CHAPTER 3

LEGAL ASPECTS

3.1 General

It is important that the explicit set of published regulations be available for the efficient operation of the sanitary sewerage and drainage system, and Municipal Council Province Wellesley (MPSP), be given authority to issue and enforce regulations for effective operation and maintenance on the basis of national and state legislations. This may be done by the office in charge of legal affairs in the new organization for the sewerage and drainage system proposed.

However, the existing regulations and by-laws pertinent to proposed Project are reviewed herewith, and brief suggestions and recommendations are presented in the following paragraphs.

3.2 Municipal Ordinance

The Municipal Ordinance enacted as Chapter 133 of old Strait Settlement in 1913 involves the provisions pertinent to the work proposed in this Report. The substantial parts of the pertinent sections of ordinance are outlined as follows:

Financial Power

Section 59: Municipal Council is empowered to levy a separate or consolidated rate or rates limited to the maximum 35% based on the annual rental value of all rated properties including buildings and lands within the municipality for the capital cost of sewerage works. There is no provision to charge the capital cost to the owners of the properties directly benefited by the construction of sewerage facilities.

Section 229: The power is given to recover the cost incurred in part or in whole for the connection, and fee for sewage removal as the operation cost in addition to any rate levied under section 59. The above sewage removal fee is limited to M$2.00 monthly per water closet or urinal.

The rate was established in 1959 and appears to be outmoded to meet the current practice of sewerage system operation.

Sections 215, 220 and 230: Power is given to collect fees for licencing public latrines and inspection fees for sewer and etc. and night soil collection fees as prescribed by the municipality.

Sections 343 and 344: The Municipal Council may borrow such sums of money as are necessary for the acquisition of land, the erection of buildings and execution of any permanent work including sewerage works. The amount of loan shall not exceed five time the annual rental value of all rated properties including buildings and land for remunerative works provided that the loan for unremunerative works shall not exceed double the annual rental value. This power for loan limiting especially for unremunerative works including sewerage works will impose a restriction on the construction development programme.

Executive Power

Sections 133 and 134: Power is given to the Municipal Council for the construction and maintenance of sewage disposal systems.

Required Use of Public Sewers

Sections 221, 222 and 223: It is prohibited to discharge or deposit in any stream, the solid, industrial wastewater or liquid sewage matter. No difinition is made for above liquid sewage matter, however, it is normally defined as combination of the liquid and water-carried wastes from sanitary conveniences of residences, commercial buildings, industrial plants and institutions including "sullage", and these sections suggest the "sullage" as all domestic wastes to be disposed to public sewers.

Section 140: It is empowered to require the owners of a house to install of proper water-closets, urinals, sinks and bathrooms and require such water-closets, urinals, sinks and bathrooms to be connected with public sewers provided that there is a public sewer 100 ft of the boundary of the premises where house is located.

Private Sewage Disposal Systems

Sections 219 & 220: Power is given to regulate and control the construction and maintenance of private sewage and wastewater disposal systems including septic tank and cess-pool, and to enter any land or building for inspection, alternations and repairs of such systems. The by-law of this Ordinance, Building By-Laws, 1950, include the provisions pertinent to the construction and maintenance of private sewage disposal systems in its Article III - Works and Fittings.

Plumbing

There is no specific provision regulating the connection of building sewer with the public sewer. However, by section 143, power is given to make by laws for plumbing. In the Building By-Laws 1950 includes the provisions for this purpose in the Article III - Works and Fittings.

Regulations on Discharge into Public Sewers

There is no provisions regulating the substance or materials to be discharged to public sewers except Section 113 which regulates the rain water discharge from roof of the house. Section 136 requires the consent of Municipal Council to make any drain into public sewers and permits to discharge the night-soil or excrementious matter from water-closet or privy into public sewers.

Other Provisions

Sections 363, 364 & 365: Power is given to purchase or sell any land and obtain easement or right of way for the public purposes authorized by Municipal Council.

Section 367: Power is granted to enter into and upon any building or land for inspection as well as the execution of the work authorized by the Ordinance.

Sections 390 and 391: Any person who commit any offence under the Ordinance or its by-laws shall be arrested by police and shall be subject to prosecution and penalties.

3.3 Street, Drainage and Building Act, 1974

The Municipal Ordinance as outlined in previous section is apparently outmoded in various respects to meet the current practice of sewerage works.

