DESIGN STANDARDS

of the

DEPARTMENT OF WASTEWATER MANAGEMENT

Volume I

July, 1993

DEPARTMENT OF WASTEWATER MANAGEMENT
CITY AND COUNTY OF HONOLULU
STATE OF HAWAII

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DEPARTMENT OF WASTEWATER MANAGEMENT
CITY AND COUNTY OF HONOLULU
STATE OF HAWAII

DESIGN STANDARDS

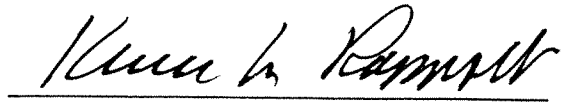
Volume I

GENERAL REQUIREMENTS FOR WASTEWATER FACILITIES

DESIGN OF SEWERS AND PUMP STATIONS

JULY, 1993

APPROVED:



DIRECTOR

FORWARD

Volume I of these standards of design is established to serve as a guide and aid in the planning of wastewater facilities and in the design of sewers and wastewater pump stations that are to be operated and maintained by the Department of Wastewater Management, City and County of Honolulu. It is the intent of these standards to present procedural and major design requirements to facilitate the approval process. It is not the intent to restrict the designer from applying his engineering knowledge and experience nor from exercising his skill or judgement. Approval of reports and designs by the Department shall in no way relieve the designer of his responsibilities and professional obligations. He shall be held responsible for the adequacy of design, the accuracy and completeness of the plans and specifications, and the operability of the facilities.

TABLE OF CONTENTS

VOLUME I

GENERAL REQUIREMENTS FOR WASTEWATER FACILITIES

DESIGN OF SEWERS

DESIGN OF PUMP STATIONS

Page

CHAPTER 20

CHAPTER 10

GENERAL REQUIREMENTS

Upon inception of a wastewater facility project, the designers shall discuss the overall plan with the Department of Wastewater Management. The designers shall make the following submittals to the Department for review and approval prior to and during the design stage of the project:

a. Engineering report, including preliminary plans

b. Environmental documents and applicable comments

c. Construction plans and specifications

d. Cost estimates

Submit four (4) copies of all reports, drawings, specifications, and other data [six (6) sets for treatment plants and pump stations]. Each submission will require a review period of at least 10 days. All submittals shall be reviewed by the Department for conformance to these standards. The designers shall be responsible for determining and meeting the requirements of all other applicable regulatory and approving agencies. After each review, one (1) copy of the material will be returned approved or showing the changes required.

Preparation of construction plans and specifications should not be undertaken until the engineering report and preliminary plans have been approved. Purchases of equipment and materials prior to final approval shall be at the risk of the designers.

Approval by the City shall in no way relieve the designers of their responsibilities and professional obligations. They shall be held responsible for the adequacy of design and accuracy and completeness of the plans and specifications. Changes or revisions to correct any deficiencies shall be made by and at the expense of the designers. Such changes and revisions shall require approval by the City.

After final approval has been secured for City financed projects, all tracings shall be transmitted to the Department by the designer. For projects not financed by the City, the designer shall furnish the Department with three (3) sets of plans and specifications [six (6) sets for treatment plants and pump stations] and one (1) copy of the bid tabulation results for the proposed facilities at least seven (7) days before the commencement of actual construction.

11. Engineering Report

A comprehensive engineering report, including preliminary plans of the wastewater facilities to be constructed shall be prepared by the designers and be submitted to the Department. The engineering report is essential to the City for determining the adequacy and feasibility of the proposed facilities under review. Any failure on the part of the applicant or his representatives to submit such a report to the City may lead to a delay in review and approval of the desired project.

The report shall be typewritten or xerox reproductions thereof, 8½" x 11", and firmly bound between appropriate covers. Bulletins, brochures, catalogues, diagrams, etc. of proposed equipment to be used shall be incorporated within or attached to the report (size limitations need not apply to these).

11.1 General: An engineering report, including preliminary plans, will include as much of the following data on wastewater facilities as pertaining to the project and as necessary, to clearly indicate the proposed facilities and their proposed functions or performances:

11.1.1 Brief description of project.

11.1.2 Locations: Indicate specific locations of existing and proposed sewers, wastewater pump stations, and wastewater treatment works.

11.1.3 Topography: Describe topography of the general area to be served by the project, including a detailed study of the specific location of the project. A suitable map shall be included with a scale of not less than 1 inch equal 400 feet and contour intervals not greater than 10 feet.

11.1.4 Population: Estimate the future population of the tributary area based on the City's Development Plan and give any past census data that are available.

11.1.5 Field Survey Data:

a. Volume and Strength of Wastewater Flows: Where there are existing sewers, the volume and strength of wastewater shall be determined.

Characteristics of wastewater to satisfy the requirements of Design Standards for Wastewater Treatment Facilities, Volume II shall be included.

Actual flow measurements during wet and dry weather are desirable.

b. Industrial Wastewaters: The volume and characteristic of present and future industrial wastewaters shall be listed.

c. Soil Investigations and Core Borings: Soil investigations shall be made in the proposed construction areas, and any unusual foundation conditions including hazardous or other sensitive material will be discussed. Ample core borings shall be made and shown on the contract drawings.

d. Corrosivity Study.

e. Noise Attenuation.

11.1.6 Flooding: If the project or any part of it is subject to flooding, discuss the preventive measures that may be used in the design of the wastewater facilities. Federal Emergency Management Agency (FEMA) flood insurance maps shall be consulted.

11.1.7 Permits and Clearances: If a project or any part of it is affected by land use restrictions, discuss permit and clearance requirements for agency review and approval. These shall include, but are not limited to, the following:

a. Flood Hazard Districts.

b. Special Management Area Use (SMA).

c. Shoreline Setback Variance.

d. Special District Permit.

e. Hawaii Coastal Zone Management Program, Federal Consistency.

f. Conservation District Use Application.

g. Historic Site Review

h. Underground Injection Control (UIC) Permit.

i. Permit for Work in Ocean Waters.

j. Department of Army Permits.

k. Stream Channel Alteration Permit.

l. Water Quality Certification.

11.2 Sewers: For sewers, the engineering report shall include in addition to the information required under Section 11.1, the following:

11.2.1 Description of Existing and Proposed Sewers:

a. Extent: Briefly describe the extent of the existing and proposed sewers with reference to a general map or exhibit. Describe the areas of probable future expansion of the sewer system.

b. Capacity: Discuss any factors which may affect future changes in populations. Indicate present zoning and Development Plan land use designation. Discuss the capacity available in the existing sewers to handle the additional flow. Show relationship of point of discharge of proposed sewers to existing system, including elevations of points of connection to existing sewers.

c. Downstream Facilities: Discuss the type and capacity of the wastewater treatment facility to which the project will discharge and indicate the ability of the wastewater treatment facility to handle the wastewater from the proposed project. If the proposed project discharges into a wastewater pump station, discuss the capacity of the pump station and indicate whether sufficient pumping capacity is available for the proposed system.

11.2.2 Basis of Design: At critical points in the system, set forth the following data for tributary areas representing both existing and future conditions:

a. Design period.

b. Design equivalent population.

c. Areas served in acres.

d. Average per capita wastewater contribution.

e. Maximum flow factor.

f. Dry weather infiltration/inflow rate.

g. Wet weather infiltration/inflow rate.

h. Design flow rates - average, maximum, and peak.

i. Size of pipe, grade, maximum velocity and capacity, pipe friction factor used, and velocity at design flow.

11.2.3 Discuss need for special structures such as siphons and stream crossings.

11.3 Wastewater Pump Stations: For wastewater pump stations, the engineering report shall include, in addition to the information required under Section 11.1, the following:

11.3.1 Description of Tributary Areas:

a. Briefly describe the extent of the existing and proposed tributary areas to each proposed station with reference to a general map or exhibit. Show the proposed sewer system layout.

b. Describe the areas of probable future expansion of the sewer system tributary to the pump station. Discuss any factors affecting future changes in population. Indicate present zoning and Development Plan land use designation.

c. Show location of proposed pump station, force main, point of discharge and elevations of force main, and receiving sewer at point of connection. Discuss the capacity available in the existing sewer to handle the additional flow.

11.3.2 Site: Discuss the accessibility of the proposed site, the proximity of residential or developed areas and availability of utilities. Show the topography of the site and the proposed layout of the pump station.

11.3.3 Basis of Design: Set forth the following data for the tributary areas, representing both existing and future conditions:

a. Design period.

b. Design equivalent population.

c. Area served in acres.

d. Average per capita wastewater contribution.

e. Maximum flow factor.

f. Dry weather infiltration/inflow rate.

g. Wet weather infiltration/inflow rate.

h. Design flow rates - average, maximum, and peak.

11.3.4 Design Data and Calculations: The following design data and calculations shall be included in the report:

a. Flow determination.

b. Force main selection.

c. Pump selection including system and characteristics curves for all proposed, present, and future pumps.

d. Pumping cycle.

e. Wet well size determination.

f. Amount of air required for ventilation.

g. Effects of water hammer.

11.3.5 Essential Features: Describe the essential features of construction and operation. If pumps, piping, or other equipment are to be installed in stages, discuss the staging sequence and the future changes necessary. Show schematic drawings of pump station and architectural treatment of the exteriors.

11.3.6 Power Failure: Describe the provisions made in the event of a power failure. Describe auxiliary power unit and emergency bypass provisions. Determine and show calculation of the effect of a power failure on the maximum elevation of wastewater in the collection system.

11.3.7 Telemetering and Supervisory Control Systems: Describe telemetering and supervisory control systems being provided.

11.3.8 Other Considerations: The following items shall be considered:

a. Odor control.

b. Detention and septicity in wet well and force main.

c. Corrosion control including selection of materials.

d. Noise Control.

e. Energy conservation.

f. Costs.

g. Safety.

h. Redundancy.

i. Flexibility.

j. Aesthetics, including landscaping.

11.4 Wastewater Treatment Facilities: For wastewater treatment facilities the engineering report shall include, in addition to the information required

under Section 11.1 and Volumes II, III, and IV, the following:

11.4.1 Description of Tributary Area:

a. Briefly describe the extent of the existing and proposed tributary areas to the proposed wastewater treatment plant with reference to a general map or exhibit.

b. Describe the areas of probable future expansion of the sewer system tributary to the wastewater treatment plant. Discuss any factors which may affect future changes in population. Indicate present zoning and Development Plan land use designation.

c. Describe the location of the wastewater treatment plant and its point of discharge with reference to the tributary sewer system and the receiving water.

11.4.2 Site: Discuss the various sites available, indicating access, proximity of residences or developed areas, and availability of utilities. Include a topographic sketch of the site and show the arrangement of present and future treatment units.

11.4.3 Brief Description of Existing Plant (if any): Discuss limitations of plant or of individual units that require additions, modifications, or expansions.

11.4.4 Basis of Design:

a. Design period.

b. Design Equivalent Population: Indicate design population and population equivalent of industrial wastewater.

c. Strength of Wastewater: Indicate BOD_5 and suspended solids (mg per liter and/or pounds per day) for wastewater. Refer to Volume II for additional requirements for treatment plants. Septicity of wastewater shall also be considered in design.

d. Total Wastewater Flows: Indicate per capita and total daily flow, and infiltration allowance.

e. Design Flow Rate: Indicate minimum, average, and maximum flow rates for the 24-hour period. The peak wet weather flow into the plant shall be also included.

f. Treatment Units: Describe and include the necessary calculations for the design of the major units of the wastewater treatment plant giving their capacities, size, equipment, and operation factors under varying conditions and methods of operation. A mass balance showing the inter-relationship of units shall be included. If major components or equipment are to be modified in stages, discuss the staging sequence and the future changes necessary.

g. Operations During Construction: Discuss a program to keep existing treatment plant and pump station units in operation during construction. Should it be necessary to take such units out of operation, discuss its impact on effluent quality and disposal.

h. Other Considerations: The following items shall be considered:

1. Odor control.

2. Detention and septicity in wet well and force main.

3. Corrosion control including selection of materials.

4. Noise Control.

5. Energy conservation.

6. Costs.

7. Safety.

8. Manpower requirement.

9. Redundancy.

10. Flexibility.

11. Aesthetics, including landscaping.

11.4.5 Effluent Disposal: Refer to Chapter 100, Effluent Disposal in Volume II of the Design Standard for basis of design for the following effluent disposal methods:

a. Marine waters.

b. Inland waters.

c. Subsurface disposal.

d. Land application/Land treatment.

e. Reclamation/Reuse.

11.4.6 Power Failure: Describe the provisions made in the event of a power failure.

11.5 Recommendations: Outline the recommendation in detail concerning the proposed works and future expansion thereof, as follows:

11.5.1 Alternate Plans: Discuss all feasible solutions and reasons for selecting the one recommended.

11.5.2 Sewer System: Describe the area and extent to which plans provide sewerage facilities for future development. If the area to be served by existing and proposed sewers does not include the natural drainage area, a brief description shall be given of that portion not included, together with information as to the probabilities of future developments, and how this area can be served. A sketch shall be provided.

11.5.3 Pump Station: Justify pump station, if appropriate, by including a present worth cost comparison against other alternatives.

11.5.4 Wastewater Treatment: Discuss the degree and type of treatment, reasons for adopting the proposed method, and adequacy for present and future needs. New methods or processes shall be fully described. A general layout and

quantitative flow diagram shall be provided.

11.5.5 Effluent Disposal: Discuss the selection of the effluent disposal method and system based on public health considerations, economic factors, degree and reliability of treatment required, location of discharge, sensitivity of the effluent receiving environment, and regulatory constraints.

