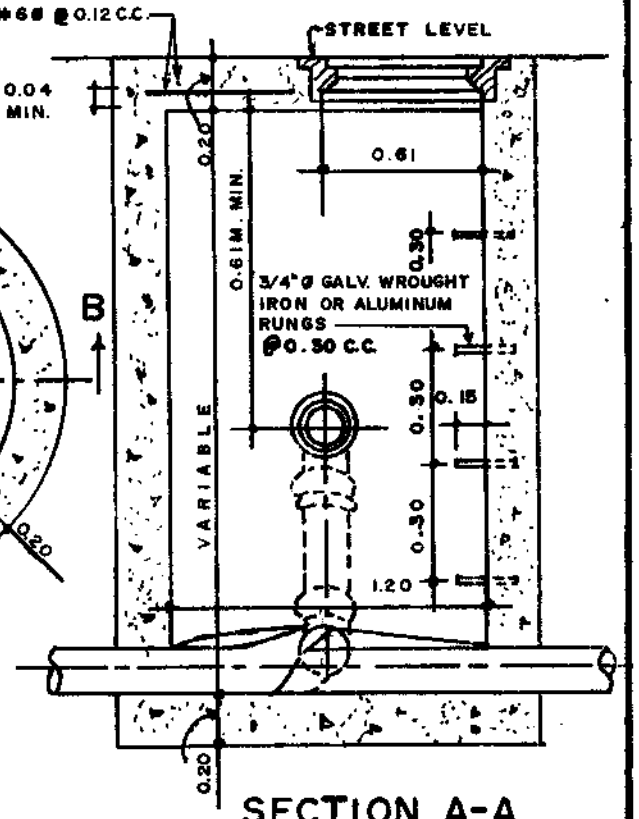
DROP. MANHOLE DETAIL

FIG. NO. 39

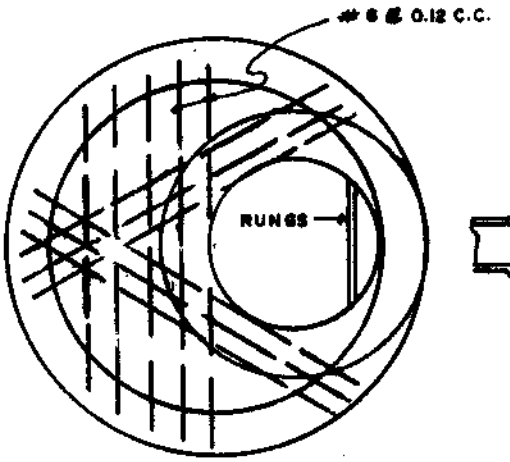
DATE 8/08/80



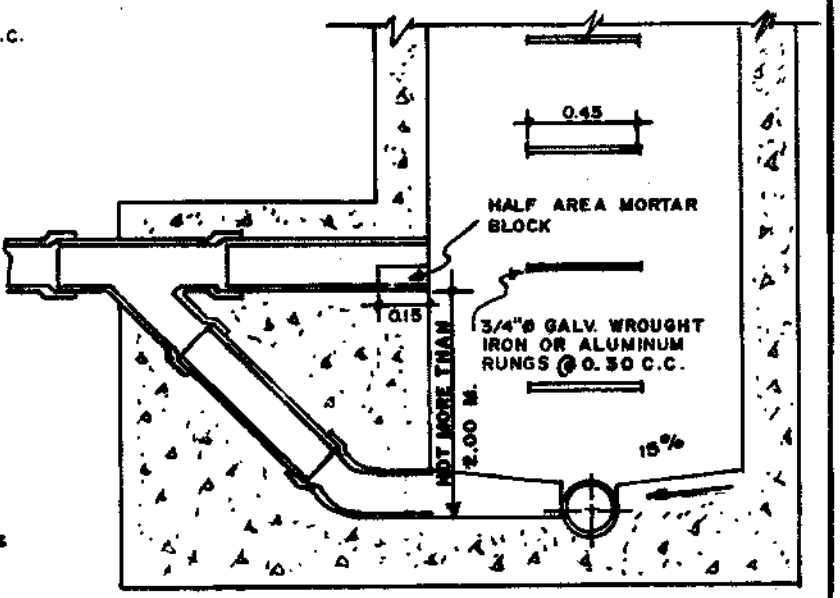
SECTIONAL PLAN



SECTION A-A



STRUCTURAL PLAN



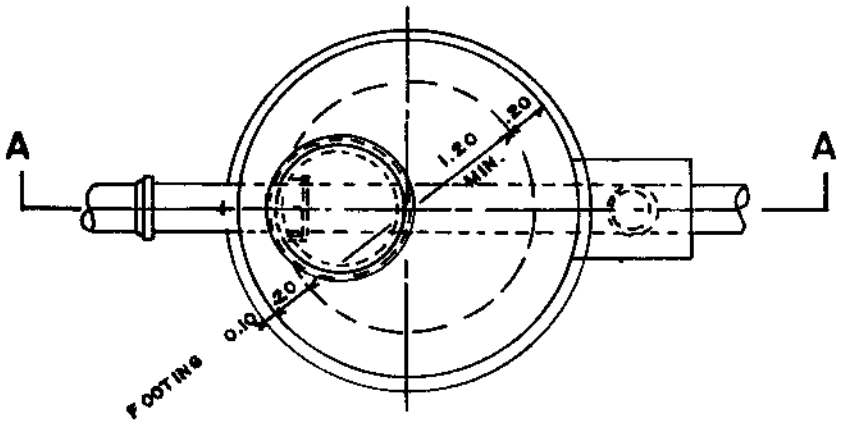
SECTION B-B

NOT TO SCALE

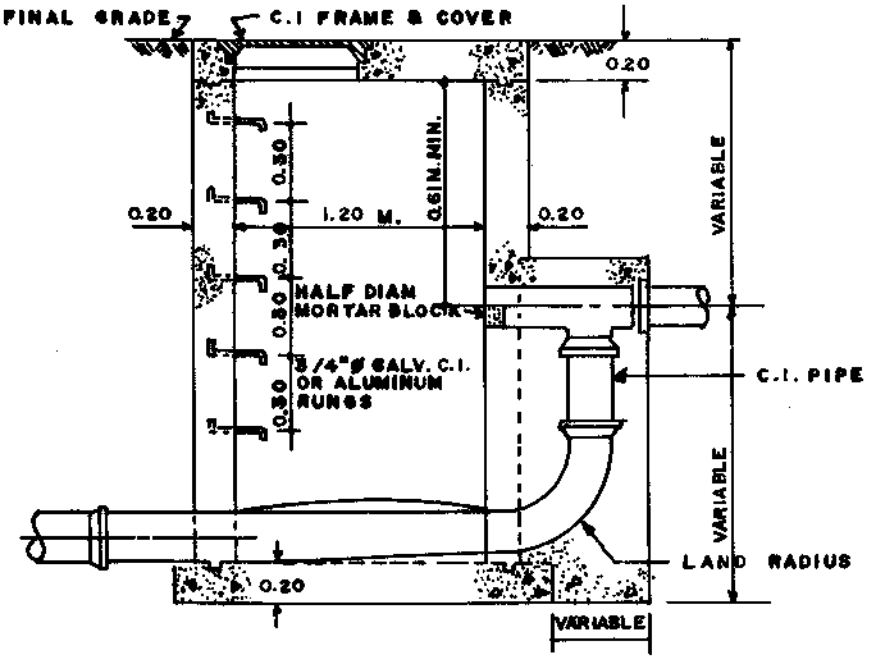
DROP MANHOLE DETAILS

FIG. NO. 40

DATE 8/08/80



PLAN



SECTION A-A

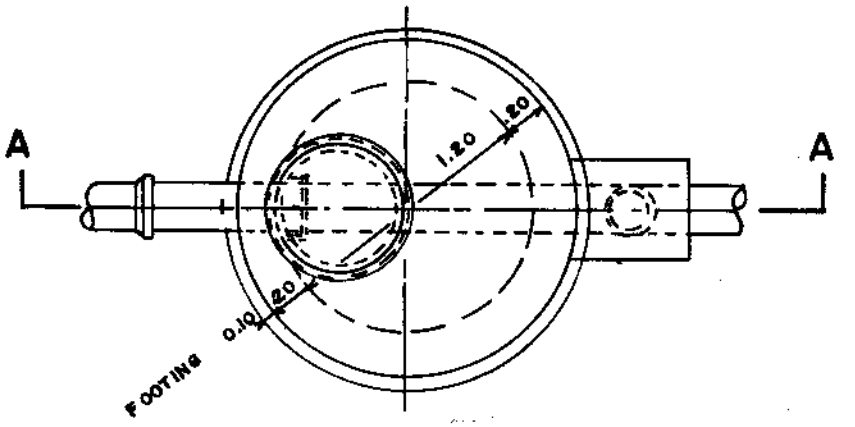
NOT TO SCALE

DROP MANHOLE DETAIL

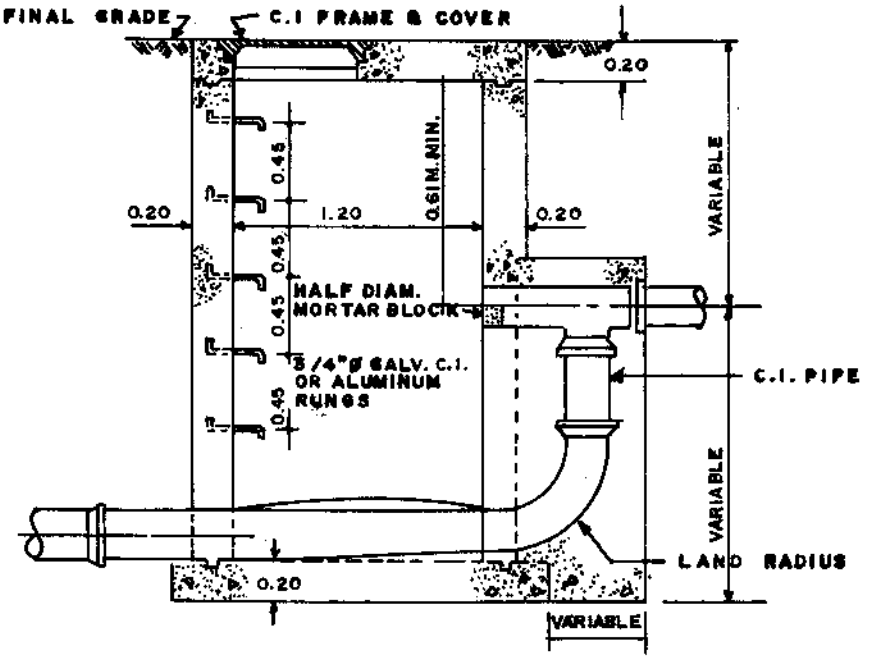
(WHEN THE DROP EXCEEDS 1.00M. AND FOR THE LINE EXCEEDS 12"ø

FIG. NO. 41

DATE: 8/08/80



PLAN



SECTION A-A

NOT TO SCALE

DROP MANHOLE DETAIL

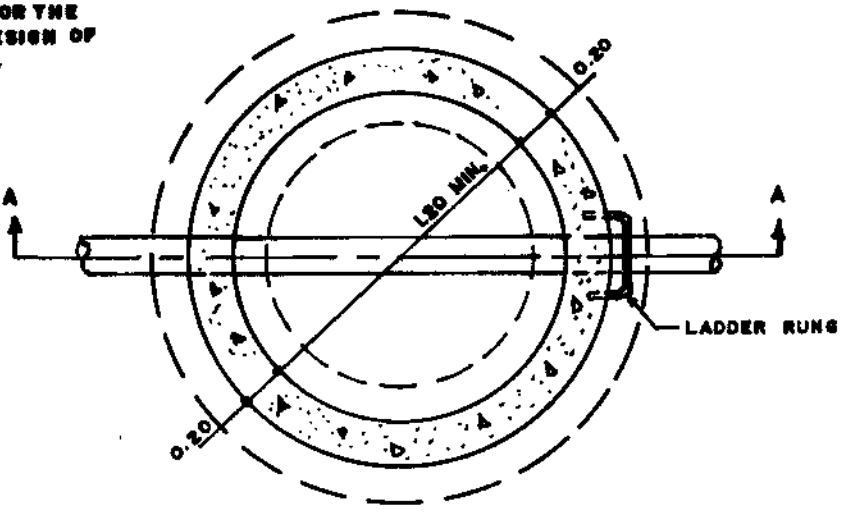
(WHEN THE DROP EXCEEDS 1.00M. AND FOR THE LINE EXCEEDS 12"ø