The recently published Street, Drainage and Building Act, 1974 includes the provisions required for sewerage works with adequate improvement and consolidation of provisions set forth in Municipal Ordinance.

The legal powers and their applications particularly relevant to sewerage management required in the proposed project are presented as follows:

Executive Power:

Sections 49 and 50 : The power is given to local authority for which definition is made to include Municipal Council, to undertake the construction and maintenance of sewerage and drainage works.

Financial Power

It is of vital importance that a legal supports to financial operations are given to sewerage authorities especially if financially autonomous authority is required. The provisions for this purpose are significantly improved as against Municipal Ordinance.

Section 51: Local Authority is given power to recover the capital cost of the sewerage and drainage works including cost of land acquisition by means of frontage charge.

It is also authorized to recover the cost from any developper in such a manner that they may be claimed by way of deposit before developpers proceed to develop an area.

Section 64: Local Authority is given the powers to levy fees or charges as may be prescribed to be paid by the sewer users.

This section implies that the Local Authority may recover the cost for the sewerage operation and maintenance by setting fees in an appropriate manner as a surcharge to water consumption.

There is no particular reference to rate or tax as indicated by Section 59 of Municipal Ordinance. If the rate or tax is regarded as necessary to be included in rate structure of proposed sewerage works, the Section 59 of Municipal Ordinance should be applied.

Section 132: The power is given to Local Authority to establish "Improvement Service Fund". This Fund can be administered by Local Authority at its absolute discretion. This suggests that the completely separate account can be maintained for the capital investments and operation financing of sewerage services. This section, therefore, deemed to be appropriately applied to the financially autonomous management of proposed organization.

Required Use of Public Sewers

Section 58 (2) & (7): The power is given to require the owner(s) of any house or building the installment of water-closets, urinals, sinks, and bathrooms to be connected with public sewer if the public sewer is available within 100 ft of the boundary of the premises.

The above section stipulates the mandatory use of public sewers. However, it may be necessary to provide the stipulation requiring the such connections to be made at the expense of the owner(s).

Private Sewage Disposal Systems

Section 58 (3) & (14): Private disposal systems as septic tank, and cess-pool are allowed to be provided where there is no sewer under the direction of Local Authority and such systems are required to be kept in proper order.

Section 62: Local Authority may in its discretion decide to take over the control, supervision, maintenance and repair of private septic tanks or other sewage purification plants to such extent that fees or charges may be levied.

There is no specific provision for such septic tank and cess-pool to be abandoned at such time a public sewer becomes available.

The mandatory use of public sewer as stipulated in Section 58 (2) should also be effectuated by provisions enforcing direct connection with sewers when it becomes available.

Plumbing

No specific provisions are found in this Act. for the control of the connection of public sewer with building disposal facilities. The Building By-Laws 1950 includes the provisions in its Article III - Works and Fittings.

Regulations on Discharge into Public Sewers

Section 55: The prior written permission is required to make any drain into any of the public sewers. No night-soil, excrementitious matter trade effluent can be discharged into sewers without prior written permission of Local Authority.

The discharge of trade effluent or industrial wastewaters are subject to specific conditions to be imposed by Local Authority.

There is a apparent need to control and regulate the quality, quantity and the manner of discharge into the sewerage systems in order to keep the satisfactory performance of the system's functions.

The domestic sewage may be controlled without providing specific conditions due to its constituent easily prescribed. The industrial wastewater should, however, be controlled by providing more specific and individual conditions.

There is a likelihood of attending problem in controlling the industrial wastewater because of different interests and opinions towards industrial development policy and control of the resultant wastes. It will be necessary, however, to provide certain standards on which the owner(s) of industries and Local Authority can negotiate to achieve agreement satisfactoring to both parties.

It is suggested here that the relevant articles of the model ordinance developed by the Sub-committee on Municipal Sewer Ordinances of the Water Pollution Control Federation of U.S.A. be utilized with appropriate modification to develop an acceptable standards on industrial wastewater control in the Project Area. Such articles relevant to control of discharge into sewers and/or sewage treatment plants are quoted below with minor adjustments.

Section 1. No person shall discharge or cause to be discharged any storm water, surface water, groundwater, roof runoff, subsurface drainage, uncontaminated cooling water, or unpolluted industrial process waters to any sanitary sewer.