11.5.6 Financing: Give estimated cost of integral parts of system for the contemplated installation and a detailed estimated annual cost of operation.

12. Construction Plans

12.1 Organization: Where a single set of plans include force mains and gravity lines, together with pump stations and treatment plants, it is preferred that the plans for pump stations and treatment plants precede the plans for the pipelines.

12.2 General: Each sheet of drawing for sewerage facilities shall have a suitable title and shall show the scale in feet, the north arrow, the date, and the name of the engineer with the stamp of his registration seal. The drawing shall be clear and legible. It shall be drawn to a scale which will permit all necessary information to be plainly shown. The size of the plan sheets should be 22" x 36". The lettering size shall be suitable for half scale reduction (1/8 inch minimum). Each sheet of drawing shall also be provided in a Computer Aided Drafting (CAD) file format specified by the City. In general, the plans shall consist of:

a. Location map showing the project site on a map of Oahu, as well as on a larger scale map of the district. This sheet should also contain the project title, sheet index, and space for approval signatures. Tax map key and street address (as applicable) shall also be shown.

b. Plot plan, key sheet, or general layout showing the general features of construction and relative location of construction elements. Elevation datum used should be indicated. Locations and logs of test borings shall be shown.

c. Details consisting of plan views, profiles, elevations, sections, schematics, notes, and supplementary views. Also include dimensions and

relative elevations of structures, the location and form of equipment, location and size of piping, water levels, and ground elevations. Ties from street monuments, property pins or other existing features to the new work should be included to enable the line to be laid out. Adequate bench marks and their elevations should also be shown on the plans.

d. Design data: The plans together with the Special Provisions, Standard Specifications, and Standard Details shall provide the working information for the contract and construction of the facilities. Specific design data shall be shown on the second sheet.

12.3 Plans of Sewers:

12.3.1 General Layout or Key Sheet: This plan shall show the following within the project area:

a. Geographical Features:

1. Topography: Existing or proposed streets and all streams or water surfaces shall be clearly shown. The direction of flow in all streams shall be indicated.

Contour lines at suitable intervals should be included when necessary.

2. Boundaries: The boundary lines of the sewer district or area shall be shown. Property lines shall also be shown.

b. Sewers: The plan shall show the location, size and direction of flow of all existing and proposed sewers.

12.3.2 Details: Profiles shall preferably have horizontal scale of one inch equals 40 feet and a vertical scale of one inch equals 4 feet. Plan view should be drawn to a corresponding horizontal scale. Plans and profiles shall show:

a. Location of streets, property lines, sewers, boring locations and log of borings.

b. Line of ground surface, size, material and types of pipe, azimuth and length between manholes, invert and surface elevation of the manhole, grade of sewer between each two adjacent manholes, and the hydraulic characteristics (friction value, slope, pipe capacity flowing full, design flow, velocity when pipe is flowing full, velocity when pipe is flowing at design flow) of the line at every change of capacity or design flow. All manholes shall be numbered and stationed on the plan and correspondingly numbered on the profile. Provide Board of Water Supply's water meter numbers.

c. Locations of all special features such as siphons, concrete encasements, etc.

d. All known existing structures and utilities both above and below ground which may interfere with the proposed construction particularly sewers, force mains, water mains, gas mains, storm drains, electrical, telephone, cable television, traffic attenuator loop, and signal corps conduits.

e. Special detail drawings, made to scale to clearly show the nature of the design, shall be furnished to show the following particulars:

    1. All stream crossings and sewer outlets, with elevations of the stream bed and of normal and extreme high and low water levels.

    2. Details of all special sewer joints and cross-sections.

    3. Details of all special appurtenances.

f. Traffic control plans as required.

g. All properties which are unsewerable by gravity shall be so noted on the plans.

12.4 Plans of Wastewater Pump Stations:

12.4.1 General Layout:

a. Plot plan showing layout of site and building(s), including driveway and number of parking stalls, exterior piping and appurtenances, fencing, and utilities. Property ties shall also be shown.

b. Plans and details of grading, drainage, erosion control, landscaping, and sprinkler system.

c. Elevation of regulatory flood level if location is in a flood plain.

d. Table of Design Data: Applicable design data from Paragraph 11.3.3 and 11.3.4 shall be included in the Table.

12.4.2 Detail Plans: Detail plans shall consist of the following:

a. Architectural plans, elevations, and details.

b. Structural plans, elevations, sections, and details.

c. Utility plans (electrical, mechanical, etc.) showing exact location and elevation to prevent damage from future excavations.

d. Mechanical plans including pump, isometrics, plumbing, ventilation, air condition and other equipment installations, piping layout, and details.

e. Electrical and telemetering plans and details including conduit schedule and lighting fixture layouts, control equipment arrangement, and wiring diagrams (one line and elementary control diagrams) for power distribution and controls.

f. Wastewater level control arrangement for operating pumps and alarms.

g. Other plans, sections, elevations, schematics, details and notes, as required, to adequately show the proposed construction.

12.5 Plans of Wastewater Treatment Plant: See Volumes II, III, and IV.

13. Specifications

13.1 General: All work to be done shall be specified by the special provisions and the current edition of the Standard Specifications for Public Works Construction. The special provisions shall supplement the Standard Specifications and shall specify in detail the construction of sewer, wastewater pump station, wastewater treatment plant and all appurtenances. Reference shall be made to the Standard Specifications when applicable. The specifications or special provisions shall be printed on 8½ inch x 11 inch paper and shall also be provided in computer file format of a word processor specified by the City.

13.2 Required Information: The specifications or special provisions shall include, but not limited to the following:

13.2.1 Workmanship and fabrication.

13.2.2 Materials.

13.2.3 Equipment.

13.2.4 Tools.

13.2.5 Testing.

14. Other Requirements

14.1 Design Calculations: Calculations pertinent to the design shall be submitted to the Division. Such calculations will be used by the City for determining the adequacy and feasibility of the proposed facilities under review. Any failure on the part of the applicant or his representatives to submit such calculations may lead to delay in review and approval of the desired project.

14.2 Revisions to Approved Plans and Specifications: Any deviations from approved plans or specifications shall be approved in writing before such changes are

made. Plans or specifications so revised should therefore be submitted well in advance of any construction work which will be affected by such changes to permit sufficient time for review and approval.

14.3 Operation During Construction: Specifications shall contain a program for keeping existing treatment plant and pump station units in operation during construction.

14.4 Record Plans: "As-built" tracings of the construction plans shall be submitted for inclusion in the City files. Such tracings shall be of a durable and permanent material. All changes made by addendums and change orders must be shown on "as-built plans."

"As-built" tracings should accurately indicate all changes made in the field. The location and elevations or details of all features constructed should be recorded accurately for future reference. All as-builts should be prepared as the work progresses and should be available to the operator soon after the facility is accepted.

14.5 Shop Drawings: Specifications shall include provisions for submission of shop drawings for review and approval before fabrication. Three (3) copies of all approved shop drawings shall be submitted to the City.

14.6 Equipment Manuals: Specifications shall include provisions for equipment manuals. The manuals shall contain sufficient information on the installation, operation, maintenance, and repair of the equipment. Manuals shall be bound in looseleaf "D" binders. Folders shall contain only the information in relation to the equipment furnished. Each binder shall be labeled on its front cover and spine with the name of the facility and subject matter.

14.7 Facilities Operations and Maintenance Manual: A detailed operations and maintenance manual for the facilities to be constructed shall be required for all Federal and State funded projects, and for all pump station and treatment plant projects. The manual shall give the operations and maintenance personnel the proper understanding, techniques, and any other information necessary to efficiently operate and maintain their facilities. O & M manuals shall comply with all applicable statutes,

ordinances and regulations, including the provisions of DOH Chapter 62 (11-62-23.1 (d) (2)).

14.8 Initial Start-Up Procedure Training: Services of field engineers or qualified personnel for all equipment provided shall be required to assist and instruct the City's operating and maintenance personnel. Such services shall commence before or concurrently with the final acceptance testing.

14.9 Spill Prevention Plan and Emergency Response Plan: The facilities O & M manual should include sufficient operating instructions to prevent spills. The plan should also provide instructions to the operator on how emergencies are to be handled.

14.10 One Year Certification: Federal regulations require a certification be prepared after one year of facility operation when Federal and State funds are used to construct the facility. The certification should be prepared by the facility designer, construction manager, or other person approved by the State Department of Health.

CHAPTER 20

DESIGN OF SEWERS

21. General

21.1 Type of System: All sewers shall be designed as Sanitary Sewers.

21.2 Ordinance Requirements: The wastewater from industrial or commercial plants should be thoroughly evaluated. Provisions of the City Ordinance (Sec. 14-1.6, Revised Ordinances of Honolulu, 1990, as amended) impose certain restrictions on the quantity, strength and character of industrial wastewater which may be discharged into public sewers.

22. Quantity of Wastewater

22.1 Design Period: In general, sewer systems should be designed for the estimated ultimate tributary equivalent population, except for systems that can be readily increased in capacity. Where Federal or other legal requirement dictates the use of other specific design period, the design period required by them may be used, unless modified by the City.

22.2 Design Flows: In determining the required capacities of sanitary sewers, the following factors shall be considered:

22.2.1 Average Daily per Capita Flow: New sewer systems shall be designed on the basis of an average per capita flow of wastewater of 80 gallons per day, unless other current data has been established by the City. Densities of residential occupancy shall be assumed to be 4 persons per home and 2.8 persons per apartment unit.

22.2.2 Other Average Flows: Other wastewater flows shall be based on land use or best available data, whichever is higher. Considerations shall be given for high wastewater generation for particular types of industries. The following equivalent populations or average flow data shall be used for the various land uses:

a. Central Business 300 cpa.*

b.	Community Business	140 cpa.
c.	Neighborhood Business	40 cpa.
d.	Resort	400 cpa.
e.	Apartment (high density)	390 cpa.
f.	Apartment (medium density)	250 cpa.
g.	Apartment (low density)	85 cpa.
h.	General Industry	100 cpa.
i.	Waterfront Industry	40 cpa.
j.	School	25 gpcd.**
k.	Institution (hospital, etc.)	200 gpcd.

* cpa. = capita per acre
** gpcd. = gallon per capita per day

22.2.3 Average Wastewater Flow: The average wastewater flow is the sum of the applicable wastewater flow obtained in Sections 22.2.1 and 22.2.2 above.

22.2.4 Maximum Wastewater Flow: The maximum wastewater flow is obtained by multiplying the average flow by a flow factor. Except as noted in Section 11.1.5, Figure 22.2.4 shall be used to obtain the flow factor for the maximum rate of wastewater flows.

22.2.5 Dry Weather Infiltration/Inflow (I/I): The following rates of dry weather I/I shall be used in the design of sewers:

a. 35 gpcd - sewers laid below the normal ground water table.

b. 5 gpcd - sewers laid above the normal ground water table.

22.2.6 Design Average Flow: The design average flow is the sum of the average wastewater flow and the applicable dry weather infiltration/inflow rate.

22.2.7 Design Maximum Flow: The design maximum flow is the sum of the maximum flow and the applicable dry weather infiltration/inflow rate.

22.2.8 Wet Weather Infiltration/Inflow: The following rates shall be used in the design of sewers:

a. 2750 gad* - sewers laid below the normal ground water table.

b. 1250 gad - sewers laid above the normal ground water table.

* gad = Gallon Per Acre Per Day

22.2.9 Design Peak Flow: The design peak flow of wastewater is the sum of the applicable quantities obtained from Sections 22.2.7 and 22.2.8.

22.2.10 Organization of Computation: Figure 22.2.10 shows the format desired for tabulating the results of computations for the design of sewers.

23. Hydraulics of Sewers

All gravity sewers shall be designed to carry the peak flow of wastewater without surcharging and to transport suspended solids in such a manner that deposits in sewers and odor nuisances therefrom are kept to a minimum.

23.1 Formula and "n" Values: All sewer design shall be based on the Manning Formula ($V = \frac{1.486}{n} r^{2/3} s^{1/2}$) using the "n" values given below:

23.1.1 0.015 - All pipes up to and including 18 inches in diameter.

23.1.2 0.013 - All pipes larger than 18 inches in diameter.

23.1.3 0.015 - Cast-in-place reinforced concrete conduit.

23.2 Velocities: All sewers shall be designed to give mean velocities of not less than 2.0 feet per second when flowing full. The following minimum slopes are to be

used for the different sized pipes:

DIAMETER(inches)	MINIMUM SLOPE(ft. per ft.)
6	0.0060
8	0.0044
10	0.0032
12	0.0028
15	0.0020
18	0.0016
21	0.0010
24	0.0008

In the design of a sewer, an attempt shall be made to obtain adequate scouring velocities at average flow. Where the initial flows are small or soil conditions are poor, adjustment in the minimum slope may be necessary. The maximum velocity generally permitted is 10 feet per second. Where velocities greater than this are unavoidable, special provisions shall be made to protect against erosion and displacement by shock. Specific approval of the City shall be obtained when these higher velocities are used.

23.3 Transitions: Whenever there are changes in size, grades, or alignment of sewers, the invert of the downstream sewer shall be designed to allow for transitional, manhole, and bend losses.

24. Design of Sewer System

24.1 Minimum Size: The minimum sizes permitted for sewers are as follows:

24.1.1 8 inch diameter for mains and branch mains in roadway areas.

24.1.2 6 inch diameter for branch mains in easements, provided such branch mains shall serve not more than 10 residential lots and there are no possibilities of future extensions.