FIG. NO. 41

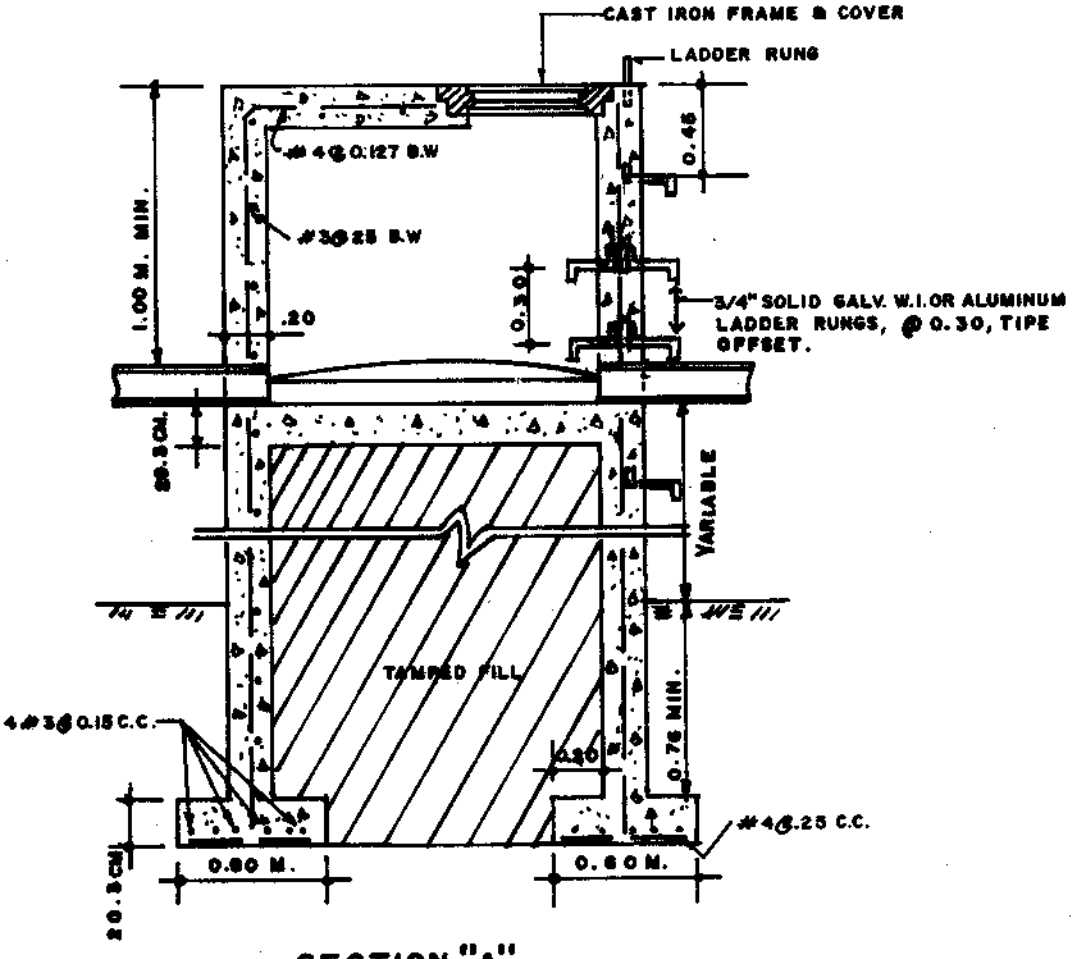
DATE: 8/08/80

NOTE

THE DEVELOPER SHALL BE RESPONSIBLE FOR THE STRUCTUBAL DESIGN OF THE MANHOLE.



SECTIONAL PLAN



SECTION "A"

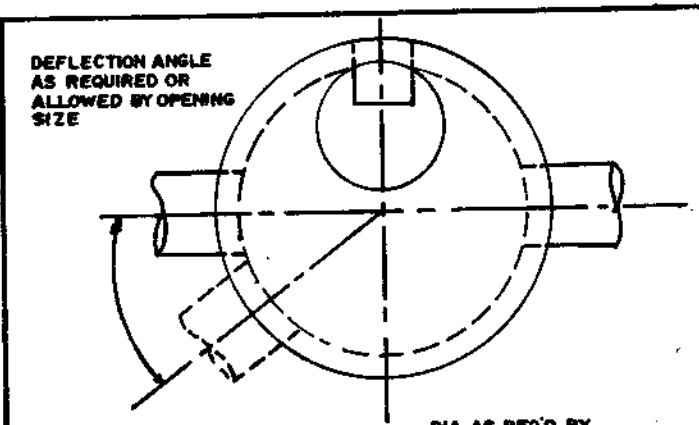
NOT TO SCALE

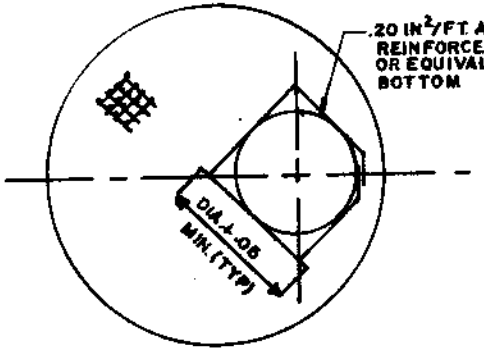
DETAILS OF ELEVATED MANHOLES

FIG. NO. 41- A

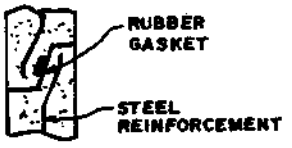
DATE 8/08/80

REINFORCED PRECAST CONCRETE MANHOLE
48"Ø FOR 8" DIA. TO 18" DIA. SEWER PIPE
60" Ø FOR 16" DIA. TO 27" DIA. SEWER PIPE

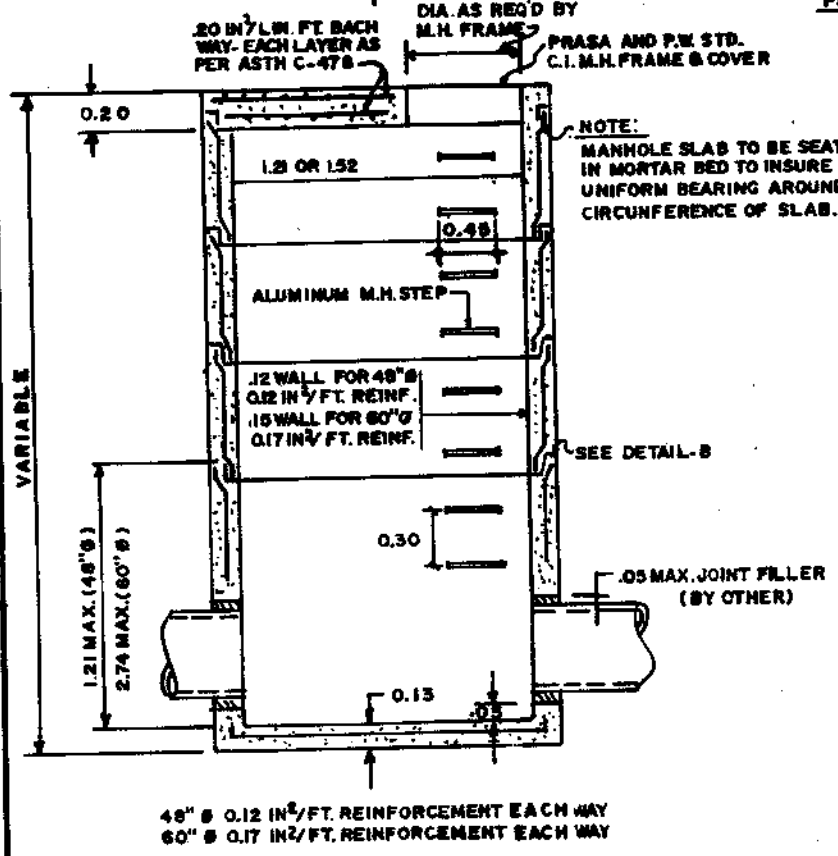




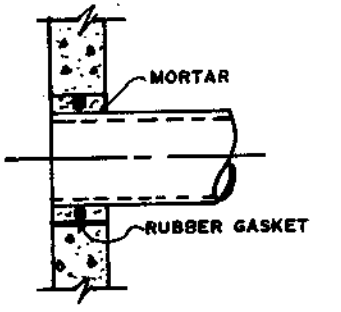
PRECAST FLAT SLAB TOP



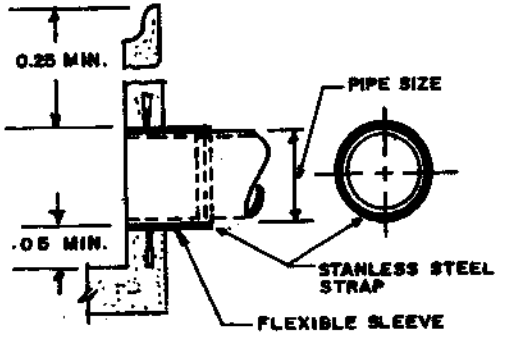
DETAIL - B
TYPICAL JOIT DETAIL
CONCRETE & ROUND RUBBER GASKET
IN ACCORDANCE WITH ASTH SPEC.C-361



NOTE:
MANHOLE SLAB TO BE SEATED IN MORTAR BED TO INSURE UNIFORM BEARING AROUND CIRCUNFERENCE OF SLAB.