Section2. Storm water and all other unpolluted drainage shall be discharged to such sewers as are specifically designated as combined sewers or storm sewers, or to a natural outlet approved by the Local Authority. Industrial cooling water or unpolluted process waters may be discharged, on approval of the Local Authority, to a storm sewer, combined sewer, or natural outlet.

Section 3. No person shall discharge or cause to be discharged any of the following described waters or wastes to any public sewers:

(a) Any gasoline, benzene, naphtha, fuel oil, or other flammable or explosive liquid, solid, or gas.

(b) Any waters or wastes containing toxic or poisonous solids, liquids, or gases in sufficient quantity, either singly or by interaction with other wastes, to injure or interfere with any sewage treatment process, constitute a hazard to humans or animals, create a public nuisance, or create any hazard in the receiving waters of the sewage treatment plant, including but not limited to cyanides in excess of two (2) mg/l as CN in the wastes as discharged to the public sewer.

(c) Any waters or wastes having a pH lower than 5.5, or having any other corrosive property capable of causing damage or hazard to structures, equipment, and personnel of the sewage works.

(d) Solid or viscous substances in quantities or of such size capable of causing obstruction to the flow in sewers or other interference with the proper operation of the sewage works such as, but not limited to, ashes, cinders, sand, mud, straw, shavings, metal, glass, rags, feathers, tar, plastics, wood, unground garbage, whole blood, paunch manure, hair and fleshings, entrails and paper dishes, cups, milk containers, etc. either whole or ground by garbage grinders.

Section 4. No person shall discharge or cause to be discharged the following described substances, materials, waters, or wastes if it appears likely in the opinion of the Local Authority that such wastes can harm either the sewage treatment process, or equipment, have an adverse effect on the receiving stream, or can otherwise endanger life, limb, public property, or constitute a nuisance. In forming his opinion as to the acceptability of these wastes, the Local Authority give consideration to such factors as the quantities of subject wastes in relation to flows and velocities in the sewers, materials of construction of the sewers, nature of the sewage treatment process, capacity of the sewage treatment plant, degree of treatability of wastes in the sewage treatment plant, and other pertinent factors. The substances prohibited are:

(a) Any liquid or vapor having a temperature higher than sixty-five (65)°C.

(b) Any water or waste containing fats, wax, grease, or oils, whether emulsified, or not, in excess of one hundred (100) mg/l or containing substances which may solidify or become viscous at temperatures between zero(0)° and sixty-five (65)°C.

(c) Any waters or wastes containing strong acid, iron, pickling wastes, or concentrated plating solutions whether neutralized or not.

(d) Any waters or wastes containing strong acid, iron, pickling wastes, or concentrated plating solutions whether neutralized or not.

(e) Any waters or wastes containing phenols or other taste-or odor-producing substances, in such concentrations exceeding limits which may be established by the Local Authority as necessary, after treatment of the composite sewage, to meet the requirements of the Government of Malaysia for such discharge to the receiving waters.

(f) Any radioactive wastes or isotopes of such half-life or concentration as may exceed limits established by the Local Authority in compliance with applicable regulations.

(g) Any waters or wastes having a pH in excess of 9.5.

(h) Materials which exert or cause:

(1) Unusual concentrations of inert suspended solids (such as, but not limited to, Fullers earth, lime slurries, and lime residues) or of dissolved solids (such as, but not limited to, sodium chloride and sodium sulfate).

(2) Excessive discoloration (such as, but not limited to, dye wastes and vegetable tanning solutions).

(3) Unusual BOD, chemical oxygen demand, or chlorine requirements in such quantities as to constitute a significant load on the sewage treatment works.

(4) Unusual volume of flow or concentration of wastes constituting "Slugs" as defined herein.

(i) Waters or wastes containing substances which are not amenable to treatment or reduction by the sewage treatment processes employed, or are amenable to treatment only to such degree that the sewage treatment plant effluent can not meet the requirements of other agencies having jurisdiction over discharge to the receiving waters.

Section 5. If any waters or wastes are discharged or are proposed to be discharged to the public sewers, which waters contain the substances or possess the characteristics enumerated in Section 4 and which in the judgment of the Local Authority may have a deleterious effect upon the sewage works, processes, equipment, or receiving waters, or which otherwise create a hazard to life or constitute a public nuisance, the Local Authority:

(a) Reject the wastes.