24.1.3 6 inch diameter for laterals.

24.1.4 At least one size larger than the force main for the line exiting the discharge manhole. This line shall also be corrosion resistant.

24.2 Alignment and Grades: Sewers less than 36 inches in diameter shall be laid with constant grades and straight alignment between manholes. Sewers 36 inches and larger in diameter may be laid on a curved alignment. The minimum curve radius shall be four times the inside diameter of the pipe. The maximum curve radius shall be approximately 10 diameters. A manhole shall be placed immediately before or after a segment of curved sewer.

24.3 Depth of Sewers: In general, sewers should be designed deep enough to serve all properties within the tributary area. All properties which are considered unsewerable by gravity because of the designed depth of sewer shall be shown on the plans as being required to pump into the gravity sewer.

24.4 Minimum Cover Over Sewers: The following minimum cover should be provided over all sewers:

24.4.1 4 feet in paved areas.

24.4.2 3 feet in sidewalk areas.

24.4.3 2 feet in easements in private property not subjected to vehicular loads.

Where the required minimum cover is not provided, additional protection shall be provided by means of jacketing or other means acceptable to the City.

24.5 Easement Widths: Wherever possible, sewers shall be laid within roads or where existing easements are available. Where the former is unavailable or where new easements are necessary, the following widths shall be considered as the standard widths for easements.

24.5.1 Lateral and Branch Sewers: 6 feet for 6 in. and 8 in. diameter pipes.

24.5.2 Trunk and Interceptor Sewers:

a. 6 feet for 8 in. and 10 in. diameter pipes.

b. 10 feet for 12 in. to 21 in. diameter pipes.

c. 15 feet for 24 in. to 36 in. diameter pipes.

d. 20 feet for 42 in. to 60 in. diameter pipes.

e. 25 feet for 66 in. diameter or larger pipes.

24.5.3 Variations: The widths of easements specified in Sections 24.5.1 and 24.5.2 may be modified by the City when unusualconditions exist.

24.6 Manhole Location and Spacing: Manholes shall be installed at the end of each line, at all changes in grade, size, or alignment and at all points where sewer lines intersect except as specified in Section 24.2. Manhole locations in low points subject to flooding such as in gutters are to be avoided. When manhole spacing is not controlled by the preceding limitation, they shall be spaced as equally as possible but not at a distance greater than that described below:

24.6.1 350 feet - pipes up to and including 36 inches in diameter in street areas.

24.6.2 250 feet - pipes up to and including 18 inches in diameter in easement areas.

24.6.3 350 feet - pipes larger than 18 inches and up to and including 36 inches in diameter in easement areas.

24.6.4 600 feet - pipes larger than 36 inches in diameter. Junction manholes may be omitted when a side sewer 8 inches or smaller joins an interceptor sewer 30 inches or larger which is on a straight alignment and when the addition of a manhole at this location would give a spacing of less than 50 feet from the nearest interceptor manhole and less than 300 feet from the other manhole. When the junction manhole on the interceptor is omitted, a manhole on the side sewer shall be provided at a distance of not more than 15 feet from the interceptor sewer.

24.7 Drop Manholes: A drop manhole or shallow drop manhole should be provided where a sewer enters a manhole at a height of 18 inches or more above the manhole invert, or where a smooth grade transition cannot be accomplished within the manhole.

24.8 Lateral Sewers: Laterals shall not exceed 100 feet in length. All laterals should end with an appropriate reducer (usually 6" x 4") at the property line.

24.9 Chimneys: Chimneys shall be provided for lateral connections if the sewer is deeper than 10 feet (top of pipe to ground line). The maximum height of chimneys shall be 12 feet. The chimney should extend to approximately 6 feet below the ground surface.

24.10 Advance Risers: Advance riser connections shall be provided for laterals 6 feet or deeper as measured from the top of the ground at the property line. The riser should extend to approximately 4 feet below the ground surface. The riser is not required if connection is made at the reducer.

24.11 Protection of Water Systems:

24.11.1 Water Supply Interconnections: There shall be no physical connection between a public or private potable water supply system and a sewer, or appurtenance thereto which could permit the passage of any wastewater into the potable water supply.

24.11.2 Relation to Water Works Structures: While no general statement can be made to cover all conditions, it is generally recognized that sewers shall be kept remote from any public water supply wells or other water supply sources and structures.

24.11.3 Relations to Water Mains:

a. Horizontal separation: Sewers shall be laid at least 6 feet, horizontally, from any existing or proposed water main. When conditions prevent a lateral separation of 6 feet, a sewer may be laid closer than 6 feet to the water main under the following condition:

1. It is laid in a separate trench or it is laid in the same trench with the water main located to one side on a bench of undisturbed earth.

2. The elevation of the top (crown) of the sewer is at least 6 inches below the bottom (invert) of the water main.

3. Other alternatives such as a concrete jacket shall be considered.

b. Vertical separation: Whenever a sewer line crosses water mains, the sewer line must be jacketed with reinforced concrete for a minimum of 5 feet on both sides of the point of crossing if the sewer is above the water main and for 3 feet on both sides if the sewer is below the water main. However, jacketing may be eliminated if the sewer line is below the water main and the separation is greater than 18 inches and structural requirements are met.

24.12 Redundant Facilities: The design shall consider all alternatives to control spills or overflows including the installation of redundant lines to be used during emergencies.

25. Appurtenances

25.1 Manholes: A standard 48 inch diameter manhole shall be provided for pipes less than 30 inches in diameter. Special manholes shall be provided for pipes 30 inches and larger in diameter. Manholes for these larger pipes may be of shapes other than round. However, the access shaft shall have a minimum dimension of 48 inches.

25.1.1 Material Types:

a. Brick manholes: The maximum height of brick manholes shall be 10 feet. It shall not be used below the normal ground water table.

b. Cast-in-place concrete manholes: This manhole may be used in all locations and at any depth.

c. Precast manholes: The use of precast manholes is permitted below the ground water table if they are made water tight. Its use is not permitted in easements and/or in areas not accessible to equipment unless the upper 4 feet is made of brick to facilitate future height adjustments.

25.1.2 Functional Types:

a. Plain manhole: A plain manhole can be used where the difference in elevation between the incoming sewer and the manhole invert is less than 18 inches.

b. Shallow drop manhole: A shallow drop manhole shall be provided where a sewer enters a manhole at an elevation in the range of 18 inches to 5 feet above the manhole invert.

c. Drop manhole: A drop manhole shall be provided where a sewer enters a manhole at an elevation of over 5 feet above the manhole invert.

25.1.3 Watertightness: Provide manhole cover inserts at all manholes with Type SA frame and cover to minimize inflow through the cover. Manhole walls below the ground water table shall be watertight.

25.1.4 Flow Channel: The flow channel through manholes shall provide for smooth transitions taking into consideration the shape and slope of the incoming and outgoing sewers.

25.1.5 Manhole Cover: Type "SA" cast iron manhole frames and covers (22 inch opening) shall be used for all sewers with pipes 21 inches or less in diameter. For lines 24 inches and larger, Type "SB" manhole frames and covers (31½ inch opening) shall be required. Special junction structures shall be provided with at least one Type "SB" manhole frame and cover.

25.1.6 Manhole Connections: Each pipe entering or leaving a manhole shall have a stub not exceeding 24 inches long. The stub may be omitted where a resilient connection is approved and provided.

25.2 Other Junction Structures: Where large lines meet, junction chambers shall be used. These are specially designed and are not considered to be standard. These structures shall be provided with an access manhole and ventilation shaft(s).

25.3 Ventilation Shaft: Ventilation shafts shall be provided for wetwells and special structures. Ventilation shafts shall be at least 24 inches in diameter. More than one shaft may be required in special cases.

25.4 Siphons: Siphons shall have not less than 2 barrels, with a minimum pipe size of 6 inches and shall be provided with necessary appurtenances for convenient flushing and maintenance. The manholes shall have adequate clearances for rodding. In general, sufficient head shall be provided and pipe sizes selected to secure velocities of at least 3 feet per second for design flows but not more than 10 feet per second at maximum flows. The inlet and outlet details shall be arranged so that:

25.4.1 The normal flow is diverted to one barrel.

25.4.2 Any barrel may be cut out of service.

26. Materials

26.1 Pipes: Any generally accepted material for sewers will be given consideration, but the material selected should be adapted to local conditions such as character of industrial wastewater, possibility of septicity, soil characteristics, external loadings, abrasion, ground water conditions, leakage, and similar problems. All sewers shall be designed to safely carry the superimposed loads. Proper allowance for loads on the sewer shall be made because of the width and depth of the trench. The following materials have been accepted and approved for use in the sanitary sewer system in the City and County of Honolulu within the limitations described:

26.1.1 Vitrified Clay Sewer Pipe: Used for gravity sewers only.

26.1.2 Reinforced Concrete Pipe: Used for gravity lines 15 inches and larger. Reinforced concrete pressure pipe may be used for siphons.

26.1.3 Cast Iron or Ductile Iron Pipe (Cement or polyethylene lined and coated): Used for siphons, and for gravity sewer where unusual loads are expected, such as over or under streams.

26.1.4 Cast-In-Place Concrete Conduits: Used in special cases when conditions restrict the use of pipes.

26.1.5 Polyvinyl Chloride (PVC) Plastic Pipe: Used only for gravity sewers in agricultural, residential, and apartment zoned areas and in sizes from 6 inches to 12 inches in diameter. It shall also be used only in suitable soils. Additional design requirements are applicable.

26.2 Joints: All joints shall be designed to minimize infiltration or exfiltration. Flexible joints shall be used for gravity sewers. Double rubber gaskets may be used for larger diameter pipes to facilitate construction and testing. All joints within easements shall be wrapped with geotextile root barrier.

26.3 Corrosion Protection: Corrosion resistant lining, coating, and wrapping shall be used when extra corrosion protection is required. Pipes 30 inches and larger shall be of corrosion resistant material or protected internally with lining.

27. Structural Considerations

27.1 Maximum Cover: The maximum allowable cover over sewers shall be determined by type of pipe, bedding condition, soil conditions, and other conditions and shall be determined by calculations. Where the maximum allowable cover is exceeded, additional protection shall be provided. The protection may be jacketing, substitution of a stronger pipe, or any other approved means.

27.2 Loads Imposed by Other Utilities: Sewer lines which cross over or under other conduits and utilities may require protection from extra loading. When the sewer crosses a conduit and the clearance is less than 12 inches, the sewer line should be jacketed with reinforced concrete for a distance of 5 feet (inside diameter plus 5 feet if conduit is over 24 inches inside diameter). Where the clearance is greater than one foot but less than 2 feet, a plain concrete jacket may be used. Final determination of structural requirement will be made by the City.

27.3 Other Imposed Loads: Consideration shall be given to all imposed loads (vehicles, retaining walls, drainage structures, etc.) on the pipes.

27.4 Pipe Cradles: All sewer pipes shall be supported by crushed rock cradles. However, as an alternate, the pipes may be supported by plain concrete cradles, reinforced concrete cradles, reinforced concrete cradles on piles or other approved means. S4C pipe

cradle seals shall be installed 10 feet from all manholes to prevent soil migration.

Where unstable soil conditions exist, the underlying unstable soils shall be replaced with crushed rock. The determination of the depth of unstable soils to be removed shall be made by the design engineer and approved by the City. If an agreement cannot be reached, the design engineer shall engage, at his cost, the services of a registered professional engineer qualified in soil mechanics for recommendations.

Geotextile fabric to envelop the pipe cradle and select backfill material shall be provided where water or unstable soil conditions are encountered.