CONNECTION WITH RUBBER GASKET



DETAIL - A
FLEXIBLE M.H. SLEEVE, OPTIONAL FOR PLASTIC CONCRETE PIPE, CAST IRON, DUCTILE IRON

NOTE:
PRASA REQUIRES FLEXIBLE M.H. SLEEVE FOR ALL M.H. (OUTLET SIZE 4"-15") WHERE THE INVERT IS BELOW WATER TABLE

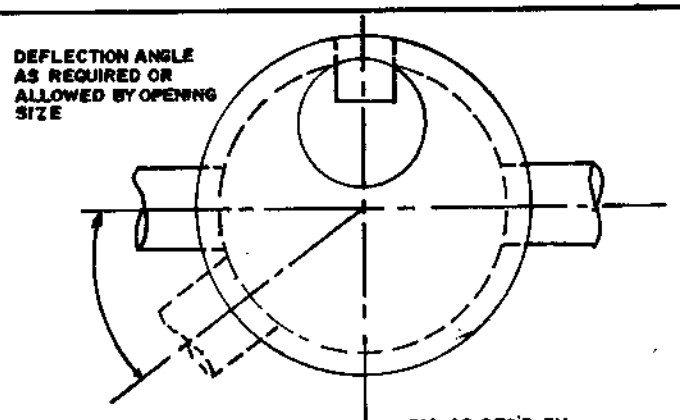
FIG. NO. 41 - B

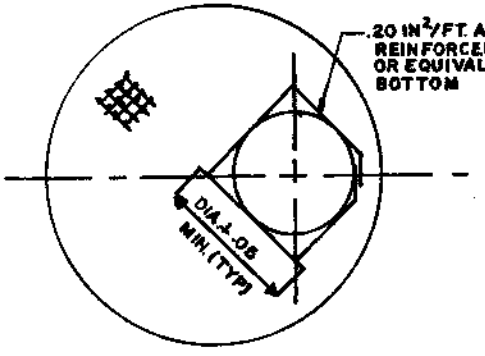
DATE 8/08/80

REINFORCED PRECAST CONCRETE MANHOLE
48"Ø FOR 8" DIA. TO 19" DIA. SEWER PIPE
60" Ø FOR 16" DIA. TO 27" DIA. SEWER PIPE

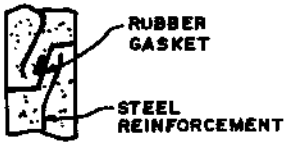
FIG. NO. 41 - B

DATE 8/08/80

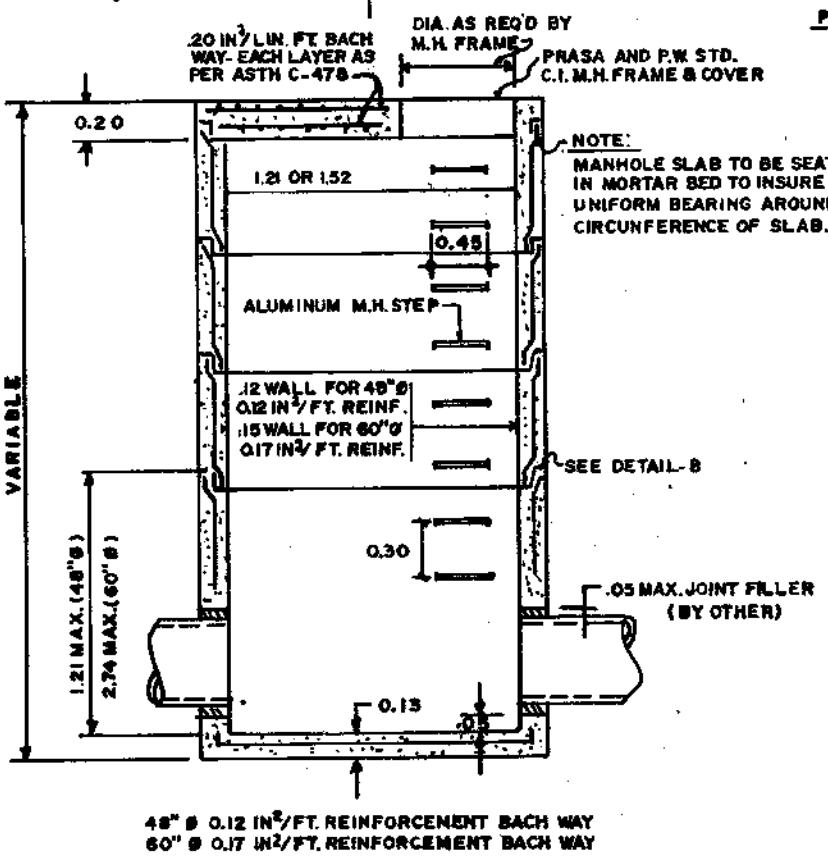




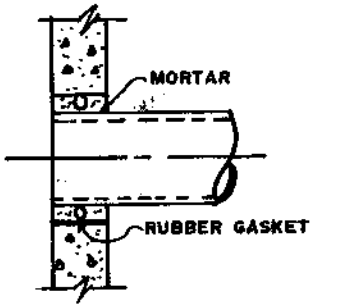
PRECAST FLAT SLAB TOP



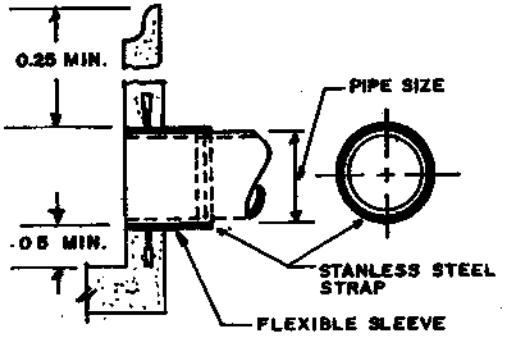
DETAIL - B
TYPICAL JOIT DETAIL
CONCRETE & ROUND RUBBER GASKET IN ACCORDANCE WITH ASTH SPEC.C-361



NOTE:
MANHOLE SLAB TO BE SEATED IN MORTAR BED TO INSURE UNIFORM BEARING AROUND CIRCUNFERENCE OF SLAB.



CONNECTION WITH RUBBER GASKET

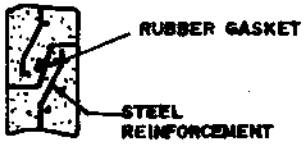


DETAIL - A
FLEXIBLE M.H. SLEEVE, OPTIONAL FOR PLASTIC CONCRETE PIPE, CAST IRON, DUCTILE IRON

NOTE:
PRASA REQUIRES FLEXIBLE M.H. SLEEVE FOR ALL M.H. (OUTLET SIZE 4"-15") WHERE THE INVERT IS BELOW WATER TABLE

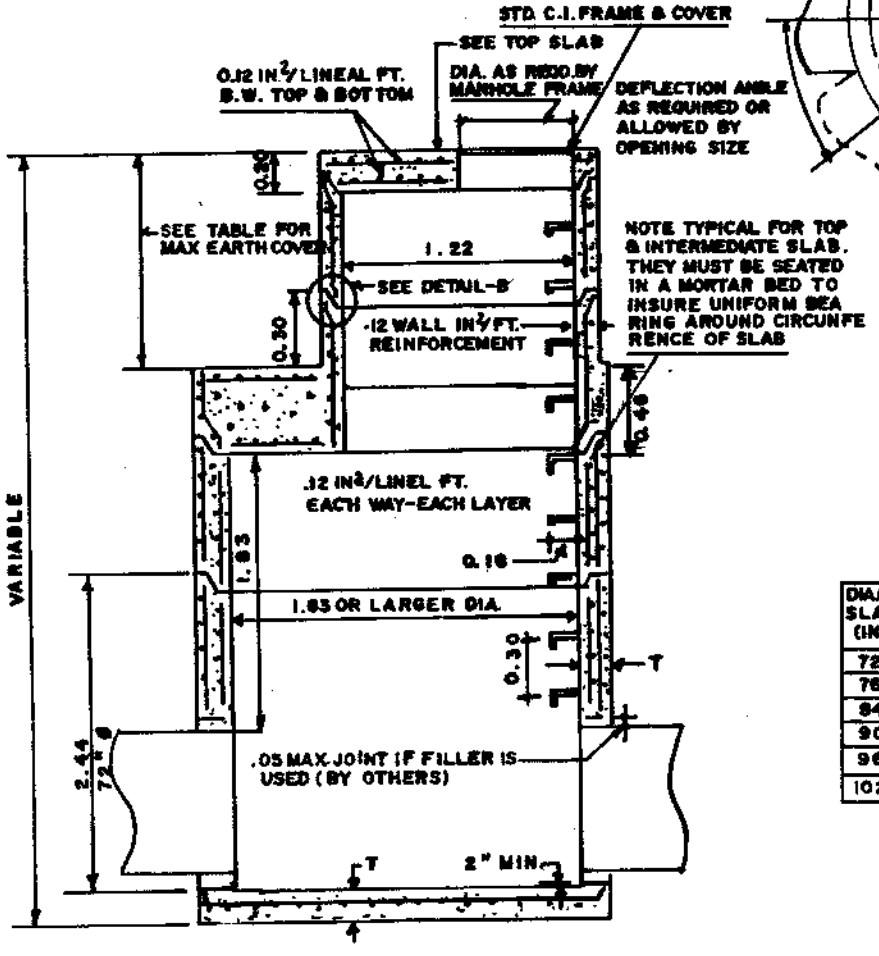
NOTE:
1- FOR DESIGN REQUIREMENTS SEE PAGES__ TO__ OF THESE NORMS.
2- SEE DETAIL FIG.__ FOR JOINT DETAIL.

REINFORCED PRECAST CONCRETE MANHOLE FOR TRUNK SEWER 30" DIA. OR LARGER



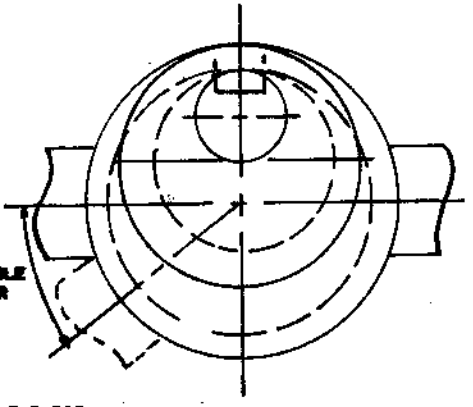
DETAIL-B

CONCRETE AND ROUND RUBBER IN ACCORDANCE WITH ASTH. SPEC C-361

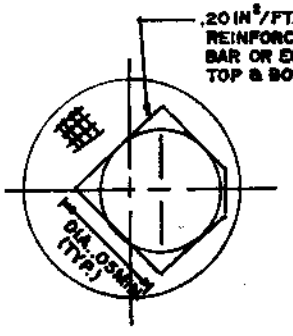


SECTIONAL VIEW

(SEE TOP VIEW FOR TRUE ORIENTATION)



TOP VIEW



INTERMEDIATE SLAB



TOP SLAB

MANHOLE BASE DETAILS

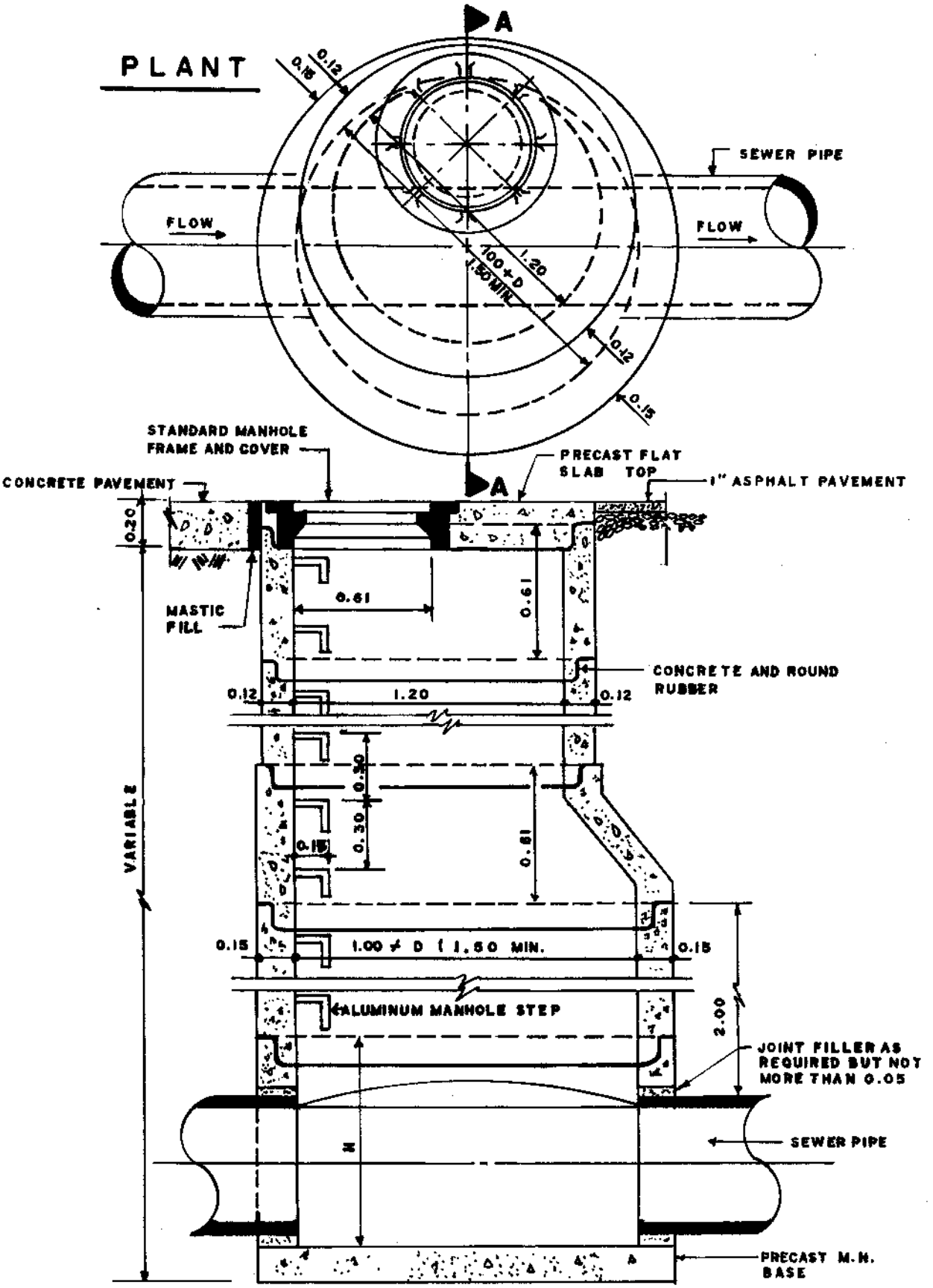
MANHOLE BASE DIA. (IN)	WALL T (IN)	NO. OF CAGES	INSIDE CAGE AS (IN²/LIN. FT.)	OUT SIDE CAGE AS (IN²/LIN.FT)	BASE SLAB-T (IN)	BASE SLAB REINFORCEMENT (IN² LINEAL FT.)
72	7	2	0.29	0.22	12	0.29 EA. WAY
78	7-1/2	2	0.95	0.25	12	0.29 EA. WAY
84	8	2	0.97	0.28	12	0.29 EA. WAY
90	8-1/2	2	0.41	0.91	12	0.29 EA. WAY
96	9	2	0.46	0.56	12	0.29 EA WAY
102	9-1/2	2	0.54	0.41	12	0.29 EA WAY

REQUIRED DESIGNS FOR INTERMEDIATE MANHOLE SLAB

DIA OF SLAB (IN)	SLAB THICKNESS IN	DIA. OF HOLE IN SLAB (IN)	AREA STEEL TOP & BOTTOM BOTH WAYS (IN²/LIN. FT.)	AREA STEEL TOP & BOTTOM AROUND HOLE (IN²/FT.)	MAX EARTH COVER. FT.
72	18	48	0.12	0.20	90
78	18	48	0.12	0.20	29
84	18	48	0.12	0.20	25
90	18	48	0.12	0.20	20
96	18	48	0.12	0.20	16
102	18	48	0.12	0.20	12