(b) Require pretreatment to an acceptable condition for discharge to the public sewers.

(c) Require control over the quantities and rates of discharge, and/or

(d) Require payment to cover the added cost of handling and treating the wastes not covered by existing taxes or sewer charges under the provisions of Section 10.

If the Local Authority permits the pretreatment or equalization of waste flows, the design and installation of the plants and equipment shall be subject to the review and approval of the Local Authority and subject to the requirements of all applicable codes, ordinances, and laws.

Section 6. Grease, oil, and sand interceptors shall be provided when, in the opinion of the Local Authority, they are necessary for the proper handling of liquid wastes containing grease in excessive amounts, or any flammable wastes, sand, or other harmful ingredients; except that such interceptors shall not be required for private living quarters or dwelling units. All interceptors shall be of a type and capacity approved by the Local Authority, and shall be located as to be readily and easily accessible for cleaning and inspection.

Section 7. Where preliminary treatment or flow-equalizing facilities are provided for any waters or wastes, they shall be maintained continuously in satisfactory and effective operation by the owner at his expense.

Section 8. When required by the Local Authority the owner of any property serviced by a building sewer carrying industrial wastes shall install a suitable control manhole together with such necessary meters and other appurtenances in the building sewer to facilitate observation, sampling, and measurement of the wastes. Such manhole, when required, shall be

accessibly and safely located and shall be constructed in accordance with plans approved by the Local Authority. The manhole shall be installed by the owner at his expense, and shall be maintained by him so as to be safe and accessible at all times.

Section 9. All measurements, tests, and analyses of the characteristics of waters and wastes to which reference is made in this ordinance shall be determined in accordance with the latest edition of "Standard Methods for the Examination of Water and Wastewater", published by the American Public Health Association, and shall be determined at the control manhole provided, or upon suitable samples taken at said control manhole. In the event that no special manhole has been required, the control manhole shall be considered to be the nearest downstream manhole in the public sewer to the point at which the building sewer is connected. Sampling shall be carried out by customarily accepted methods to reflect the effect of constitutents upon the sewage works and to determine the existence of hazards to life, limb, and property. (The particular analyses involved will determine whether a twenty-four (24) hour composite of all outfalls of a premise is appropriate or whether a grab sample or samples should be taken. Normally, but not always, BOD and suspended solids analyses are obtained from 24-hr. composites of all outfalls whereas pH's are determined from periodic grab samples.)

Section10. No statement contained in this article shall be construed as preventing any special agreement or arrangement between the Local Authority and any industrial concern whereby an industrial waste of unusual strength or character may be accepted by the Local Authority for treatment, subject to payment therefore, by the industrial concern.

Other Provisions

The Local Authority is empowered to enter into any private property or premises to execute the works as altering, enlarging, repairing or cleaning the sewer and drains by Sections 52 and 53.

Section 97 reads in part "Any Local Authority may, for the purposes of this Act, ... enter at all reasonable house ... any building or land as well for the purpose of making any survey or inspection as for the purpose of executing any work authorized by this Act ..... Section 122, 123, 124, 125, 126 provide legal procedures as court trial, prosecution, conviction, arrest for any person guilty of an offence under this Act or any by-laws made thereunder.

3.4 The Environmental Quality Act, 1974

Under this Act, the Minister of Environment is appointed to be charged with the responsibility for environmental protection of whole of Malaysia.

Under the Minister, Director General of Environmental Quality is appointed to execute all activities required to environmental pollution control. The Environmental Quality Council is also established as an advisory council consisting of the members representing various authorities and institutions concerned.

The provisions which have direct or indirect bearings on sewerage works are Sections 21, 24 and 25 for regulation on discharge of waste into soil, land and inland waters, Sections 26, 27 and 29 on oil discharge into Malaysian waters, and Section 31 which enforce the provision of adequate equipment to control and eliminate polluted waste from industries.

3.5 Conclusion

As far as the existing regulations are concerned, the Street, Drainage and Building Act, 1974 is considered to be provided with most adequate provisions to be required for the proposed sewerage and drainage works.

While it is recommended that the Street, Drainage and Building Act, 1974 would be basically applied for the sewerage and drainage works, some minor changes or supplements are suggested as for the following points.

In Section 50 the local authority is empowered to request the State Authority to acquire any property, for the construction of surface and storm water drains only. However, sewerage works also be qualified for the compulsory acquisition of lands.