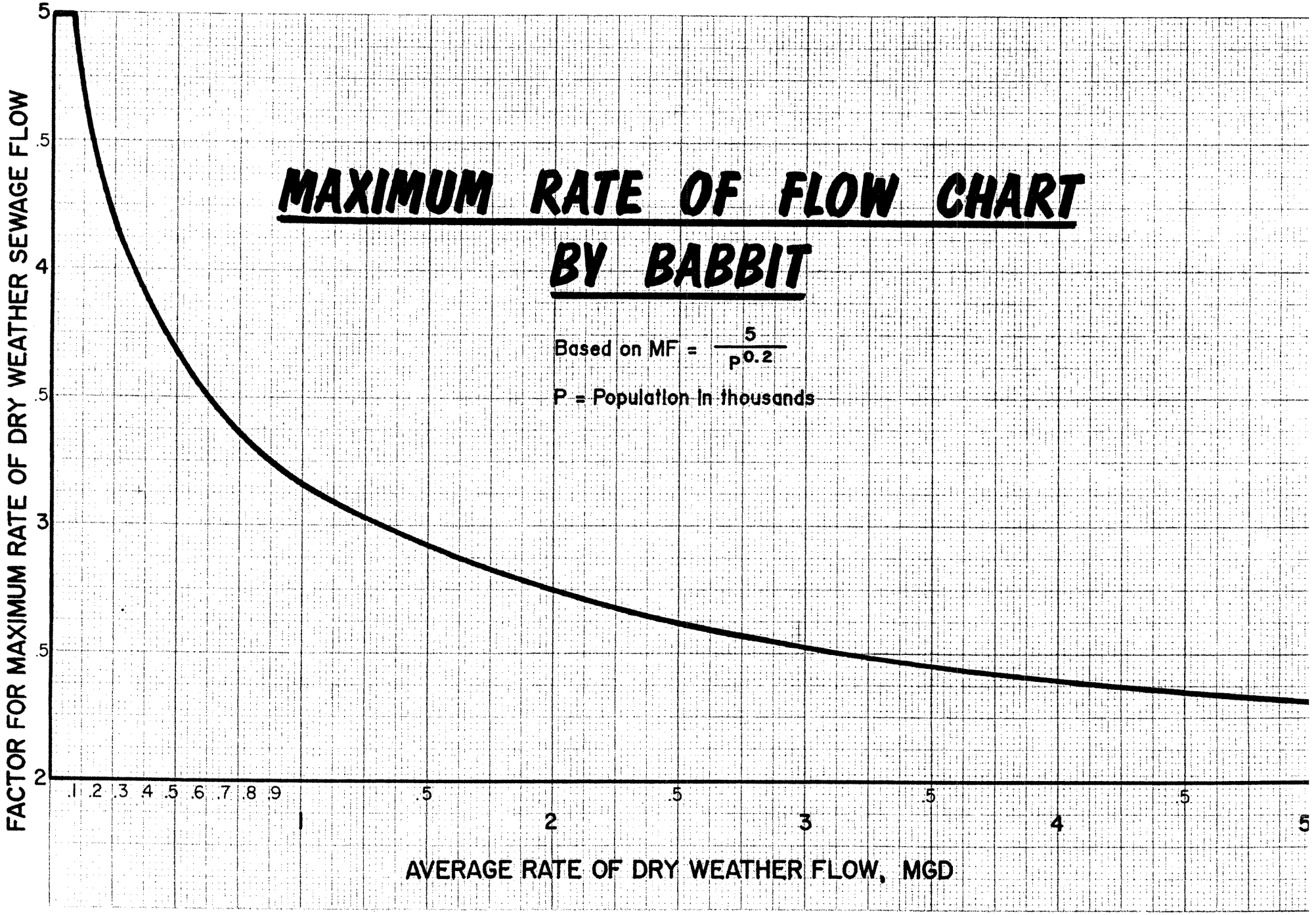

MAXIMUM RATE OF FLOW CHART
BY BABBIT
Based on MF = 5 / P^0.2
P = Population in thousands
FACTOR FOR MAXIMUM RATE OF DRY WEATHER SEWAGE FLOW
5
.5
4
.5
3
.5
2
.1 .2 .3 .4 .5 .6 .7 .8 .9
1
.5
2
.5
3
.5
4
.5
5
AVERAGE RATE OF DRY WEATHER FLOW, MGD

FIG. 22.2.4

PW-WM-174 (11/83)

COMPUTATION OF WASTEWATER FLOW

SEWER:

DISTRICT:

REFERENCE MAPS:

PAGE:

COMPUTED BY:

DATE:

SEWER LOCATION		TRIBUTARY AREA (ACRES)		TRIBUTARY EQUIVALENT POPULATION						WASTEWATER FLOW COMPUTATION								( )EXISTING ( )ULTIMATE SEWER STUDY			
				RESIDENTIAL		OTHER		TOTAL													
DISTRICT ZONE OR STREET	POINT	INCREMENT	TOTAL	INCREMENT	TOTAL	INCREMENT	TOTAL	INCREMENT	TOTAL	AVERAGE WASTEWATER FLOW @ ____ GPCD (MGD)	MAX FLOW FACTOR	MAX FLOW (MGD)	DRY WEATHER INFIL./INFLOW @ ____ GPCD (MGD)	DESIGN AVE. FLOW (MGD)	DESIGN MAX. FLOW (MGD)	WET WEATHER INFIL./INFLOW @ ____ GPAD (MGD)	DESIGN PEAK FLOW (MGD)	PIPE DIAMETER (IN)	SLOPE (%)	VELOCITY (FPS)	CAPACITY (MGD)

REMARKS:

Figure 22.2.10

CHAPTER 30

DESIGN OF WASTEWATER PUMP STATIONS

31. Factors to be Considered

31.1 Type of Station:

31.1.1 Built-In-Place Wastewater Pump Station: Except as noted in Section 31.1.2, all pump stations shall be built-in-place and shall be of the dry well type.

31.1.2 Factory-Built Wastewater Pump Station: Factory-built pump stations are acceptable for temporary use under the following conditions:

a. Equipped with State Division of Occupational Safety & Health (HIDOSH) certified elevator for access and auxiliary ladder for emergency use.

b. The size of the enclosure shall be 8 feet minimum diameter. Access tube shall be 4 feet minimum diameter.

c. The size of the pumps shall not exceed 6 inches.

d. The pump motor shall be of a totally enclosed design conforming to NEMA standards. Motor frame size should not be larger than NEMA 326 U.

e. The number of pumps installed shall be two, one of which is a standby unit.

f. The pumps and motors should be pedestal mounted, close-coupled, or submersible (dry pit).

g. The design of the station, equipment and appurtenances provided shall meet all applicable portions of these standards.

h. Stations shall be properly protected against corrosion by protective coatings and cathodic protection as applicable.

i. Adequate ventilation shall be provided.

j. Flow measurement device shall be provided.

31.2 Wastewater Flows and Design Capacity:

31.2.1 Wastewater Flows: Wastewater flows shall be determined in accordance with Section 22.

31.2.2 Design Capacity: Wastewater pump stations shall be designed to discharge peak flows.

31.3 Location: Wastewater pump stations shall be located where tributary areas will be most effectively serviced and where development, construction, and operational costs would be at a minimum. Pump stations should not be subject to flooding and shall be readily accessible. Wastewater pump station sites should be located near a stream or body of water.

Wastewater pump station sites shall be adequate to allow on-site parking of service trucks and equipment and to buffer adjoining properties from noise. Future modification and expansion requirements shall be given consideration.

32. Site Improvements

32.1 Grading: Wastewater pump stations shall be properly graded and provided with adequate drainage facilities to carry away storm waters. Adjacent properties shall not be jeopardized by such provisions.

32.2 Driveways and Parking Areas: Paved driveways and parking areas shall be provided for service trucks. Width of driveways should be 12 feet minimum. Pavement shall be of asphaltic concrete or Portland cement concrete. Concrete curbs shall be required for all pump stations. Entrance gates should be set inward, toward the station, at least 18-feet to provide safety for trucks entering or leaving the station.

32.3 Fencing: Pump station sites should be fenced in with a 6 feet high fence or wall. If requirements of Section 33.1 or the Comprehensive Zoning Code (CZC) dictates, masonry walls or other approved types of enclosures may be provided.

Where chain link fences are used, the wire fabric shall be 9 gauge minimum. In suspected corrosive areas corrosion protection or additional thickness shall be provided.

In isolated areas, three strands of barbed wire should be installed along the top of the fence on an arm projecting inward at an angle of 45 degrees.

Gates shall be provided with heavy duty padlock hasp fixture and shall be designed for safe opening and closing during strong winds. At facilities where HECO transformers are installed within the station's perimeter, the hasp shall be designed to accommodate two padlocks. This design will allow access with either padlock removed.

A minimum 1 foot wide gravel strip shall be provided under fencing. Gravel strip shall be contained with redwood or other approved durable material headers.

32.4 Landscaping: Sites shall be landscaped to blend with the surrounding environment to render a pleasing overall appearance. Consideration shall be made to minimize groundskeeping maintenance. Trees may be allowed within the facility's perimeter. However, root intrusion problems shall be considered. Chain link fencing shall be screened with landscaping to conform to the Land Use Ordinance.

In lieu of grass for ground landscaping, crushed rock such as coral chips, red cinder stone or blue stone shall be considered.

32.5 Sprinkler System: Adequate automatic sprinkler systems shall be installed for lawn/foliage irrigation.

For pump stations not located on treatment plant sites and landscaped with rock, cinder or coral aggregate, the sprinkler system may be a manually operated system. Sprinkler systems for this type of landscaping shall be designed to irrigate the plants and foliage only.

33. Structure and Appurtenances

33.1 Architectural Design: Wastewater pump stations shall be architecturally designed to be in harmony with surrounding development. Materials shall be selected to keep construction and maintenance cost at a practical level. As much as possible, non-corrosive materials shall be used. All architectural design shall be prepared by a registered architect.

33.2 Substructure: Built-in-place pump station substructures shall be reinforced concrete construction. All substructures shall be waterproof and watertight. Test borings shall be made to determine the soil characteristics and groundwater conditions at all pump station sites and foundations shall be suitably designed. Consideration shall be given to flotation during construction and/or flooding condition.

33.2.1 Dry Wells: Dry wells shall be sized to meet space requirements for equipment, piping and ease of maintenance. Adequate working space, at least 2 feet clear, shall be provided between and around pumps and other equipment. Provide 3 feet clearance for electrical equipment to comply with the National Electrical Code. Space and provisions for planned future pumps and equipment shall also be provided.

33.2.2 Wet Wells: Wet wells shall be designed on the basis of minimizing deposits of solids, preventing wastewater from becoming septic, and avoiding frequent starting of pumps. Minimum pump cycle (period from start to start) for any one pump shall be 5 minutes. Maximum retention time of wastewater in wet wells shall be 30 minutes at average flow (when computing retention time, total volume of wastewater in wet well shall be considered).

Wet wells shall have a minimum inside width of 5 feet and should be sized to keep the wastewater levels within the following limits:

a. High water level: Desired - invert of incoming sewer. Maximum - crown of incoming sewer.

b. Low water level: Not lower than top of pump casing.

c. Vertical distance between pump start and stop levels: 6 inches minimum.

Floors shall have a slope of 1:1 minimum, sloping towards a hopper bottom. The hopper bottom shall be designed for proper installation and function of pump suction inlets.

Influent lines shall be designed without vertical drops into the wet well to minimize release of entrained air/gases.

The wet well shall be divided into two or more sections, properly interconnected, to facilitate repairs and cleaning.

Wet wells shall have a PVC lining to protect against hydrogen sulfide corrosion unless corrosion is not expected.

33.2.3 Access: Reinforced concrete or structural steel stairways shall be provided for access to dry wells. Stairways shall have a clear passage of at least 30 inches. Stairs shall be provided with permanent non-slip treading. Factory-built stations shall be provided with man-lift elevators for primary access and a fixed ladder for backup use.

Access shall be provided to all wet well compartments by means of manholes and 316 stainless steel or other approved ladder rungs. Access manholes shall be located where they can best facilitate maintenance operations.

33.2.4 Ventilation: Dry well shall be ventilated by a mechanical air exhaust system providing at least one air change every 3 minutes. Outlets of exhaust system should not be located less than 12 feet from any opening except when exhausting through the roof. Ventilation exhaust shall be located downwind of any inlet openings. Velocity in air ducts shall not exceed 1500 fpm. When required fan capacity is large, the use of two fans should be considered.

Switches for the operation of the ventilation equipment shall be interlocked with the dry well light switch.

Ventilation shafts shall be provided for wet well compartments with only one access opening.

33.2.5 Drainage: Dry well floors shall be constructed to drain by gravity into trench drains channeled to a sump. The sump pump shall be a submersible unit.

Minimum sump pump capacity shall be 25 gpm with exception of stations equipped with water seal systems, hydraulic operated cone-check valves, or similar type equipment. These stations shall be provided with duplex submersible pumps, each capable of pumping at least 50 gpm. A switch for lead/lag operations shall be provided at the MCC.

Sump pump discharge shall enter the wet well adjacent to and as high as possible to the ground floor level. For pump stations with capacities greater than 20 mgd, sump discharge shall enter into both wet well compartments with valves for isolating flows.

Trench drains should be covered with corrosion resistant gratings. Floor framing for gratings, including their anchoring devices shall be 316L stainless steel.

33.3 Superstructure: Except for factory-built stations, all pump stations shall have a superstructure.

33.3.1 Floor Elevation and Area: Ground level floors shall be a minimum of 1 foot above the regulatory flood level of the area immediately adjacent to the pump station. The latest flood zone map shall be consulted. Floor areas shall be adequate for mechanical equipment, electrical equipment and controls, sanitary facilities, storage, and future expansion. Adequate working space, at least 2 feet clear, shall be provided between and around all equipment. Provide 3 feet clearance for electrical equipment to comply with the National Electrical Code.

33.3.2 Height: Height of superstructure shall provide adequate working height. Whenever possible, height of superstructures shall be adequate to permit the removal of motor rotor from its stator or the removal of other equipment of larger size with the installed hoisting equipment.

33.3.3 Materials of Construction: The following materials are acceptable for construction of superstructures:

a. Beams and Columns - reinforced concrete or structural steel.

b. Roof - reinforced concrete.

c. Wall - masonry or reinforced concrete.

Other materials may be considered if requirements of Section 33.1 dictates.

33.3.4 Insect Screens: All openings in the structure for ventilation or light, except doorways, shall be equipped with removable stainless steel insect screens.

33.3.5 Doors: Doors shall be of adequate size to permit removal of pumps, motors, and other equipment.

Locks shall be able to be keyed to the Department of Wastewater Management master key.

33.3.6 Roofing: Unless otherwise approved, roofing shall be 15 pound asphalt felt built-up roofing. Roofing shall be a minimum of 5-ply for permanent installations and 3-ply for temporary installations. Flashing shall be copper.

33.3.7 Railings and Stairways: Railings and stairways shall conform to HIOSH regulations and City Building Codes.

33.3.8 Outdoor Enclosures: Gages, meters, and control devices installed outdoors shall be mounted within weather protected enclosures. Gages integral of other devices such as bearing thermometer on motors are excepted. HECO meter shall be located to permit easy viewing by HECO.

33.4 Provision for Equipment Removal: Provisions shall be made to facilitate removing pumps and other equipment for repair and maintenance.