DATE: 8/08/80

FIG. NUM. 41-C



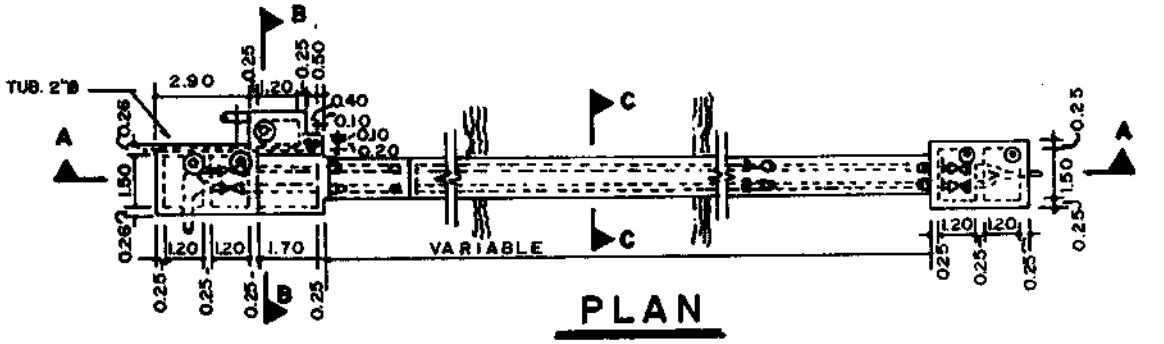
SECTION A-A

NOT TO SCALE

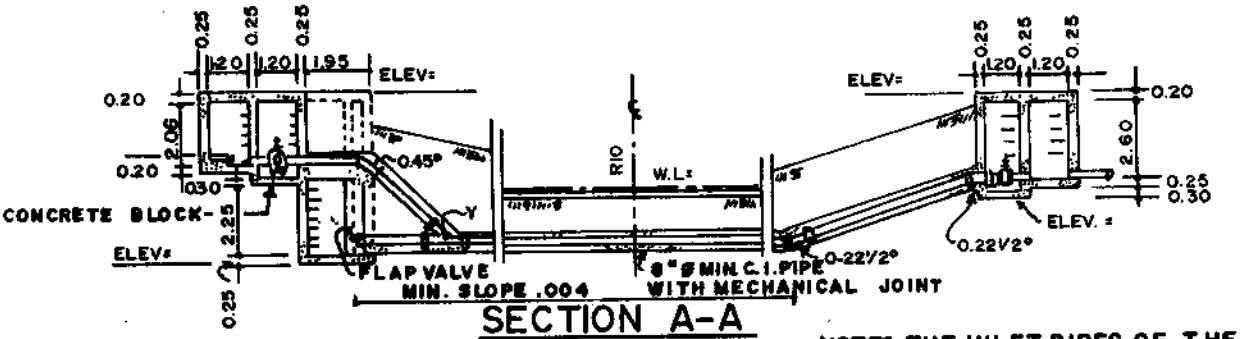
DETAIL OF PRECAST STANDARD MANHOLES FOR TRUNK SEWER 30" DIA. AND LARGER

FIG.NO. 41-D

DATE: 7/11/80



PLAN

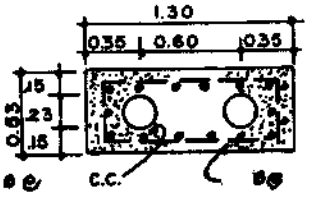


SECTION A-A

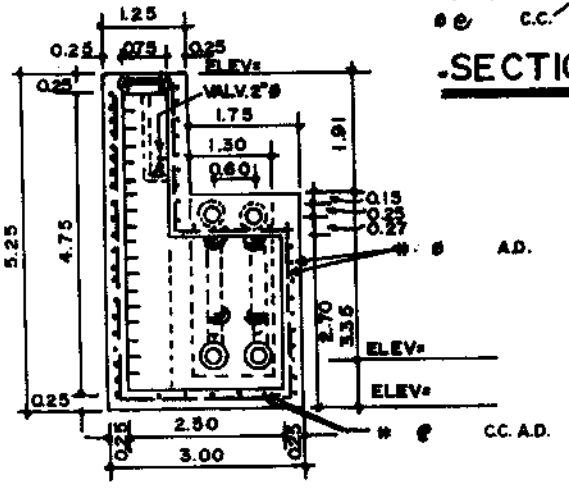
NOTE

THE DEVELOPER SHALL BE RESPONSIBLE FOR THE STRUCTURAL DESIGN.

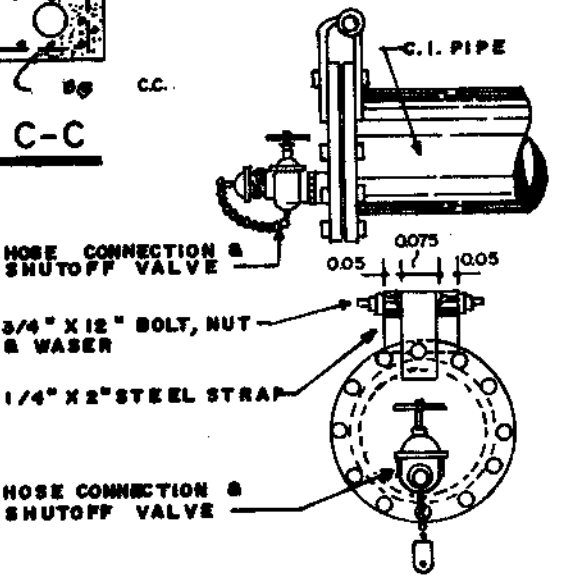
NOTE: THE INLET PIPES OF THE SIPHON CAN BE AT DIFFERENT ELEVATIONS DEPENDING ON THE CRITERIA USED WHEN DESIGNING.



