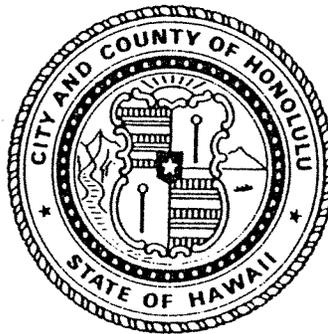


DESIGN STANDARDS  
of the  
DEPARTMENT OF  
WASTEWATER MANAGEMENT

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.



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## 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 Telemetry and Supervisory Control Systems: Describe telemetry 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<sub>5</sub> 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:

<u>DIAMETER</u> (inches)	<u>MINIMUM SLOPE</u> (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 unusual conditions 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  $MF = \frac{5}{P^{0.2}}$   
P = Population in thousands

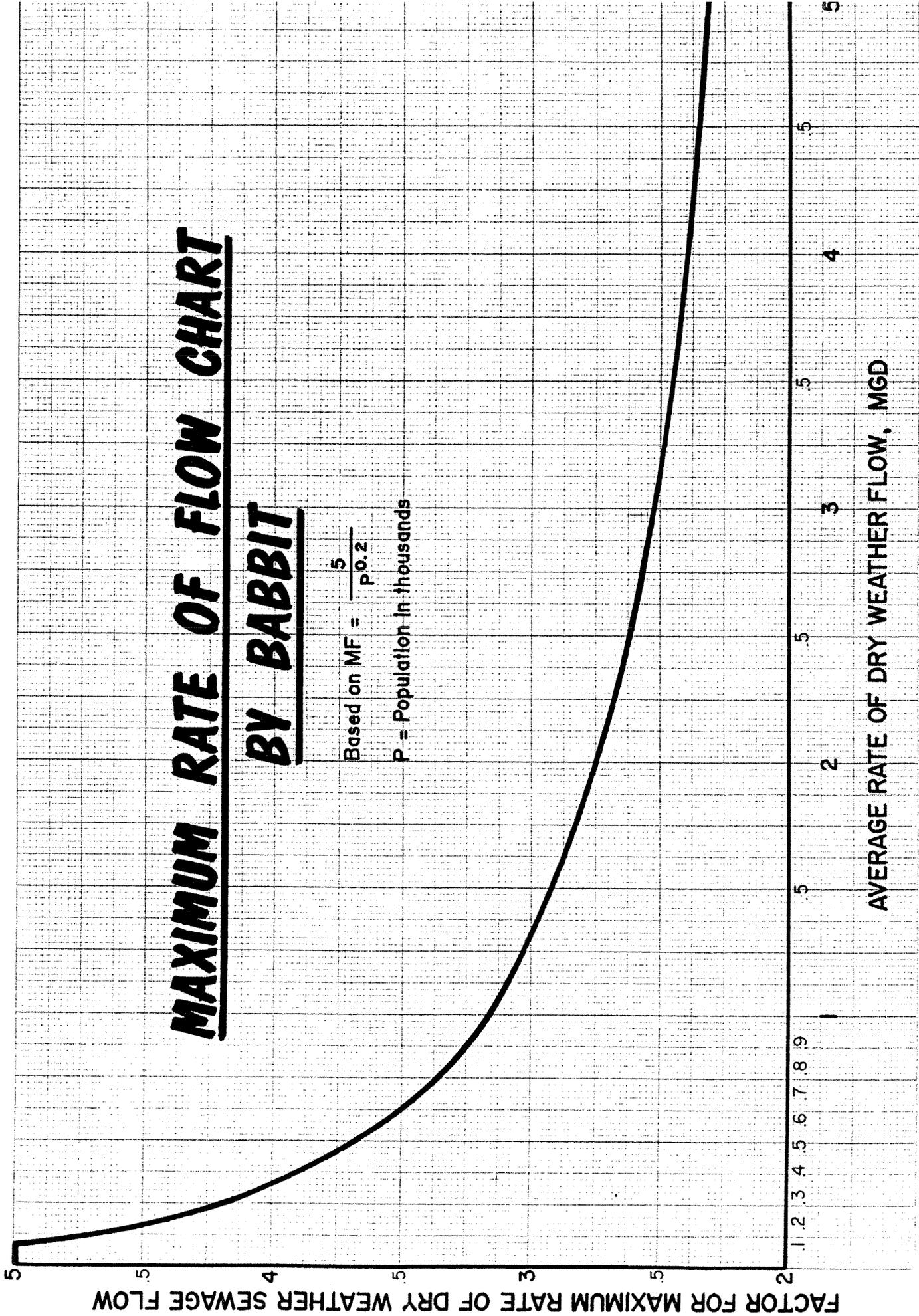


FIG. 22.2.4

### COMPUTATION OF WASTEWATER FLOW

SEWER: \_\_\_\_\_ PAGE: \_\_\_\_\_  
 DISTRICT: \_\_\_\_\_ COMPUTED BY: \_\_\_\_\_  
 REFERENCE MAPS: \_\_\_\_\_ DATE: \_\_\_\_\_

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