33.4.1 Openings: Openings shall be provided in ground and intermediate level floors of pump stations.

Ground level floor openings shall be covered with removable gratings and provided with removable pipe posts and guard chains around its periphery. Stationary posts with removable pipe railing sections shall be provided around intermediate floor openings. All openings shall be provided with portable peripheral curbing and shall be large enough to provide ample room to install or remove pumps and other equipment.

33.4.2 Hoists: Built-in-place pump stations shall be equipped with trolley type hoists traveling on steel beams or traveling bridge cranes.

Traveling bridge cranes shall be provided for installations equipped with 6 mgd pumps and larger. Bridge cranes shall be electrically controlled.

Hoists for station with a vertical lift of 25 feet or more (pump room floor to top floor) shall be electrically powered. Plug-in type hoists operating on single phase 120 volts may be allowed for small stations.

33.4.3 Eye Bolts: Eye bolts for block and tackle type hoist shall be provided over pumps, valves, header piping, and other locations to facilitate maintenance operations and equipment removal. The load rating of each eyebolt shall be shown on the plans.

33.4.4 Headroom: Sufficient headroom, including room for lifting device, shall be provided to allow pump rotating element to be removed without disturbing the pump volute.

33.5 Station Facilities:

33.5.1 Sanitary Fixtures and Accessories:

a. Built-in-place pump stations shall be provided with the following minimum sanitary fixtures and accessories:

1. Service sink - acid resisting, white enameled, cast iron body, stainless steel rim.

2. Water closet - vitreous china, wall hung, close-coupled closet combination with open front, black closet seat without cover.

3. Paper towel dispenser - chromium plated.

4. Toilet paper holder - chromium plated.

5. Paper toilet seat cover dispenser - chromium plated.

6. Soap dish - chromium plated.

7. Waste paper basket - plastic or noncorrosive material.

8. Wall mirror - approximately 12 in. x 24 in.

9. Small storage cabinet for janitorial supplies - approximately 12 in. wide, 18 in. high, and 8 in. deep.

b. Factory-built stations located in isolated areas shall be provided with the minimum fixtures and accessories listed in the preceding paragraph and housed in a suitable structure.

c. Whenever required by the City, additional sanitary fixtures and accessories shall be provided as follows:

1. Lavatory (vitreous china) for pump stations of capacities greater than 20 mgd.

2. Shower for pump stations of capacities greater than 20 mgd and also for pump stations in isolated areas. Shower shall be equipped with soap holder-grab bar combination and curtain rod. A minimum of 6 lockers and a 30 gallon hot water heater with timer shall be provided where showers are installed.

d. Plumbing code: Plumbing shall conform to the requirements of the State Department of Health and to the Plumbing Code of the City and County of Honolulu.

33.5.2 Light Fixtures and Receptacles:

a. Light fixtures: Light fixtures shall be provided to supply adequate illumination within pump stations and shall be mounted where relamping can be accomplished with reasonable ease. Light fixtures shall also be installed next to exterior doors on the outside and around the perimeter of the building with at least one light over the wet well cover manholes. Wet wells shall not require light fixtures. In general, light fixtures below ground level shall be vaportight fixtures. Fluorescent fixtures using 48 inch T-8 type tubes are preferred. High pressure sodium fixtures

shall be used if appropriate.

b. Night lights: Night lights shall be provided above all building entrances and equipped with lamp shades to prevent glare beyond the perimeter fence line. Consideration shall be made for a night light at the perimeter entrance gate. Night lights shall be automatically controlled by photocells.

c. Emergency lights: Battery-powered emergency lights shall be provided at all floor levels of the pump station and emergency generator location or building. Emergency lights shall be connected to the normal service via a receptacle, mounted adjacent to the emergency light.

d. Receptacles: Weather-proof receptacles shall be installed at all floor levels of pump station and outside the building, adjacent to the wetwell.

e. Electrical code: Electrical system shall conform to the National Electric Code, the Building Code of the City and County of Honolulu, and the Flood Hazard Ordinance of the City and County of Honolulu.

33.5.3 Telephone: Telephone terminal cabinet and touch tone instrument shall be provided unless waived by the City.

33.5.4 Miscellaneous Equipment: All pump stations shall be equipped with the following:

a. Fire extinguishers: Fifteen lbs. CO_2 for MCC room and generator area. Ten lbs. dry chemical for lower floors. All fire extinguishers shall be wall mounted.

b. First aid kit meeting City standards.

c. Eight inch electric clock.

d. Plastic trash receptacle, thirty gallons capacity with cover.

e. Desk and chair.

f. Storage cabinet for flammable materials.

g. Legal size drawer file cabinet with lock.

34. Pumps, Motors, and Controls

34.1 Sewage Pumps and Motors:

34.1.1 General: Major pump stations, except factory-built WWPS, shall be equipped with a minimum of three pumps. After evaluation, smaller pump stations may be equipped with two pumps. Pumps shall be capable of operating over the range of flows without excessive cycling and without long retention time (Section 33.2.2).

Variable speed drives shall be utilized for wastewater treatment plant influent pump stations and whenever conditions such as long retention periods or short pumping cycles cannot be avoided. Dual speed motors may be considered where appropriate.

All pump stations shall be equipped with a standby pump equal in capacity to the largest of the main pumping units. The main pumping units shall be capable of handling the station's peak flow without the use of the standby unit.

Pumps shall be capable of passing spheres of at least 2½ inches and shall have a minimum discharge opening of 4 inches in diameter. Speed of pumps shall not exceed 1200 rpm.

Pumps shall be capable of safely rotating in reverse direction at full runaway speed without damage to appurtenances under the shutoff head of the units. The brake horsepower required at full motor speed at any head along the curve shall not exceed the rated horsepower of the motors.

34.1.2 System Head-Capacity Curves: Pumps should be selected so that the head-capacity characteristics correspond as nearly as possible to the overall station requirements.

This should be accomplished by the preparation of the system head-capacity curves showing all conditions of head and capacity under which the pumps will be required to operate. The system head-capacity curves should be developed using standard hydraulic methods for determining friction losses to show the minimum and maximum head losses that can be expected. The equivalent length method using the Hazen-Williams formula is preferred.

34.1.2 (Con't.) Minimum and maximum head losses should be determined using "C" values of 150 (new PVC or polyethylene pipe), 140 (other new pipe), 120 (aged PVC or polyethylene pipe) and 100 (other aged pipe), or as appropriate.

The system head-capacity curves should consist of the following:

a. System curves: Curves showing total dynamic losses in the force main at varying pumping rates for minimum and maximum static heads.

b. Individual pump characteristic curves:

Curves furnished by pump manufacturer showing pump's head-capacity characteristics. Curves at minimum and maximum anticipated speeds shall be furnished for variable speed pumps.

c. Modified pump curves: Curves showing pump's head-capacity characteristics at the station header, obtained by deducting friction losses in the suction and discharge piping of each individual pump from their characteristic curves at corresponding pumping rates.

d. Combined modified curves: Curves showing multiple pump operation, obtained by adding capacities at points of equal heads on the modified pump curves.

e. NPSH Curves: Curves showing the available system net positive suction head (NPSHA) and the pump's required net positive suction head (NPSHR) shall also be evaluated to minimize the occurrence of cavitation. The NPSHA and NPSHR curves shall include the operating conditions of minimum static suction head and maximum frictional loss (C=100) over the entire operating range of each pump. For variable speed pumps where operation of a single pump at the maximum speed will result in cavitation, NPSHA and NPSHR curves shall also be evaluated at the highest variable speed that the pump will experience when it is operated alone or when operated simultaneously with other pumps.

Figure 34.1.2 illustrates a set of system head-capacity curves. The intersection of the modified pump curves and combined modified curves with the system curves shows the station capacity for the several conditions of operation. Pumps should be selected and rated so that the maximum station pumping capacity available (at maximum wet well Figure 34.1.2 level and C=100) equals or exceeds the anticipated peak flow into the station. Pumps should also be rated at the minimum heads at which each is expected to operate. Minimum shutoff heads should be specified. Pumps should have their maximum overall efficiency at or near the rated capacity and head and should operate with reasonable efficiency over their operating ranges.

34.1.3 Types of Pumps: All pumps shall be vertical units. Motors for stations with pump capacities greater than 2 mgd shall be installed on the ground level floor and connected to pumps with removable driveshafts, intermediate driveshafts, and equipped with removable and adjustable flexible couplings.

For pumps of less than 2 mgd capacity, submersible pumps may be used for dry pit installation. Consideration for pump on/off cycling shall be made to avoid high motor temperature.

Motors for stations with pump capacities less than 2 mgd may be pedestal mounted. Vertical, close-coupled units may be used for temporary pump stations.

34.1.4 Pump Construction:

a. Dry Pit Pump

1. Handholes shall be provided on the periphery of pump casings and suction elbows for purposes of inspection and removal of obstructions. Handhole covers shall be flanged and secured to bossed sections and shall have interior surfaces formed to match interior surfaces of casting to which attached. Pump casing handhole should be located so that visual inspection can be made of the discharge end as well as the volute. Handholes should be a minimum of 4 inches or about half

34.1.4 (Con't.) of the pump size.

2. Pumps shall have flanged suction and discharge nozzles, faced and drilled to conform to ANSI Class 125 lb. standard. Pumps of sizes greater than 5 inches shall be furnished with suction elbows that are separate and not integrally cast with any other part of the pump. Suction elbows shall be designed to prevent cavitation. Guide vanes shall not be used in suction nozzles.

3. Pumps of sizes greater than 5 inches shall be provided with either fabricated structural steel supports or cast iron ribbed supports. Cast iron supports shall be integrally cast with the pump casing or suction nozzle.

4. Base plates or sole plates shall be provided. Plates shall be anchored by stainless steel bolts with stainless steel lock washers and grouted to reinforced concrete pedestals. Hardened steel jacking screws for leveling and for aligning of pumps should be provided. Mating surfaces shall be machined and all holes shall be drilled and shall not be burned.

5. Intermediate drive shaft sections should be not more than 12 feet in length. Where more than one drive shaft is required, self-aligning steady bearings shall be provided at each intermediate location. Bearings shall be equipped with mechanism to allow alignment adjustments. Bearing and shaft guards shall be provided. Safe access to bearing and guards shall be provided. Grease fittings shall be equipped with extension tubing to facilitate lubrication.

6. Drain and air release lines shall be provided for all pumps. Drain lines shall be installed at the packing drip reservoir and at the center line of the suction pipe. Air release line shall be installed at high point of pump casings. Connecting points shall

34.1.4 (Con't.) be bossed, drilled, and tapped. Minimum size shall be ½ inch. Air release lines from pump to the first valve shall be brass. Provisions shall be made for a sampling tap for wastewater unless waived by the City.

7. Other features of pumps shall be as follows:

a). Bearing housing - of single cast piece or fabricated structural steel.

b). Bearings - not less than two.

c). Shaft sleeve - replaceable stainless steel sleeve, from the outside end of the seal gland to the impeller, and set screwed to the drive shaft.

d). Sealing gland - double mechanical seal with suitable fluid sealing/lubrication system.

e). Casing and impeller wearing rings - stainless steel and "Z" or "L" shaped.

f). Suction plate - separate from suction elbow (pumps 5 inches and smaller may be excepted).

g). Taper pins and jacking screws - on all machined joints and handholes.

h). Eyebolts or other provisions for lifting - on volute and bearing housing.

i). Impeller locknut - with smooth surface, no sharp corners and edges, and easily removable and replaceable.

j). Seals - on both the upper and lower sections of the bearing housing.

k). Tapered shaft - tapered for the full length of fit and keyed to the impeller. Exception may be

34.1.4 (Con't.) made for 4 inch pumps.

8. Stock bronze fitted pumps with cast iron casings and bronze impellers are permitted for temporary installations. Impeller rings and shaft sleeve shall be bronze.

b. Submersible Pump

1. Handholes shall be provided on the periphery of pump casings and suction elbows for purposes of inspection and removal of obstructions. Handhole covers shall be flanged and secured to bossed sections and shall have interior surfaces formed to match interior surfaces of casting to which attached. Pump casing handhole should be located so that visual inspection can be made of the discharge end as well as the volute. Handholes should be a minimum of 4 inches or about half of the pump size.

2. Pumps shall have flanged suction and discharge nozzles, faced and drilled to conform to ANSI Class 125 lb. standard. Pumps of sizes greater than 5 inches shall be furnished with suction elbows that are separate and not integrally cast with any other part of the pump. Suction elbows shall be designed to prevent cavitation. Guide vanes shall not be used in suction nozzles.

3. Base plates or sole plates shall be provided. Plates shall be anchored by stainless steel bolts with stainless steel lock washers and grouted to reinforced concrete pedestals. Hardened steel jacking screws for leveling and for aligning of pumps should be provided. Mating surfaces shall be machined and all holes shall be drilled and shall not be burned.

4. Drain and air release lines shall be provided for all pumps. Drain lines shall be installed at the center line of the suction pipe. Air release line shall be installed at high point of pump casings. Connecting points shall

34.1.4 (Con't.) be bossed, drilled, and tapped. Minimum size shall be ½ inch. Air release lines from pump to the first valve shall be brass. Provisions shall be made for a sampling tap for wastewater unless waived by the City.