SECTION C-C



SECTION B-B



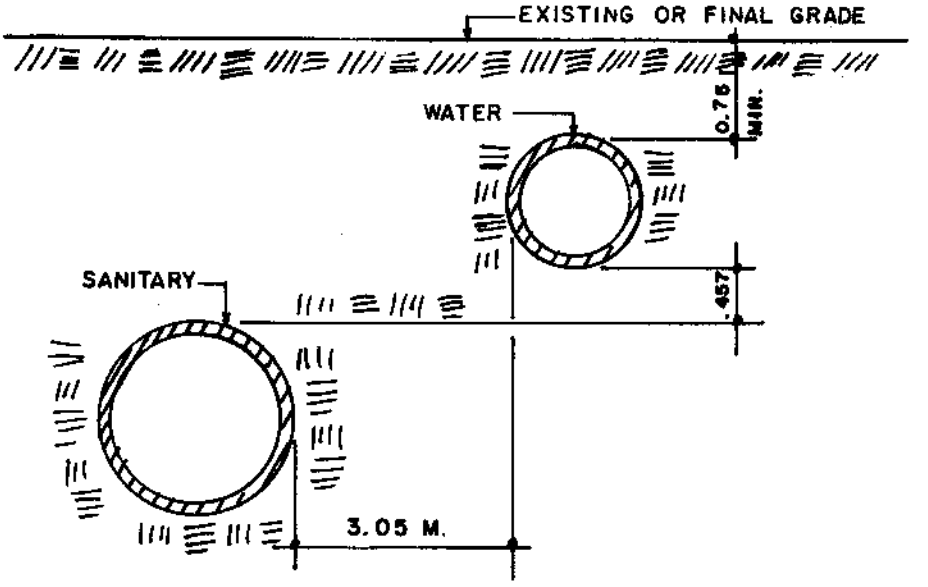
FLAP VALVE DETAIL

NOT TO SCALE

ILLUSTRATIVE SIPHON DETAIL

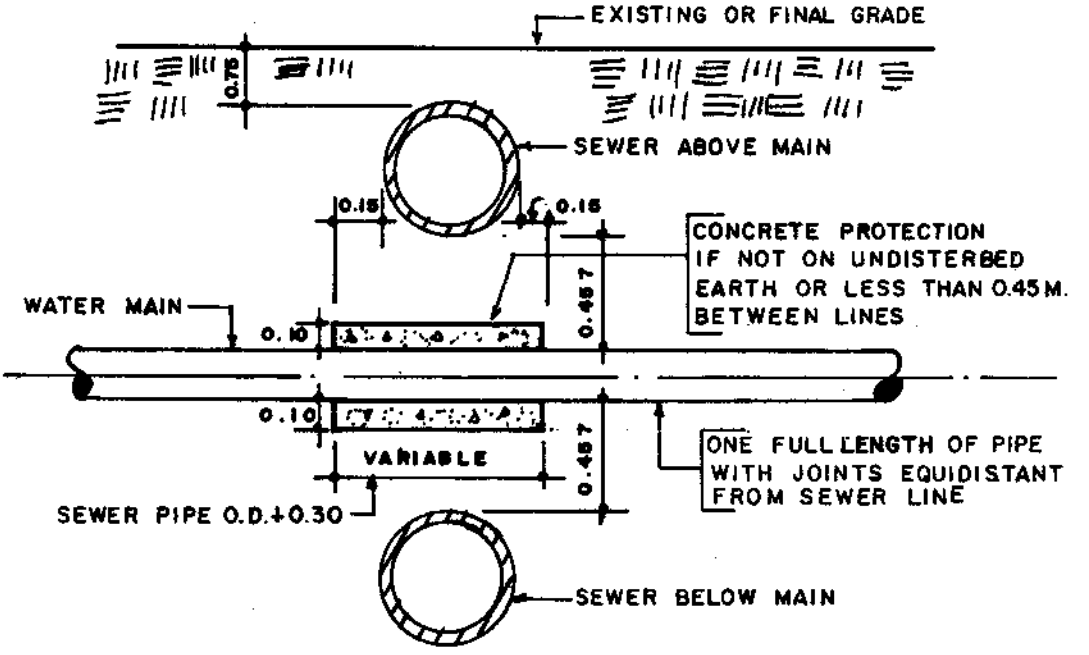
FIG. NO. 42

DATE 8/08/80



PARALLEL INSTALLATION

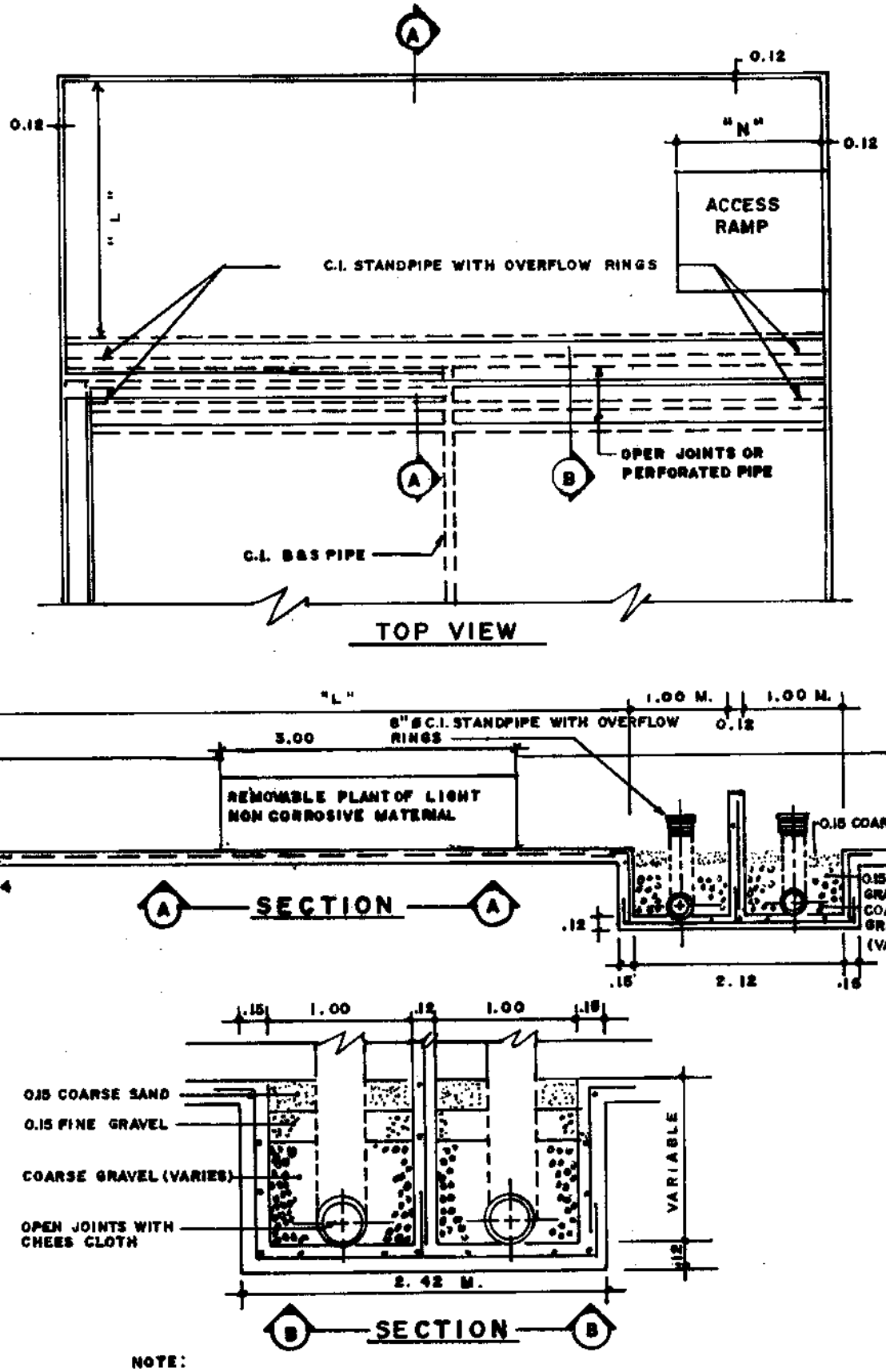
NOT TO SCALE



CROSSING INSTALLATION

NOT TO SCALE

SEPARATION OF WATER & SEWER MAINS	FIG. NO. 43
	DATE 8/06/80



NO TO SCALE

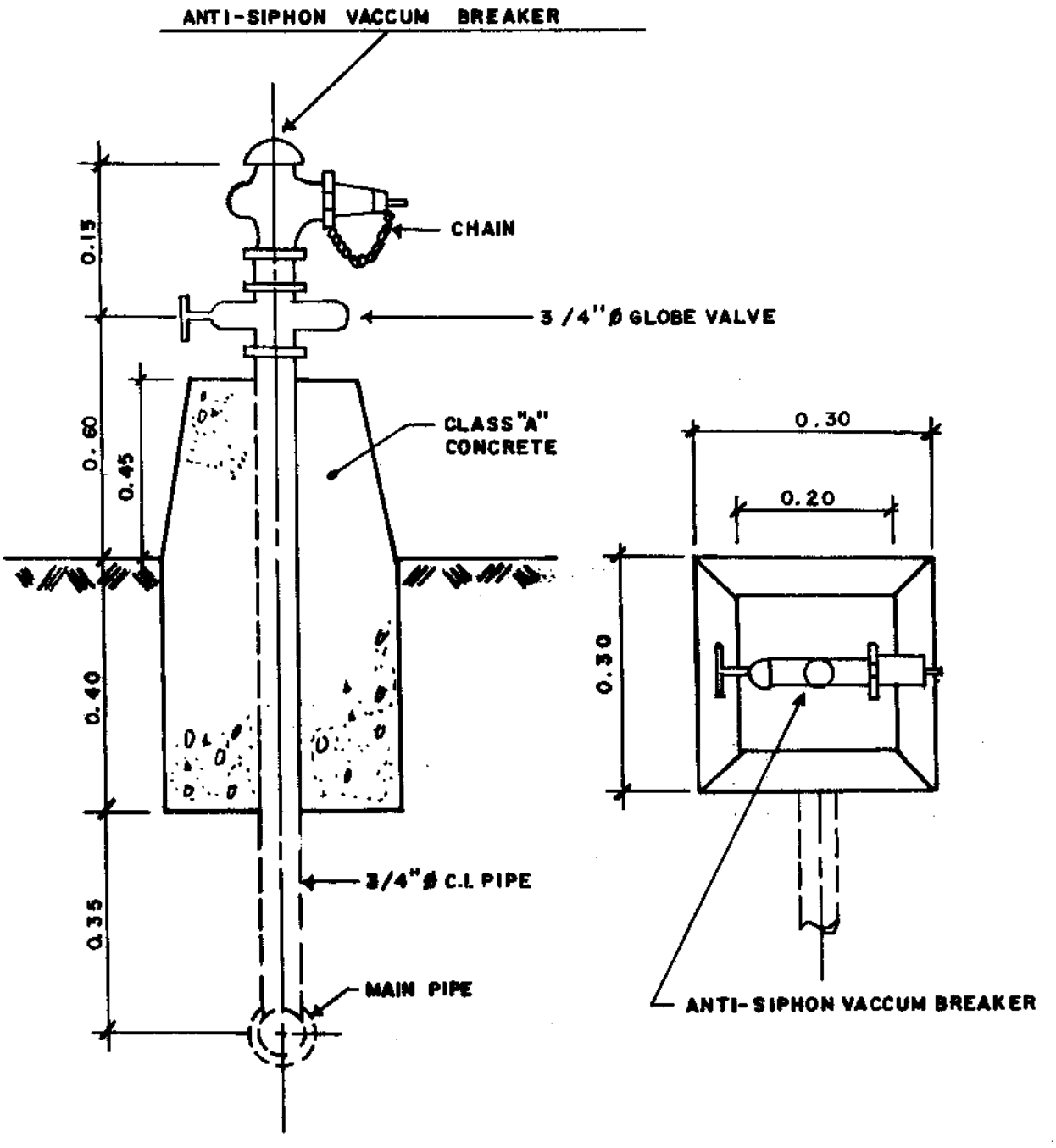
NOTE:

DIMENSIONS SHOWN ARE RECOMMENDED MINIMUM, OTHERS AS REQUIRED

SLUDGE DRYING BEDS

FIG. NUM. 44

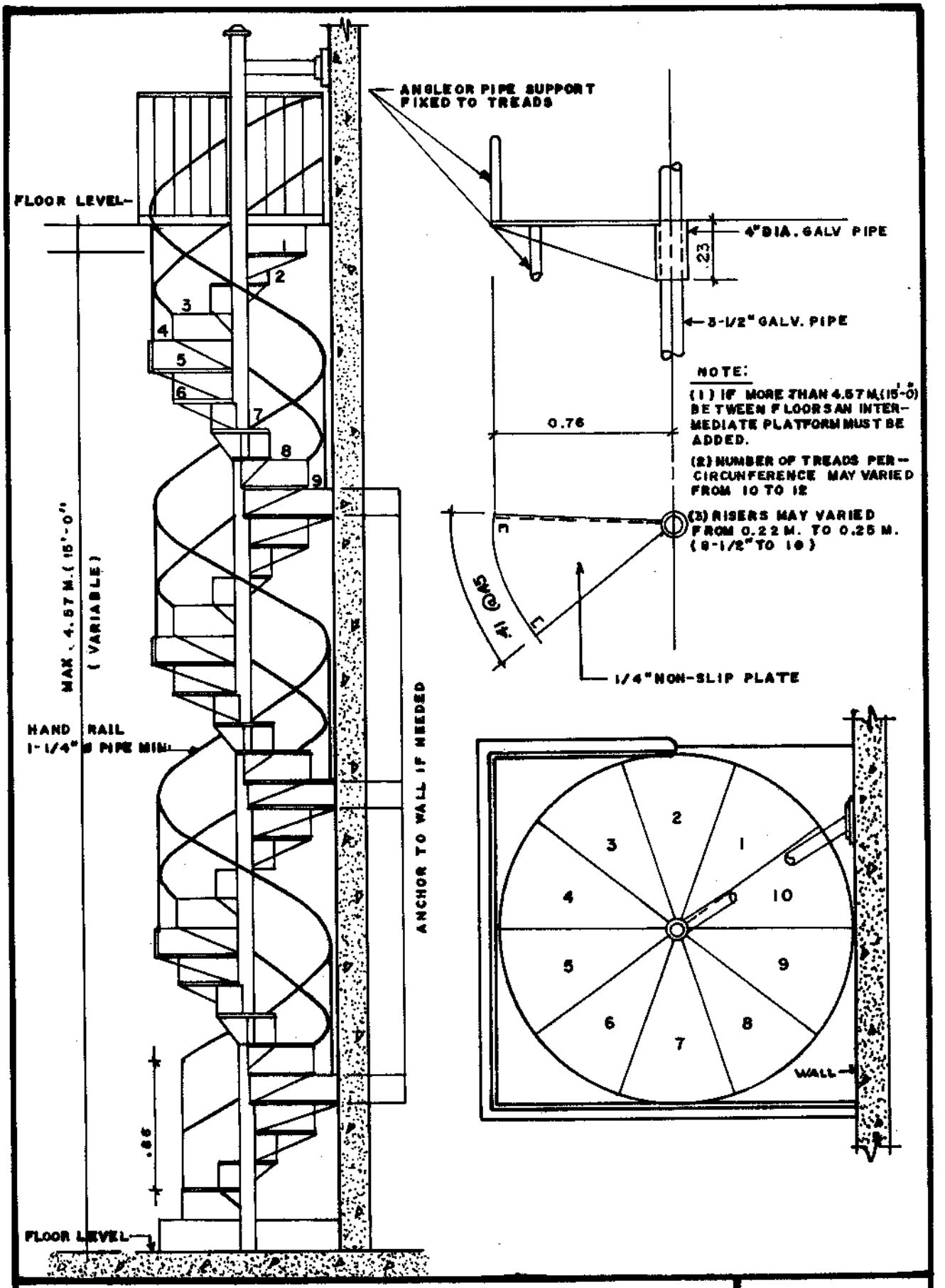
DATE 8/08/80



HOSE VALVE DETAIL

FIG. NO. 45

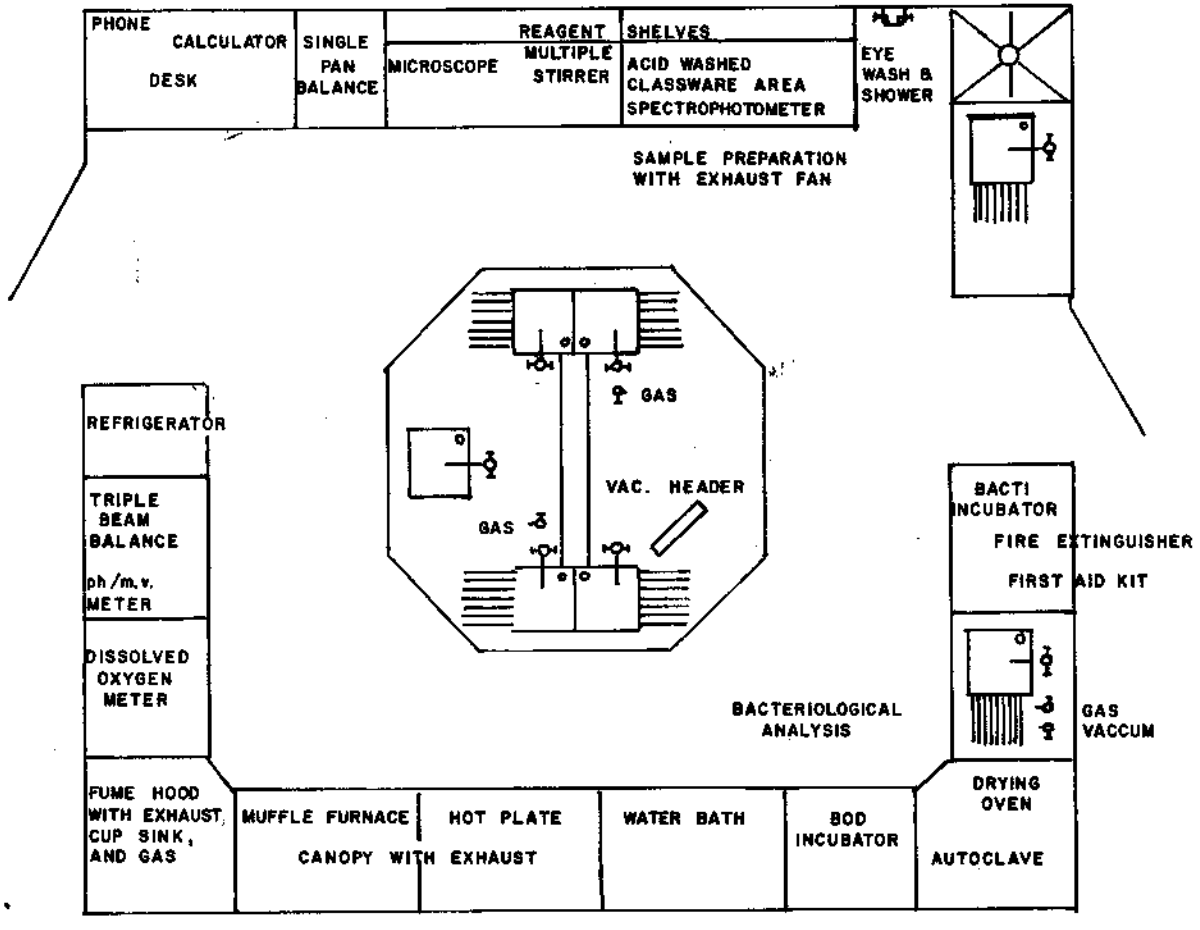
DATE 7/11/80



SPIRAL STAIR DETAIL

FIG. NO. 46

DATE 8/08/80



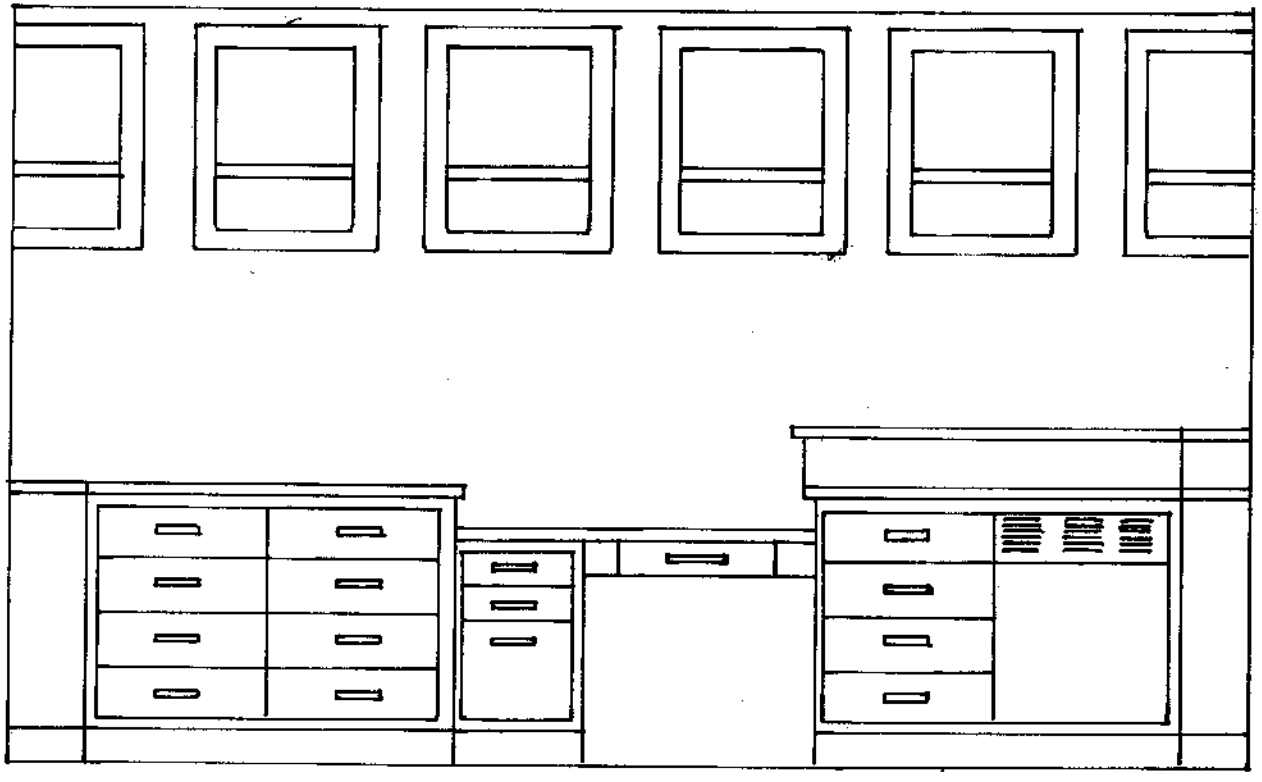
NOT TO SCALE

ILLUSTRATION OF ADEQUATE LABORATORY ARRANGEMENT-I

DATE 8/08/80

FIG. NO. 47

Can make



ELEVATION

DATE 8/08/80

FIG. NO. 48

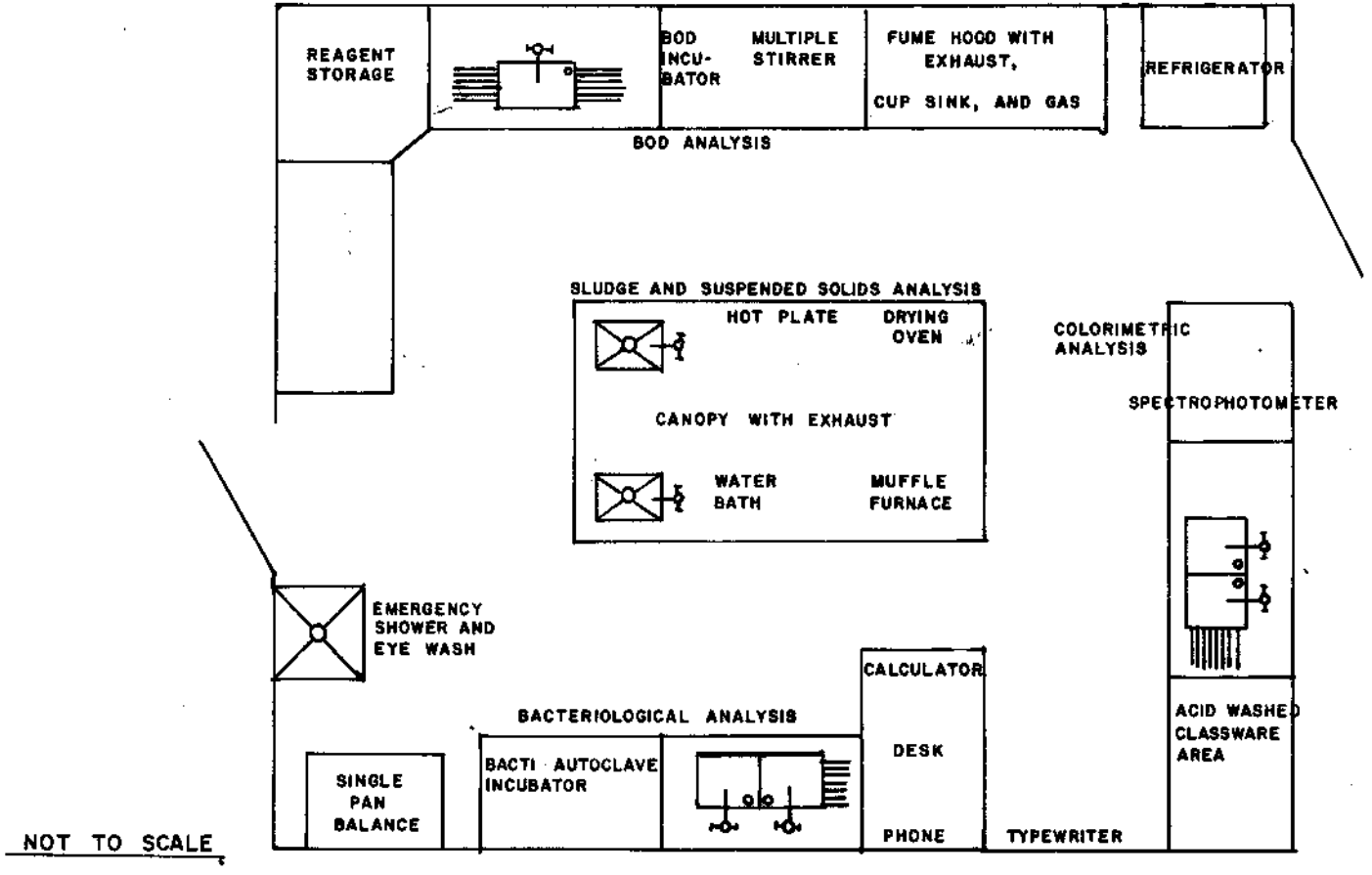
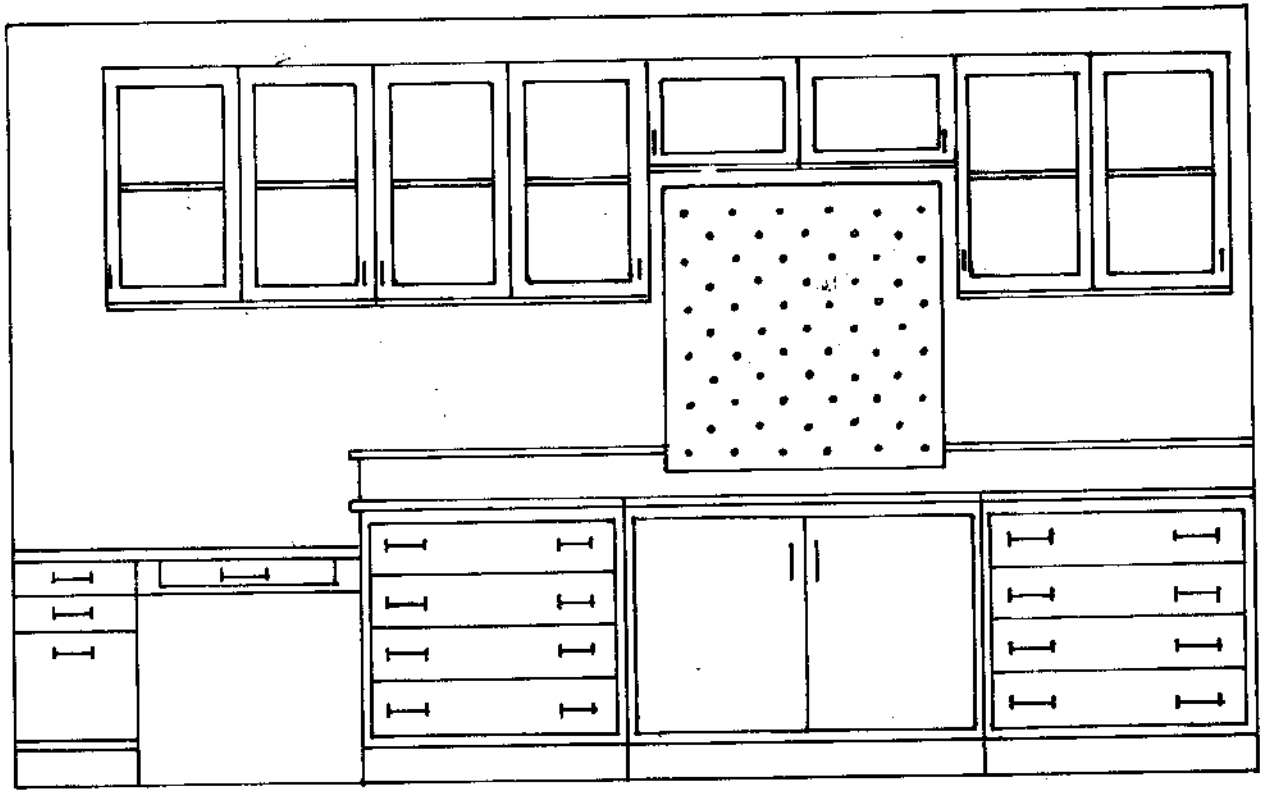