5. Other features of pumps shall be as follows:

a). Pump shaft shall be stainless steel.

b). Bearings - not less than two, sealed, and grease lubricated.

c). Seal - tandem, double mechanical seal running in an oil reservoir. It shall be composed of two separate lapped-face seals, each consisting of one stationary and one rotating tungsten-carbide ring; with each pair held in contact by a separate springs. The compression spring shall be protected against exposure to the pump liquid.

d). Casing and impeller wearing rings - stainless steel and "Z" or "L" shaped.

e). Suction plate - separate from suction elbow (pumps 5 inches and smaller may be excepted).

f). Taper pins and jacking screws - on all machined joints and handholes.

g). Eyebolts or other provisions for lifting - on volute and bearing housing.

h). Impeller locknut - with smooth surface, no sharp corners and edges, and easily removable and replaceable.

i). Tapered shaft - tapered for the full length of fit and keyed to the impeller. Exception may be made for 4 inch pumps.

j). Sensors, indicators, and alarm - provide the following:
High temperature - sensor, indicator, and alarm
Vibration - sensor or alarm
Seal leakage - sensor or alarm

34.1.5 Motor Construction:

a. Dry Pit Motor

1. Motors shall conform to the latest standards of the NEMA and the IEEE. Motors shall have ample capacity to operate the pumps under all head and discharge conditions without overloading. Starting current taken by the motors shall not exceed the values as regulated by the Hawaiian Electric Company or as permitted by the emergency generator. Motors shall be capable of safely rotating in the reverse direction at runaway speed without damage to appurtenances under shutoff head. Motors shall operate pumps through flexible shafts and couplings. Vertical shaft motors mounted on floors shall be furnished with rugged cast iron or steel foundation rings. Motors shall be induction type, drip proof, and suitable for operation from 230/460 volts, 3 phase, 60 cycle A.C. power systems. Motors shall have a service factor of 1.15. All pump motors shall have running time meters installed at the starter. All pump motors above 20 HP shall have an ammeter installed at the starter.

Dry pit sump pump motor shall have running time meters installed at the starter.

2. Motors 100 HP or larger shall be provided with oil lubrication. Smaller sized motors shall be grease lubricated. Motors 7½ HP or larger shall be provided with space heaters. Variable speed motors shall be provided with a RPM measuring device with a 4 to 20 milliamp output and a panel mounted digital RPM indicator.

b. Submersible Motor

1. Motors shall conform to the latest standards of the NEMA and the IEEE. Motors shall have ample capacity to operate the pumps under all head and discharge conditions without overloading. Starting current taken by the motors shall not exceed the values as regulated by the Hawaiian Electric Company or as permitted by the emergency generator. Motors shall be capable of safely rotating in the reverse direction at runaway speed without damage to appurtenances under shutoff head. Motors shall be suitable for operation from 230/460 volts, 3 phase, 60 cycle A.C. power systems. Motors shall have a service factor of 1.15. All pump motors shall have running time meters installed at the starter. All pump motors above 20 HP shall have an ammeter installed at the starter. The motor power wiring shall be brought up directly to the level of the MCC.

2. Pump motors shall be housed in a watertight casing and shall have moisture resistant insulated windings. Pump motors shall have cooling characteristics suitable to permit continuous operation in a non-submerged condition.

34.1.6 Indicating Pressure Gauges: Indicating pressure gauges shall be provided at discharge nozzle and suction plate of pumps. Indication shall be in feet. Isolation valves and stainless steel diaphragm seals shall be provided at gauges.

34.1.7 Testing: All wastewater pumps shall be factory tested in accordance with the ASME Power Test Codes or the Standards of the Hydraulic Institute. Five (5) certified copies of the pump curves and data shall be furnished with each pump requiring drive motors 40 HP or smaller. For pumps requiring drive motors greater than 40 HP, a witness shop test shall be required and five (5) certified copies of the pump curves, data and report shall be furnished with each pump. Each pump casing shall be tested under a

hydrostatic pressure of not less than 60 psi. All impellers, including spares, shall be statically and dynamically balanced.

All electric motors shall be tested by the motor manufacturer. Routine tests are required for motors rated at 40 HP or less and Witnessed Complete Tests shall be required for motors larger than 40 HP. Five (5) copies of the certified or witnessed test data shall be furnished for each motor.

All pumps shall be field tested to demonstrate satisfactory operations.

34.1.8 Spare Parts: All installations shall be furnished with the following minimum spare parts:

a. For each pump:

1. One set renewable sleeve for the pump shaft.

2. One set of gaskets for all pump casing joints.

3. One set of wearing rings, complete, for both pump casing and impeller.

4. All parts recommended in the manufacturer's O & M manual.

b. In addition to the above, provide for each different size pump:

1. One complete pump, including suction plate.

2. One set of each type of bearing used in the pump and shafting.

3. One packing gland complete with rings, nuts, bolts, and one box of coil packing (if applicable).

4. One mechanical seal assembly (if applicable).

c. For submersible pump:

1. One complete pump unit with stand.

d. For motor:

1. One set bearings, complete for each size of motor 30 HP or larger.

2. One set space heaters for each size of motor.

3. One set brushes for each wound rotor motor.

4. One brush holder assembly (for each size of wound rotor motor).

e. For generator:

1. All parts recommended in the manufacturer's O & M manual.

2. One circuit board for the voltage regulator.

f. For ventilation fan:

1. One set fan drive belts.

34.2 Starters and Controls:

34.2.1 Liquid Level Controls: The operation of wastewater pump motors shall be automatically controlled by liquid level sensing devices, actuated by wastewater level fluctuations in the wet well. Float type, pneumatic type, or a combination of float and pneumatic type device should be provided. Automatic control settings shall be manually adjustable.

Duplicate control units shall be provided for all pump stations equipped with split wetwell chambers. Controlling devices should also be capable of alternating the lead pump and setting off high and low level alarm. The operating range of controlling devices shall conform with the requirements of Section 33.2.2.

34.2.2 Selector Switches: HAND-OFF-AUTO selector switches shall be provided to operate pumps. Selector switches shall be located at the motor control center and watertight switches

next to pumps. Both selector switch settings must be the same in order for the pump to operate (Example: HAND-HAND or AUTO-AUTO).

Automatic and manual control for variable speed pumps shall be capable of being adjusted over the effective speed range.

34.2.3 Starters: Unless otherwise restricted by the Hawaiian Electric Company starters shall be of the combination, magnetic, across-the-line type. Reduced voltage starters shall be of the auto-transformer type.

34.2.4 Control Centers: Starters shall be mounted and wired as an integral part of free standing, unitized, enclosed control centers.

Control centers shall be designed and constructed in accordance with the latest standards of the NEMA and the IEEE. Starters for temporary installations may be surface mounted.

Control center cabinets shall be installed to permit full opening of doors without interference from adjoining cabinets, walls or other equipment. Split hinge doors may be used to prevent opening interference.

All major components of control centers shall be by one manufacturer. If more than one control center is to be installed it should preferably be of the same type and manufacturer. The manufacturer must have a qualified electrical service engineer permanently assigned and residing in the State of Hawaii. All panel units, devices, indicating lights, and instrumentation shall be identified by engraved nameplates or metal collars.

34.2.5 Indicating Lights and Elapsed Time Meters:

Appropriate indicating lights and elapsed time meters should be installed for each starter. The running time meters shall be non-resetting, digital display, including a one-tenth hour feature. Indicating lights should be of the push-to-test type or light emitting diode (LED).

34.3 Instrumentation and SCADA System:

34.3.1 Pump stations should be provided with instrumentation and SCADA systems with the following:

a. Telemeter:

1. Discharge flow.

2. Discharge pressure.

3. Wet well level.

b. Report-back of operational status:

1. Sewage pumps.

2. Sump pumps.

3. Emergency generator.

4. Other items of importance to operations.

c. Alarms:

1. Normal power source failure.

2. Alternate power source failure.

3. Generator operating.

4. Main buss power failure.

5. Low level in wet well.

6. High level in wet well.

7. High level in pump room sump.

8. Other equipment failures which could endanger pump station operations.

9. Building intrusion.

34.3.2 When conditions dictate that installations be remotely controlled from supervisory stations, the following additional functions should be provided:

a. Report-back:

1. Operational status of each pump (running or not running).

2. Operational status of any other item of importance to remote control operations.

b. Supervisory remote controls:

1. Start and stop pumps.

2. Other control functions of importance to remote control operations.

c. Alarms:

1. Warning of transfer to supervisory remote control operations.

2. Other alarms of importance to remote control operations.

34.3.3 All readings, alarms, and indications, shall be relayed to supervisory stations designated by the Department of Wastewater Management.

34.3.4 Instrumentation systems should be provided by one supplier with field and shop maintenance facilities and full time local service engineers.

34.3.5 Flow Meters:

a. Flow meter receiving instruments at the pump station shall be capable of totalizing, indicating, and recording flows.

b. Recorder shall be electronic type with a month duration, 4-inch wide strip chart and a visible face of approximately 4 inches.

c. Indicator shall be 4 inches long or shall be digital with approximately one inch high numerals.

d. Flow meter pressure differential producers shall be of the standard venturi type. Insert type differential producers or Dall tubes shall not be permitted.

e. Magnetic flow meters may not be used.

34.3.6 Level Meters:

a. Wet well level meter receiving instruments at the pump station shall be capable of indicating and recording wet well levels.

b. Recorder shall be electronic type with a month duration, 4-inch wide strip chart and a visible face of approximately 4 inches.

c. Indicator shall be 4 inches long or shall be digital with approximately one inch high numerals.

d. Fuel level (inventory) meter shall be installed in the generator room for diesel fuel tank systems.

34.3.7 Pressure Meters:

a. Force main pressure meter receiving instruments at the pump station shall be capable of indicating and recording pressure.

b. Recorder shall be electronic type with a month duration, 4-inch wide strip chart and a visible face of approximately 4 inches.

c. Indicator shall be 4 inches long or shall be digital with approximately one inch high numerals.

d. Single recorder with three inputs may be used.

34.3.8 Strain Gauge Sensors: Strain gauge sensors should not be used unless absolutely necessary.

34.3.9 Instrumentation Panels: All pertinent receiving instruments, devices, alarms, indicating lights, and remote controls shall be mounted on centralized instrument panels. All items shall be identified with engraved nameplates. Electrical power to the panel and all instruments shall be through an uninterruptible power supply unit.

34.3.10 Indicating Lights: Appropriate indicating lights shall be provided to show the status of equipment operation, alarms, controls, etc.

Indicating lights shall be of the push-to-test type or light emitting diodes (LED).

34.3.11 Amperage Meter: An analog ammeter shall be provided for each sewage pump motor.

35. Piping, Including Valves

35.1 Wastewater Pump Piping:

35.1.1 Discharge and header (manifold) piping for wastewater pumps shall be not less than 4 inches in diameter. Suction piping shall be not less than 6 inches in diameter.

35.1.2 Velocities in wastewater pump piping shall be as follows:

a.	Suction from wet well	5 fps (desirable max.) 6 fps (absolute max.)
b.	Discharge to header	7 fps (desirable max.) 8 fps (absolute max.)
c.	Header (Manifold)	6 fps (desirable max.) 7 fps (absolute max.) 2 fps (desirable min.) 1.5 fps (absolute min.)
d.	Discharge risers	3 fps (absolute min.)

35.1.3 Pipe and fittings shall be cast iron or ductile iron, cement lined and coated on the inside. Cast iron pipes shall be Class 150 and fittings ANSI Class 250. Ductile iron pipe shall be Class 52 minimum. Buried pipe and fittings shall be protected on the outside with an approved corrosion protection coating and cathodic protection. Zinc chromate primer shall be used on the outside for exposed piping to be painted with enamel. In general, joints shall be flanged with flanges faced and drilled to conform to ANSI Class 125 lb. standard with full face gaskets. Adequate braces and supports shall be provided for piping to assure that no undue strains are induced.

35.1.4 Piping shall be arranged so that all pumps discharge into a common header. In permanent pump stations, discharge lines shall not enter headers perpendicularly. Base bends, properly supported on concrete pedestals, shall be provided at the bottom of vertical risers. Headers shall be properly blocked to resist water hammer.

35.1.5 Suction lines shall have turned-down bellmouth inlets. Bottom of the bellmouth shall not be more than D/2 nor less than D/3 (in which D is the diameter of the suction bell) above the floor of the wet well. Reducers used on the suction side of pumps shall be of the eccentric type to prevent air pockets.

35.1.6 Gate valves in suction lines, except for temporary pump stations and pump stations with capacity 1 mgd or smaller, shall be provided with extension stems to floor stand operators on the ground level floor. In general, gate valves shall be solid wedge, rising stem type with iron body, bronze trimmed, outside screw and yoke, and flanged ends. Flanges shall conform to ANSI Class 125 lb. standard except where high pressures are encountered. Valve operators for valves 16 inches or larger shall be electrically motorized. All motorized actuators shall have manual operation back-up provisions.

35.1.7 Swing check valves shall be provided on the discharge side of pumps and shall be placed horizontally between the gate valves and the pumps. Where damaging effects of water hammer are anticipated, valves with controlled rate of closure shall be installed (see Section 38.10 on water hammer). In general, swing check valves shall be iron bodied, bronze trimmed with outside lever and weight, and flanged ends. Flanges shall conform to ANSI Class 125 lb. standard except where high pressures are encountered.

35.2 Sump Pump Piping: All sump pump fixed piping in wetwells shall be schedule 80 PVC and in dry wells shall be brass. A gate valve and check valve shall be installed on the discharge line. Flanged joints or unions shall be provided on the discharge line to facilitate dismantling of the piping. Minimum diameter of the discharge line shall be 2 inches. Velocity in discharge risers shall not be less than 3 fps. The discharge point shall be installed at the highest elevation possible to prevent reverse flow when the wet well is filled to capacity. Typical discharge elevation should be under and close to the ground floor.

The sump pump shall be fitted with a flexible PVC hose, minimum 2-inch diameter. Camlock fittings shall be provided for the PVC hose connectors to the pump and fixed piping.

35.3 Waste, Drain, and Vent Lines: Pipe and fittings shall be extra heavy cast iron soil type, except piping installed above ground or inside pump stations and piping 2½ inches in diameter or smaller, may be standard weight galvanized steel pipe with standard cast iron screwed, recessed drainage fittings. Cleanouts shall be provided as necessary and shall be solid cast brass, rough finish with square heads. Bronze access frames and covers shall be provided for finish floors and walls.

Frames and covers for wall installation shall be square with polished finish. Those for floor installations shall be round with scoriated finish. Cleanout shall be readily accessible.

35.4 Potable Water Piping: Water piping and fittings 3 inches in diameter or smaller shall be copper except that water piping 1 inch in diameter and smaller within structures shall be Type K copper pipe with standard brass fittings.

Exposed water piping and fittings larger than 3 inches in diameter shall be of galvanized steel. Exposed water piping within structures shall be installed at elevations that permit easy access for maintenance.

Buried water piping and fittings larger than 3 inches in diameter shall be schedule 80 PVC. A locating wire, conductive tape, or other means of locating the buried plastic piping shall also be provided.

35.5 Sprinkler System Piping: Sprinkler system piping shall be solvent welded schedule 40 PVC. Lawn risers shall be PVC or polypropylene and shrubbery risers shall be galvanized steel.

35.6 Piping Between Flow Tube and Instruments: Piping between flow tube to flow transmitter shall be 1 inch minimum diameter 316 stainless steel. Horizontal runs shall have a minimum declining slope of ¼ inch per foot from the flow tube to the in-station equipment and shall be permanently supported and braced to prevent sediment traps and/or air pockets. Piping shall be connected to the flow tube on a horizontal axis. 316 stainless steel valves, unions and necessary fittings shall be installed close to the flow tube to facilitate maintenance. 316 stainless steel ball valves, gate valves, unions, tees and elbows shall be used on the entire system. The flow transmitters and diaphragm seals shall be installed inside the pump station and mounted for easy access and maintenance.

35.7 Pipe Sleeves: Pipe sleeves shall be provided whenever small piping passes through concrete walls. Wall pipe shall be used for larger piping.

36. Emergency Provisions

Emergency facilities shall be provided to protect pump stations and the community from possible damages that may result from power failure, emergency maintenance shutdown, pumping capacity being exceeded, or other unforeseen circumstances.

36.1 Overflow: Pump stations shall be provided with overflow piping whenever discharge into a stream or other body of water is possible without creating undue hazards to health and property upon the approval of the Director. Overflow lines shall be sized to handle peak flows whenever possible and shall be set at elevations low enough to prevent or minimize backup of wastewater into any house or building. Flap gates shall be provided. An assessment addressing the use of the overflow shall be provided.

36.2 Standby Electric Power Equipment: Stations shall be equipped with a diesel powered generator(s) to provide electric power to pump the peak flow. The generator's synchronous speed shall be 1800 RPM. The engine-generator set shall be a new, standard, current model and in accordance with ANSI and NEMA standards. Provide vehicular access including a pad for a portable generator.

Fuel daytank if required, of approved capacity, equipped with two fuel pumps. Pumps shall have a manual selective feature for automatic primary and standby operations.

36.2.1 Operation of the emergency facilities shall be automatic upon power failure. Power failure monitors shall monitor all three phases. Monitoring of one phase of a three-phase system is not adequate.

36.2.2 Automatic load transfer switches shall conform to Hawaiian Electric Company requirements. When possible, bypass of the automatic transfer switch and manual override of automatic functions should be provided.

36.2.3 Major pump stations may require the installation of dual Hawaiian Electric Company power in addition to an engine driven generator.

36.2.4 A plug for connection of a portable load bank shall be provided to fully load the generator periodically. The connection shall be made to the generator side of the transfer switch via a circuit breaker. This connection can also

be used to connect a portable generator when the installed generator is not available for service.

36.2.5 Telemetering and SCADA systems shall be powered through an uninterruptable power supply unit. The uninterruptable power supply shall be sufficiently sized to furnish emergency power for a minimum 30 minutes.

36.3 Fuel Storage System: The system shall comply with Federal, State and City regulations. The fuel tank capacity shall be based on 2 days at peak sewage flow and 5 days at the daily average flow. However, the fuel tank shall not be smaller than 1,000 gallons.

Underground fuel tank installation shall be designed to prevent surface water infiltration into the fuel tank system.

A leak alert monitor shall be provided with capabilities to display fuel inventory, and with audio and visual leak alarms.

36.4 Portable Pump Facilities: Where feasible, pump stations should be equipped to pump wastewater from the wet well into the force main with a portable pump. This shall be accomplished by providing fixed discharge and suction piping for the portable pump with connections to the force main and the wet well. The portable pump discharge piping shall be connected to the downstream side of the flow meter tube and shall include a gate valve, 90° elbow, flanged reducer (if required), and a blind flange. The suction piping shall be connected to the wet well and shall include piping with a 90° elbow and a blind flange. All piping for the portable pumps shall be sized with consideration to the capacity of the installed pumps and the operating characteristics of the available standby pumps. Portable pumps should be located near the wet well to minimize the possible occurrence of cavitation. Provide vehicluar access including a pad for a portable engine-driven pump.

37. Miscellaneous

37.1 Potable Water Supply: All pump stations shall be provided with a potable water supply system for sanitary fixtures, lawn sprinkling, washdown, and other maintenance purposes.

Adequate and conveniently located water outlets shall be provided for flushing and washing purposes. Hose bibbs shall be 3/4-inch with vacuum breakers at all floor levels and outside of pump station. Stop cock valves

shall be provided immediately before each hose bibb located within the building.

Two conveniently located 1½-inch diameter standpipes shall be provided adjacent to the wetwell. The standpipes shall have 1½-inch angle globe valves for National Standard fire hose thread and end cap with chain. A 3/4-inch hose bibb with vacuum breakers shall be installed on the standpipe directly below the 1½-inch globe valve.

The main water supply line shall be 2-inch in diameter, metered and equipped with a master valve located within the station's perimeter fence. A 2-inch reduced pressure backflow preventer shall also be provided and located within the station's perimeter fence.

Under no circumstances shall potable water supply be directly connected to sewage pumps or piping. Seal water, positive air gap and/or pneumatic water tanks shall be provided as necessary.

The potable water supply system shall conform to City, State, and Federal codes and regulations.

37.2 Painting: All pump stations shall be painted in accordance with the best practice and in strict compliance with the paint manufacturer's instructions and recommendations. No lead-base primer or paint shall be used. A minimum of two finish coats over one prime coat shall be required. Color shall be recommended by the architect and approved by the City. Standard colors of the City shall be considered.

37.3 Corrosion Protection: All materials and equipment exposed to corrosive conditions shall be either corrosion resistant or protected with appropriate protective coatings or linings.

37.4 Odor Control: All stations shall be provided with a 6-inch wetwell vent pipe to be used for treatment of foul odors. The vent pipe shall be schedule 40, 316 stainless steel, permanently installed through the wetwell slab and covered with a blind flange. A receptacle, at appropriate voltage, shall be installed near the vent pipe.

38. Force Mains

38.1 Locations: Force mains should be located in streets or along road right-of-ways whenever possible.

In locating force mains, ease of installation and maintenance and elimination of high points shall be

considered. Air release valves shall be installed on high points. Easement widths shall conform to the requirements as set forth in Section 24.5.

38.2 Sizing:

38.2.1 Force mains shall be sized not less than 6 inches in diameter (6 inches upon approval).

38.2.2 Velocities in force mains shall be as follows:

a. Minimum: 3.0 fps (desirable)
1.75 fps (absolute)

b. Maximum: 10.0 fps

38.2.3 Force mains shall be designed to carry the maximum rate of pumping without excessive frictional head loss. Total dynamic head should not exceed 100 feet.

38.3 Materials: The material selected shall be adapted to local conditions with special consideration given to the quality of wastewater, possible septic conditions, soil characteristics, internal pressure, abrasion, external loadings, foundations, necessity of reducing the number of joints and other similar problems. Corrosion resistant lining, coating, wrapping, and cathodic protection shall be used when corrosion protection is required. Insulating flanges or fittings may be required at entrance or exits from buildings. The following materials are acceptable for force mains subject to the conditions indicated:

38.3.1 Ductile Iron Pipe (Cement or other approved lining and Coated): Ductile iron pipe shall be tape wrapped and have cathodic protection where the force main may be subjected to external corrosion.

38.3.2 Reinforced Concrete Pressure Pipe: Reinforced concrete pressure pipe shall not be used where force mains may be subjected to more than 150 feet head.

38.3.3 Polyvinyl Chloride (PVC) Pipe: PVC pipe shall comply to AWWA C-900 for pipes 12-inch diameter and smaller and AWWA C-905 for pipes with diameter greater than 12 inches.

38.3.4 High Density Polyethylene (HDPE) Pipe: HDPE pipe shall be the heat fused joint type and the maximum SDR shall be 17.

38.4 Cover: Minimum and maximum cover over force mains shall conform to the requirements as set forth in Sections 24 and 27.

38.5 Clearances: Clearances between force mains and other utilities shall conform to the requirements as set forth in Sections 24 and 27.

38.6 Alignment and Grade: Pipe shall be laid in a straight alignment and with constant grades where possible. Force mains may be curved by deflecting the joints to eliminate the necessity for fittings. In no case shall the deflection exceed the maximum as set forth by the manufacturer for the type of pipe used. Fittings shall be used when alignment or grade changes cannot be accomplished by joint deflection.

38.7 Appurtenances

38.7.1 Air Bleeders: Air bleeders and valves shall be provided at high points. A corporation stop shall be provided at the force main connection. Internal and external corrosion shall be considered.

38.7.2 Blow Offs: Blow off valves and vaults will not generally be required. However, a blow off valve and vault may be required where sedimentation may occur.

38.7.3 Emergency By-Pass: Whenever possible, emergency by-pass facilities should be provided.

38.7.4 On force main bypass systems designed to discharge into a body of water, stream, etc., two discharge valves shall be provided on the bypass line. The valves shall be designed to permit access for maintenance. Provision shall be included to allow removal of sewage between the two valves. This installation will allow valve maintenance-exercising without causing a sewage spill incident.

38.8 Structural Considerations:

38.8.1 Pipe Loads: Force mains shall be designed to withstand all internal and external forces to which they may be subjected. Internal forces will be the pressure from the wastewater and the water hammer effect. External forces to be considered are loads due to:

a. trench backfilling.

b. superimposed uniform loads.
c. superimposed concentrated loads.

38.8.2 Foundation: Test borings shall be made to determine soil conditions. Beddings shall be designed to adequately support pipe and minimize settlement.

38.8.3 Reaction Blocks and Anchorage: Reaction blocks and anchorage shall be provided at bends and fittings. Reaction block and anchorage may be required at joint deflections.

38.9 Termination: Force main discharge outlets shall be designed to minimize turbulence and sulfide release and be submerged at all times. The interior surface of the outlet manhole and first downstream manhole shall be protected with plastic lining.

38.9.1 Discharge manholes are a constant source of odor complaints. The severity of odor and its treatment shall be considered. A suitable odor control means shall be incorporated.

38.9.2 Gravity connection to the force main discharge manhole and connection to the first leg of the gravity line exiting the discharge manhole will not be permitted. Foul gases within the discharge manholes can travel into gravity lines and laterals and result in odor complaints.

38.10 Water Hammer: Water hammer shall be investigated and necessary measures shall be provided for in the design of force mains.

Water hammer effect caused by the sudden shutoff of pumps or the rapid closing of valves shall be investigated. The following method may be considered by the designer if he deems it appropriate.

38.10.1 Determine maximum water hammer pressure.

Max. water hammer pressure (ft)

$$= \text{Static head (ft)} + \frac{av}{g}$$

where:

$a = 4660/(1 + KB)^{\frac{1}{2}}$ = velocity of sound in water in the force main in fps.

K = ratio of the elastic modulus of water to

that of the pipe material.

B = ratio of pipe diameter to wall thickness.

v = maximum velocity in the force main at peak flow or the destroyed velocity.

g = acceleration due to gravity = 32.2 ft/sec/sec

38.10.2 Where the maximum water hammer pressure is less than the strength of the pipe used, no further investigation need be made.