ILLUSTRATION OF ADEQUATE LABORATORY ARRANGEMENT-2

DATE 8/08/80

FIG. NO. 49



ELEVATION

DATE 8/08/80

FIG.NO. 50

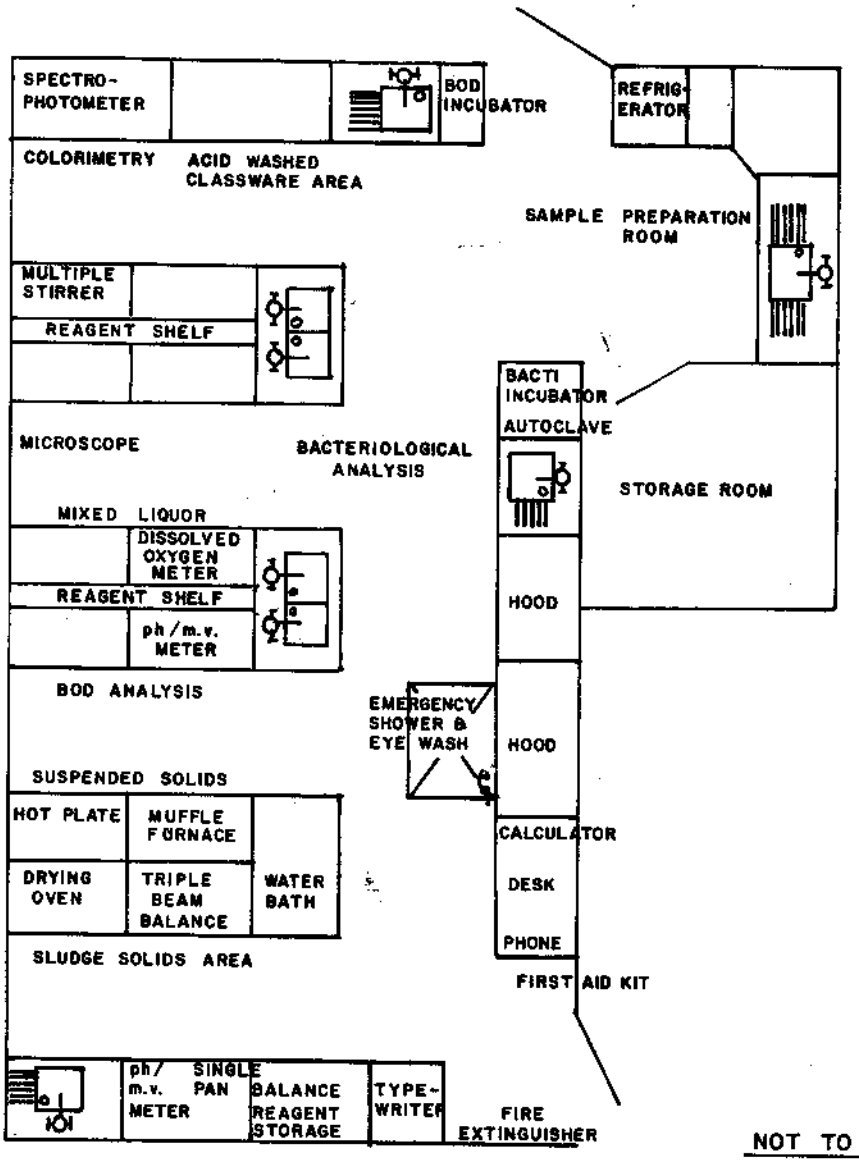
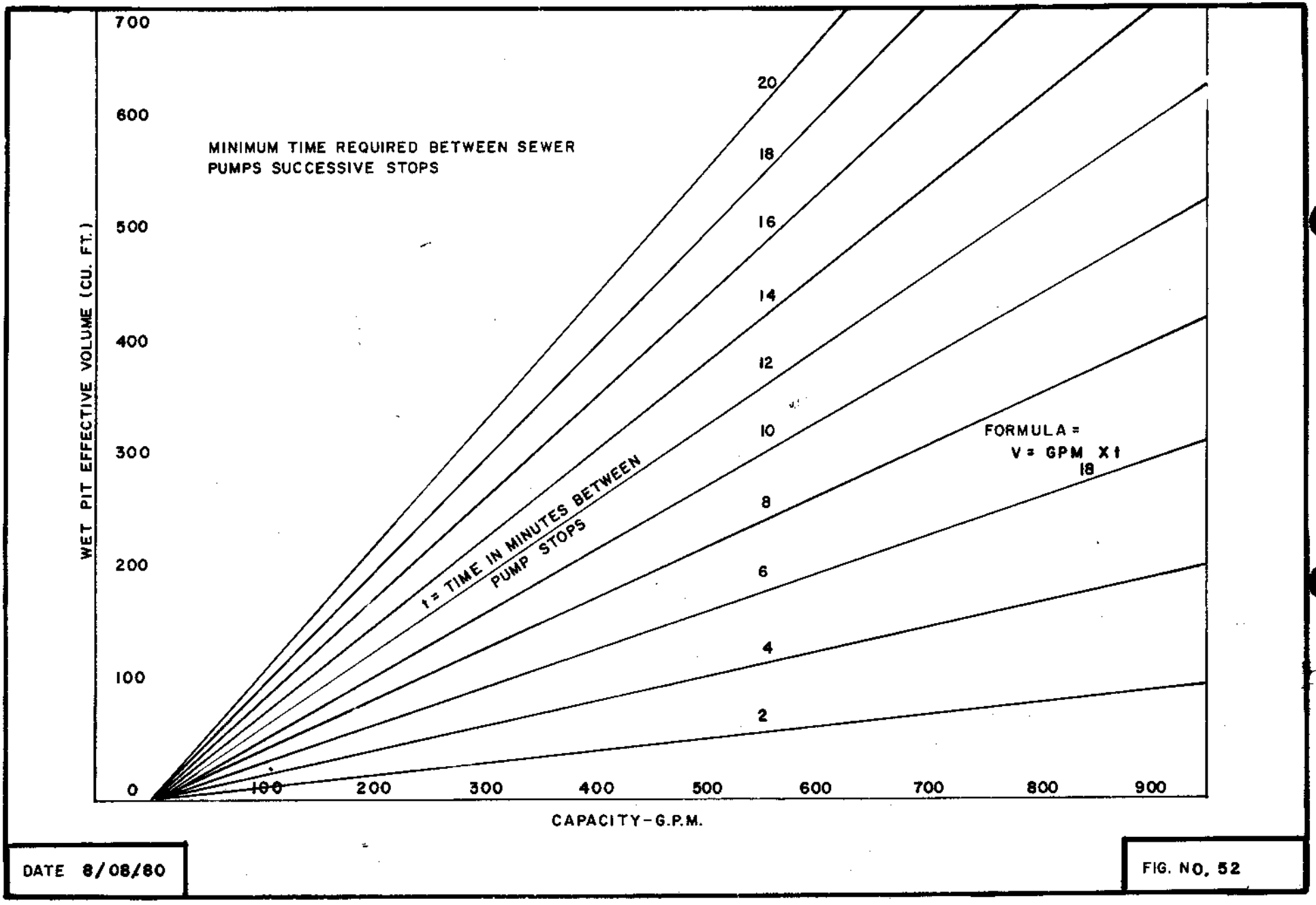