38.10.3 Where the maximum water hammer pressure is greater than the strength of the pipe used, further investigation shall be made in the following manner:

a. Determine one cycle period.

$$\text{One cycle period} = \frac{2L}{a}$$

where L = length of the force main in feet.

b. Determine line constant.

$$\text{Line constant} = \frac{av}{2gH}$$

where H = static head in feet.

c. Determine allowable pressure rise.

$$\text{Allowable pressure rise} = \frac{\text{Allowable pipe strength (ft)}}{\text{Static head (ft)}}$$

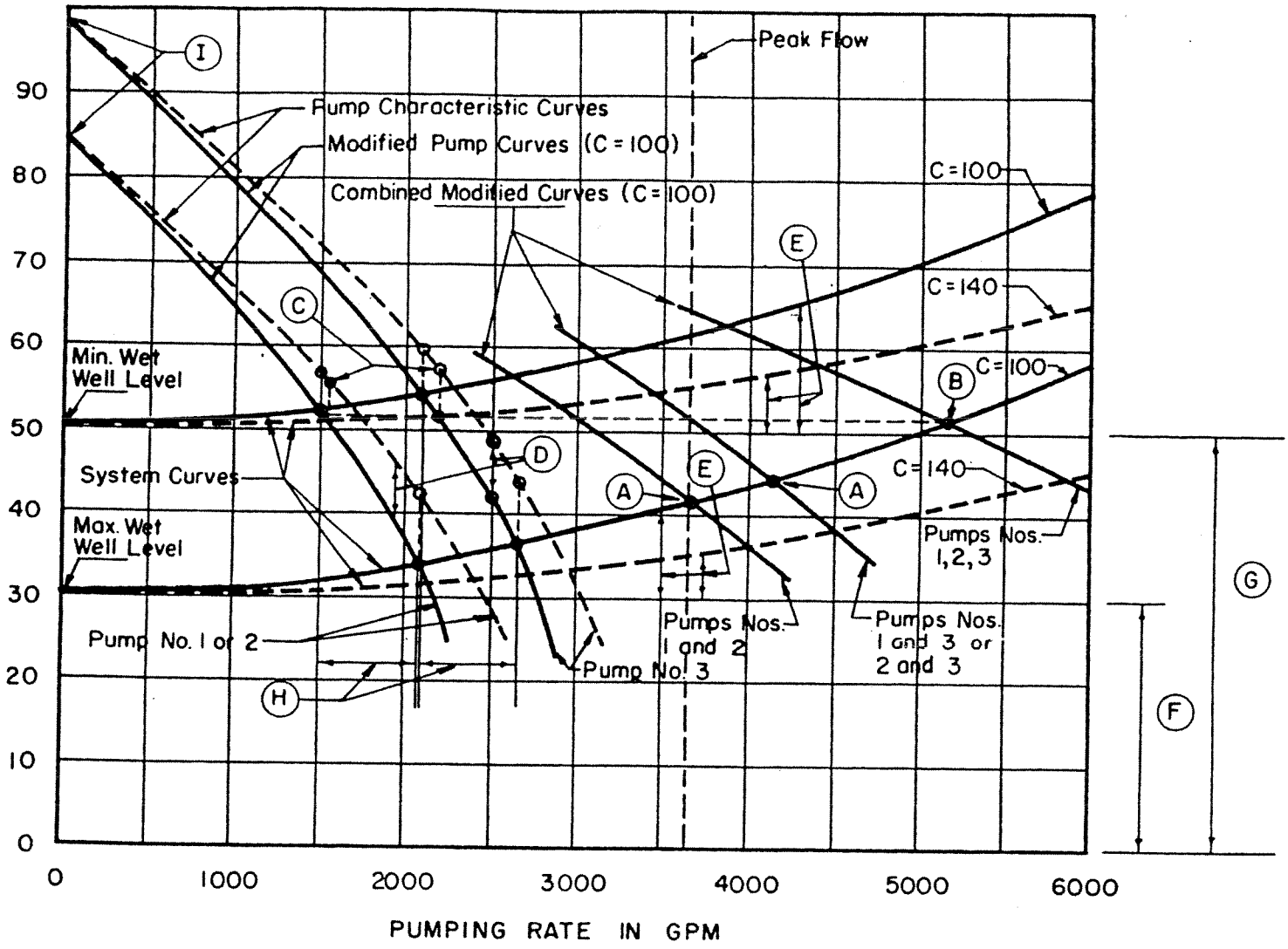
d. Apply these factors to the Allievi Chart (Fig. 38.10) and obtain factor "r".

e. Determine time of closure.

Time of closure = "r" times one cycle period.

38.10.4 If the time of closure is less than 2 seconds, no special design consideration is needed.

38.10.5 If the time of closure is greater than 2 seconds, some special design consideration for the control of water hammer is necessary. The use of slow closing valves or higher strength pipe shall be investigated.



Ⓐ Pumping capacity with two pumps in operation.
Ⓑ Maximum station pumping capacity.
Ⓒ Rated capacity and head of pumps.
Ⓓ Friction losses in suction and discharge piping of pumps. (Typical anywhere along curve)
Ⓔ Friction losses in force main. (Typical anywhere along curve)
Ⓕ Static head with sewage level in wet well at maximum operating level.
Ⓖ Static head with sewage level in wet well at minimum operating level.
Ⓗ Operating ranges of pumps.
Ⓘ Pump shutoff heads.

Note: 1. For clarity, modified pump curves and combined modified curves for C = 140 have been omitted. These curves should be shown to obtain maximum possible station pumping capacity and minimum possible head within the operating ranges of pumps.

2. For new pipe, C = 140 except for PVC or Polyethelene pipe, C = 150.

FIG. 34.1.2 TYPICAL SYSTEM HEAD-CAPACITY CURVES

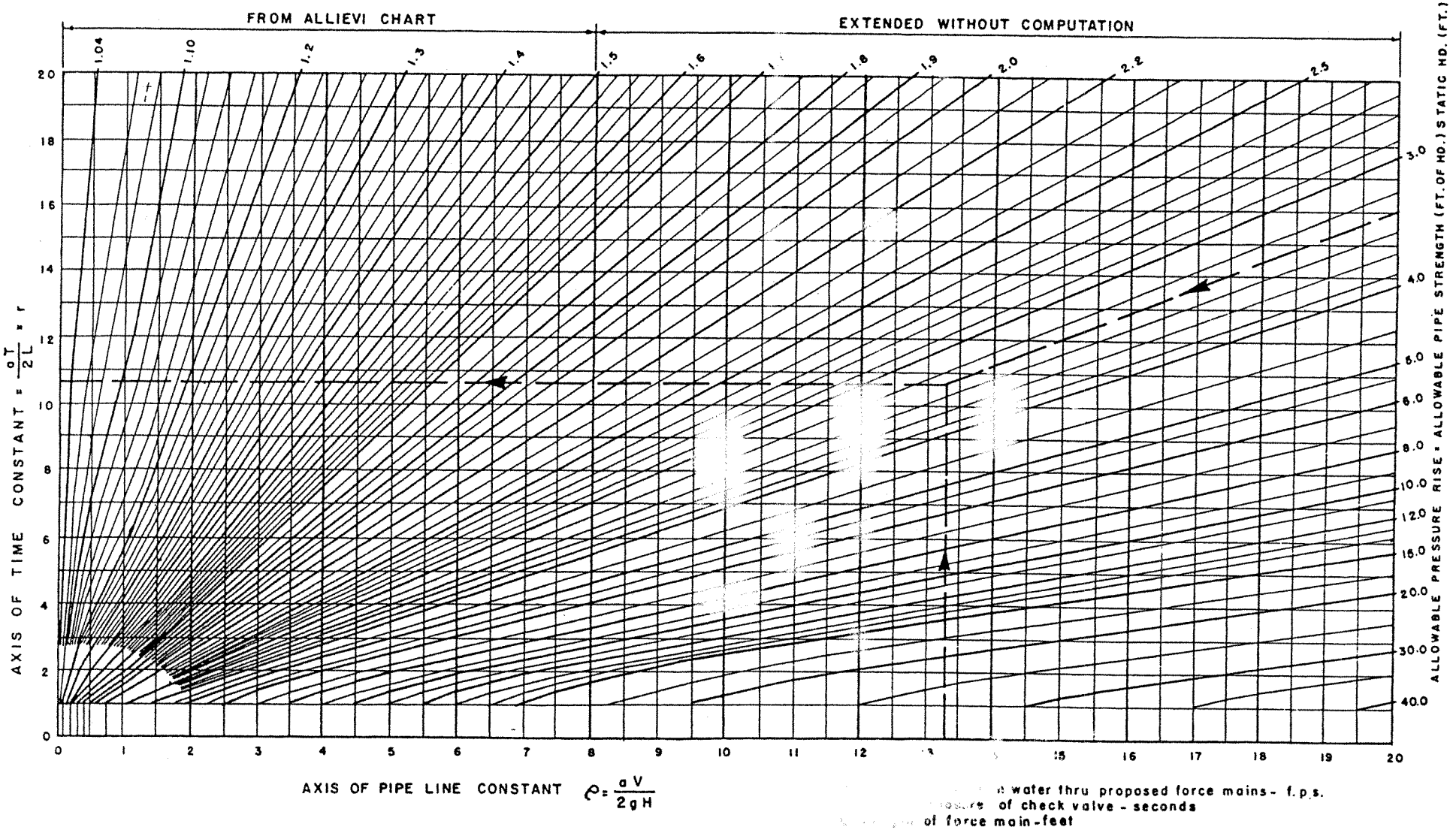

FROM ALLIEVI CHART
EXTENDED WITHOUT COMPUTATION
1.04
1.10
1.2
1.3
1.4
1.5
1.6
1.8
1.9
2.0
2.2
2.5
AXIS OF TIME CONSTANT = $\frac{aT}{2L}$ = r
AXIS OF PIPE LINE CONSTANT $\rho = \frac{aV}{2gH}$
ALLOWABLE PRESSURE RISE = ALLOWABLE PIPE STRENGTH (FT. OF HD.) STATIC HD. (FT.)
3.0
4.0
5.0
6.0
8.0
10.0
12.0
15.0
20.0
30.0
40.0
water thru proposed force mains - f.p.s.
of check valve - seconds
of force main - feet
V = Max velocity in force main or destroyed velocity - f.p.s.
g = Acceleration of gravity - 32.2 f./s./s.

Figure 38.10

GLOSSARY

The usage of these terms in this glossary is intended for use only for these Design Standards. These definitions may conflict with City and County legal documents.

Branch Sewer - A sewer which receives wastewater from a relatively small area and discharges into a trunk sewer.

City, or City and County - City and County of Honolulu, a municipal corporation.

Contractor - One who furnishes the materials, labor, and equipment necessary for the physical accomplishment of the work.

Department of Health - The Department of Health, State of Hawaii.

Designer - A registered engineer actively furnishing the professional and technical skill required in planning, administration, and construction of the works.

Director - Director, Department of Wastewater Management, City and County of Honolulu, or his authorized representatives.

Domestic Wastewater - The water carried wastes produced from non-commercial or non-industrial activities and which result from ordinary human living processes.

Dry Well - Compartment where non-submerged pumping equipment, devices, and appurtenances are installed.

Force Main - A pipeline conveying wastewater under pressure from the discharge end of a pump station to a point where wastewater flows by gravity.

Gravity Sewer - A sewer in which all wastewater flows in descending gradients from source to outlet, or where no pumping is required.

Ground Water - Subsurface water occupying the saturation zone of the ground.

Industrial Wastewater - All water carried wastes of the community excluding domestic wastewater, infiltration/inflow and uncontaminated water.

Infiltration/Inflow - Surface and ground water which leaks into a sewer through joints, manhole covers, or breaks.

Interceptor - A sewer which receives flows from one or more trunk sewers and conveys such wastewater to a point for treatment or disposal.

Invert - The lowest point in the internal cross section of a conduit, manhole, sump or wet well, etc.

Lateral Sewer or Lateral - A sewer which serves no more than three (3) lots, which discharges into a branch or other sewer, and which has no other common sewer tributary to it.

Manhole - An access shaft or chamber from the surface of the ground to a sewer.

Master Plan - The Water Quality Management Plan (208 Plan) for the City and County of Honolulu and detailed documents prepared to implement the 208 Plan.

Permanent Wastewater Facilities - Wastewater facilities which are built according to the wastewater master plan as to location and capacity and intended to be at that location indefinitely.

Sanitary Sewer - A pipe or conduit for carrying wastewater to which storm, surface, and ground water are not intentionally admitted.

Shall - Indicates a mandatory requirement.

Should, Preferred, Recommend - Indicates discretionary use on the part of the City and County.

Siphon or Inverted Siphon - A sewer, often crossing beneath a gulch, a watercourse or an obstruction, which runs full or under greater than atmospheric pressure because its profile is depressed below the hydraulic grade line.

Slope - The inclination or gradient of the invert of a sewer expressed as a decimal, or percentage.

Standard Details - The current edition of the Standard Details for Public Works Construction, Departments of Public Works, City and County of Honolulu and the Counties of Kauai, Maui, and Hawaii.

Standard Specifications - The current edition of the Standard Specifications for Public Works Construction, Departments of Public Works, City and County of Honolulu and the Counties of Kauai, Maui, and Hawaii.

Temporary Wastewater Facilities - Wastewater facilities which are built for private development (subdivision) and intended to remain in service only until their needs are over. Temporary facilities expected to be in service for 10 or more years as determined by the Department of Wastewater Management shall be designed and constructed as a permanent facility.

Trunk Sewer, Main Sewer, or Main - A sewer which receives flows from one or more branch sewers.

Wastewater Facilities - A comprehensive term which includes facilities for collecting, transporting, pumping, treating, and disposing of wastewater.

Wastewater Pump Station - An installation employing mechanical equipment and devices for raising or lifting wastewater and discharging it into a gravity system or a wastewater facility.

Wastewater Treatment Plant - An arrangement of devices and structures where wastewater is treated to remove or alter its objectionable constituents and thus render it less offensive and hazardous.

Wet Well - Compartment used for the storage of wastewater for pumping purposes.

ACRONYMS

ANSI	AMERICAN NATIONAL STANDARDS INSTITUTE, INC.
HECO	HAWAIIAN ELECTRIC COMPANY
IEEE	INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC.
NEMA	NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION
SCADA	SUPERVISORY CONTROL AND DATA ACQUISITION