ILLUSTRATION OF ADEQUATE LABORATORY ARRANGEMENT-3

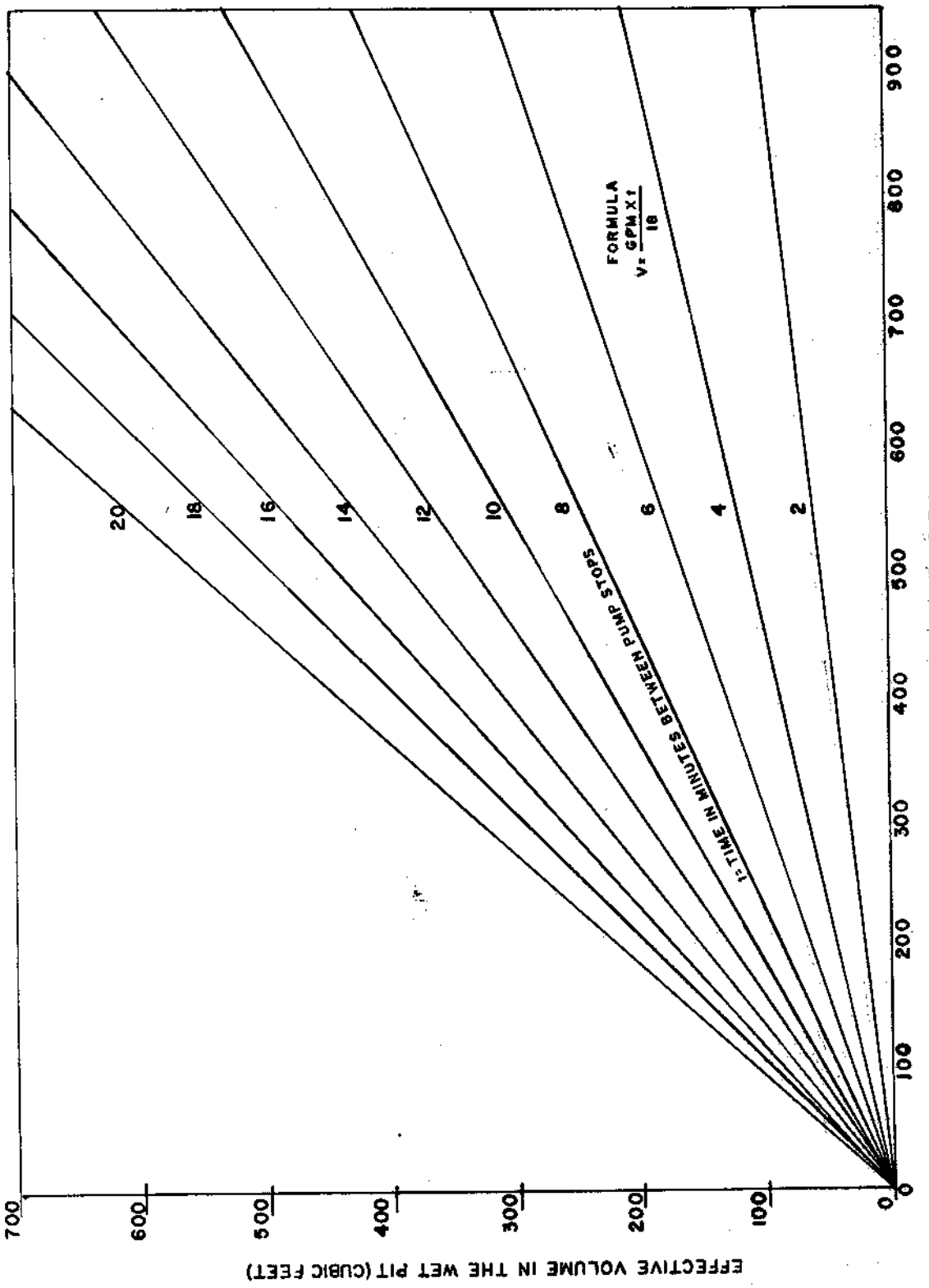
FIG. NO. 51

DATE 8/08/80



DATE 8/08/80

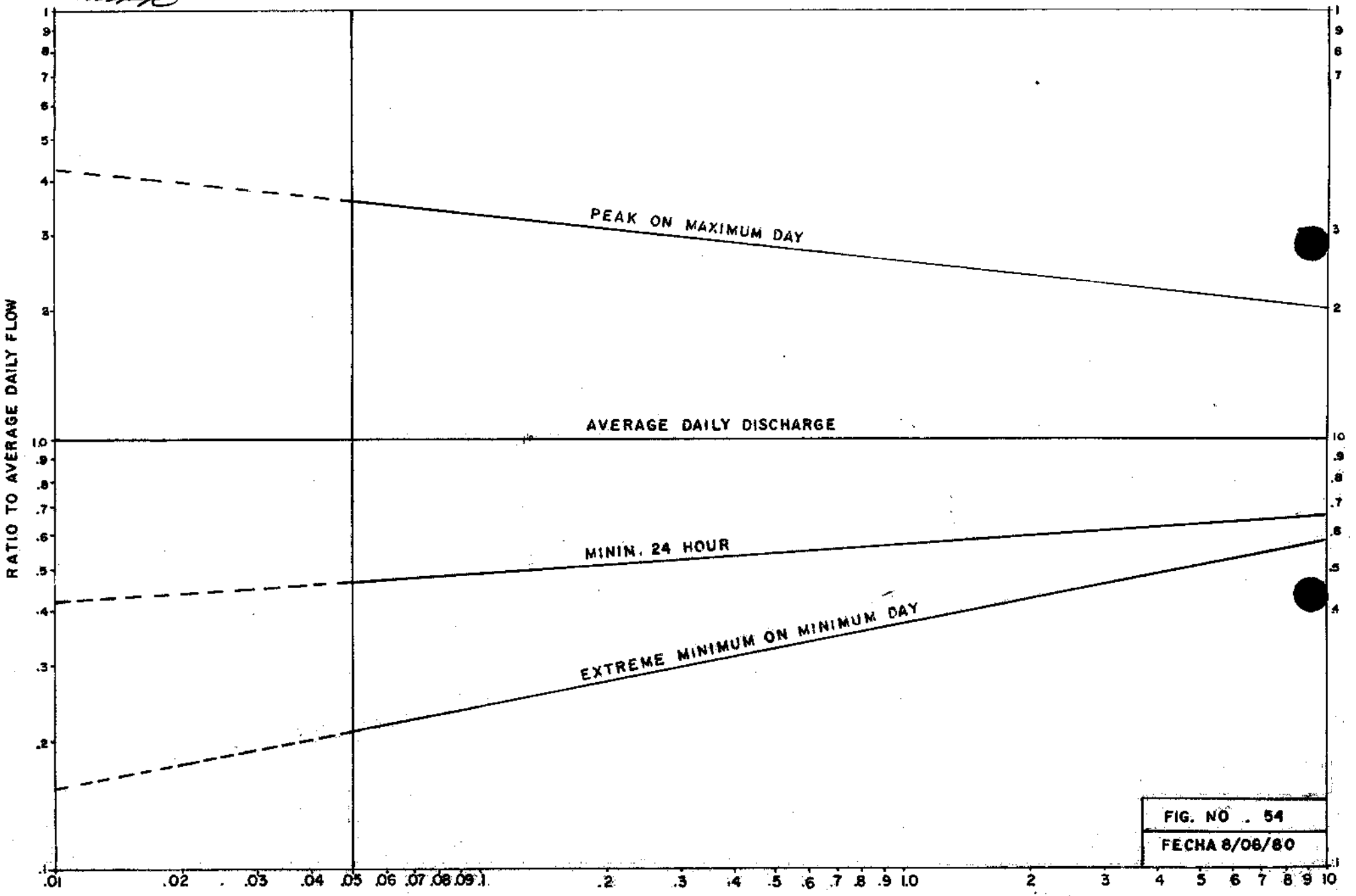
FIG. NO. 52



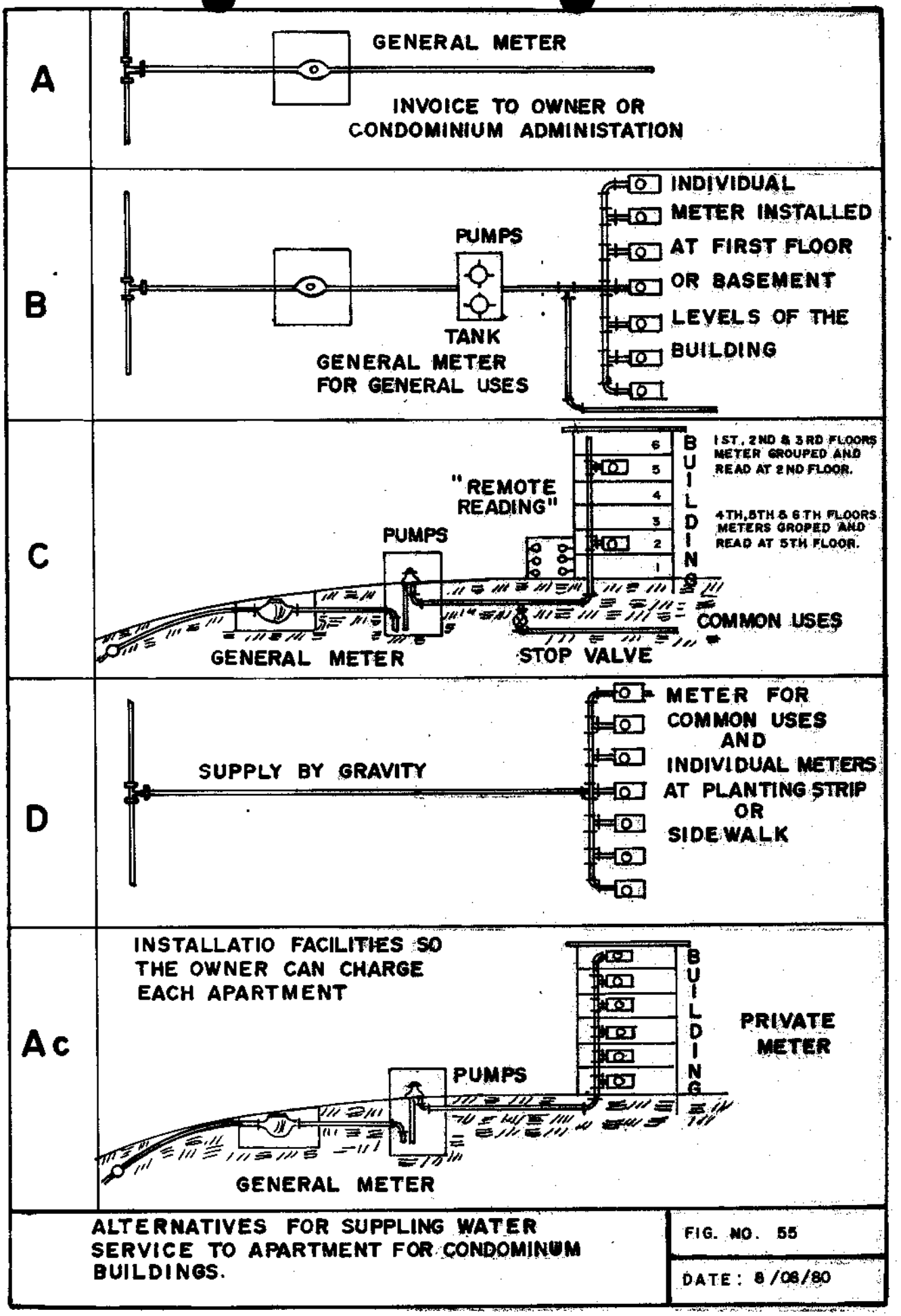
MINIMUN TIME REQUIRED BETWEEN SUCCESSIVE STOPS OF THE SANITARY SEWER PUMP

FIG. NO. 53

DATE 8/08/80



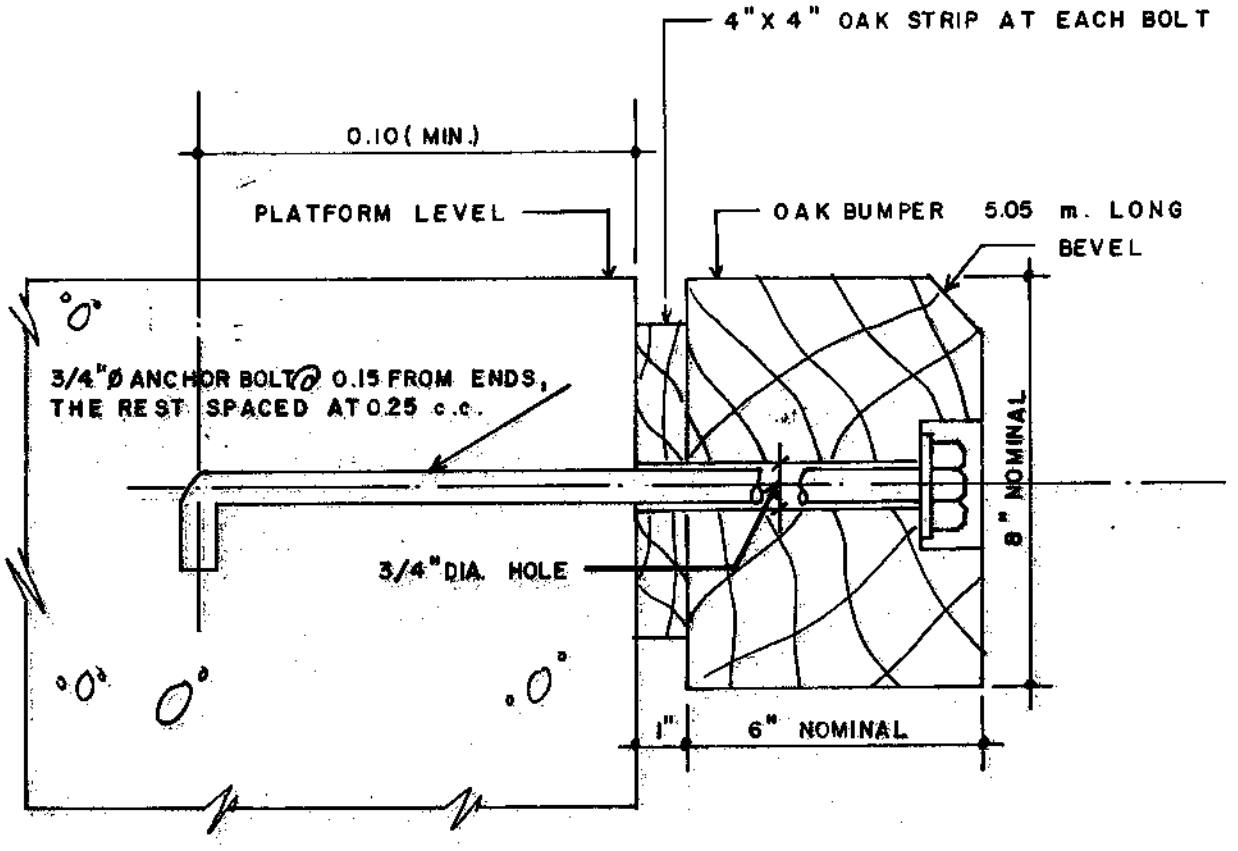
VARIATIONS IN DAILY SEWAGE FLOW



ALTERNATIVES FOR SUPPLING WATER SERVICE TO APARTMENT FOR CONDOMINUM BUILDINGS.

FIG. NO. 55

DATE : 8/06/80

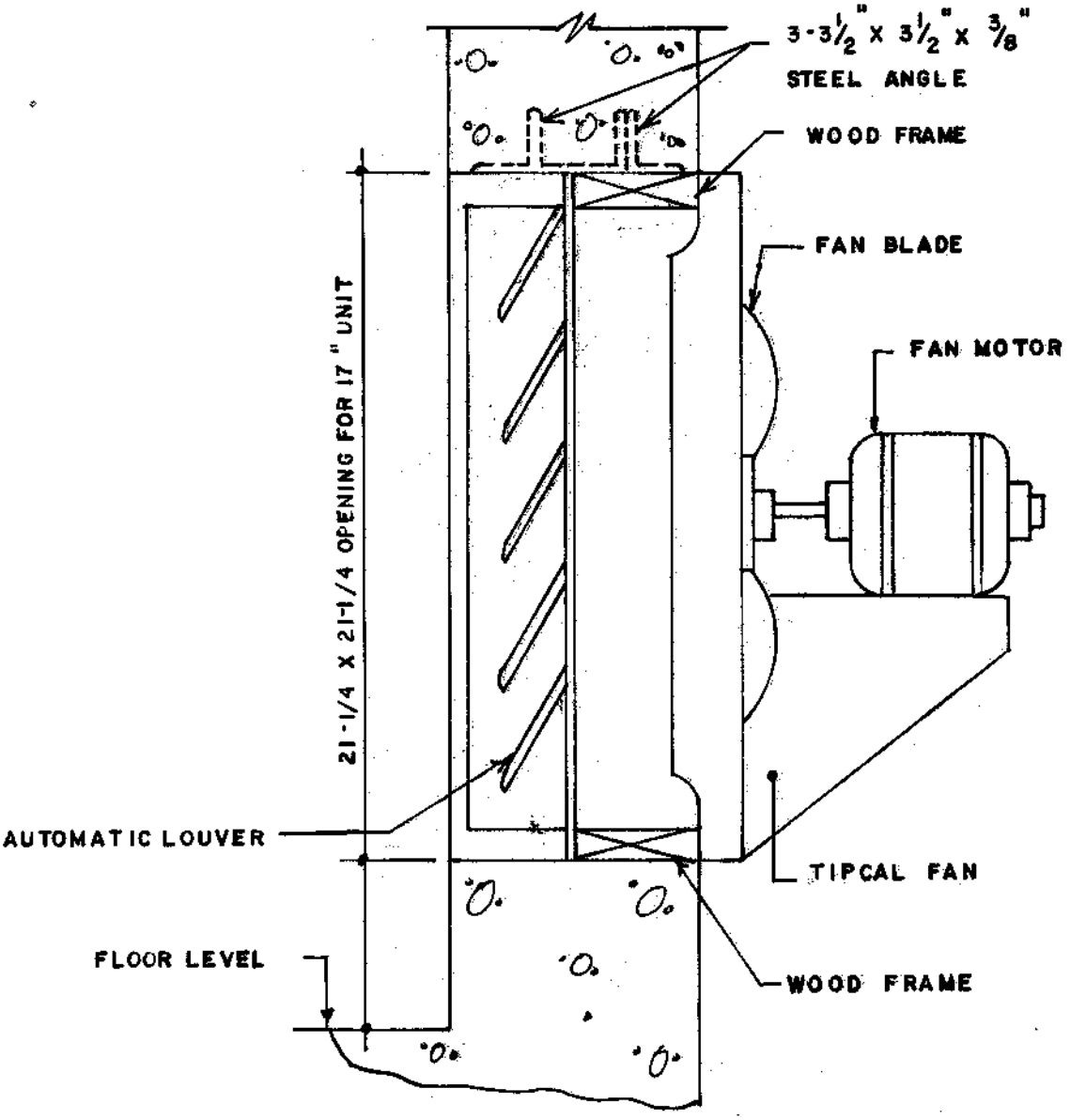


LOADING PLATFORM BUMPER

NOT TO SCALE

FIG. NO. 56

DATE: 8/08/80



SECTION

EXHAUST FAN DETAIL
17" UNIT

NOT TO SCALE

FIG. NO. 57
DATE: 8/08/80