In Section 51 the local authority is authorized to recover the capital cost of the sewerage and drainage works including costs of land acquisition by means of frontage charge from any developers, before preceeding to develop the area. However, a legal provision would be necessary for requiring the developer to provide sewerage facilities or deposit a frontage charge as a condition of approval of the development.

In Section 55 the prior written permission in required for the discharge of trade effluent. However, subject to the conditions imposed to such permission. This section refers to general trade effluent but does not deal in detail with the consitions imposed to the quality and strength of trade wastes.

In Section 64 local authority is impowered to levy fee or charges to compensate the necessary expenses for operation and maintenance of the system plus debt service payment to be paid by the sewer users. In this section the provision would be required to authorize the collection of sewerage service fee by means of surcharge based on water consumption and quality and strength of trade wastes.

The more specific controlling conditions would be necessary to protect the sewerage and drainage systems. In this connection the provision of regulations based on the standard articles of model ordinance as presented in previous pages V 20 - 24 would be recommended or alternative Trade Waste By-Laws should be considered.

The By-Laws for the Sewerage and Sanitary Installation By-Laws would also be necessary as no specific provision are presently found for the plumbing of sewerage and drainage systems in order to control the connection of public sewer and drain with household and building disposal facilities.

CHAPTER 4

FINANCIAL CONSIDERATION

4.1 General

This chapter deals with the financial aspects of the project extended to the year 2000 with the objective to estimate the minimum requirements for the implementation of the planned Project. The description is, therefore, limited to preliminary analaysis of financial viability providing that the details will be provided in feasibility report to be prepared consecutively.

4.2 Cost Estimation

The total cost of the Sewerage and drainage of the Project up to the year 2000 is estimated on the basis of 1976 prices together with figures escalated at annual inflation rate of 5% as indicated in following pages. As it is necessary to define the capital requirements for the Government the division of the costs to be borne by the Government and private sector including developer is attempted to provide the base on which required amount of capital to recover the costs from various sources will be estimated.

The price escalation is normally required to be reflected in estimation of required capital for the construction extended over the years to avoid any substantial discrepancy between estimated costs and costs actually required at the implementation of the construction programme. It should be noted, however, that it is difficult to make a realistic estimates of future trends of inflation over an extended period of time especially when world economic situation is showing wide fluctuation.

In Malaysia the ratio of inflation has also marked upward and downward variations until recent stabilization of economy. The present

inflation rate of 5% projected by nation wide census is utilized, however, to illustrate the notional reflection of the inflation on the project costs as a whole as indicated in the brackets noted under 1976 prices in each table of cost estimation. Those notional figures in brackets indicate the costs escalated up to the middle year of each stage to obtain average figures.

TABLE V-1 Total Construction Cost by Stage at 1976 Price Level

(1,000 M$)

Element of System	Stage	1st Stage (1981-1985)	2nd Stage (1986-1990)	3rd Stage (1991-1995)	4th Stage (1996-2000)	Total
(A) to be borne by public sector	Sewerage	63,250 (88,990)	116,850 (209,820)	85,300 (195,520)	86,200 (252,200)	351,600 (746,530)
	Drainage	68,330 (96,140)	8,410 (15,080)	38,550 (88,330)	111,940 (327,490)	227,230 (527,040)
	Total	131,580 (185,130)	125,260 (224,900)	123,850 (283,850)	198,140 (579,690)	578,830 (1,273,570)
(B) to be borne by private sector	Sewerage	100,790 (141,800)	51,410 (92,320)	137,110 (314,250)	163,480 (478,190)	452,790 (1,026,560)
	Drainage	52,580 (73,980)	25,140 (45,150)	45,170 (103,540)	83,020 (242,840)	205,910 (465,510)
	Total	153,370 (215,780)	76,550 (137,470)	182,280 (417,790)	246,500 (721,030)	658,700 (1,492,070)
(C) Grand Total		284,950 (400,910)	201,810 (362,370)	306,130 (701,640)	444,640 (1,300,720)	1,237,530 (2,765,640)

Note: Figures in the brackets include 5% escalation per annum starting from 1977 up to 1983 for the 1st stage, 1988 for the 2nd stage, 1933 for the 3rd stage and 1998 for the 4th stage. This is due to the fact the amount indicated above are the gross estimated costs and are not broken down into the detailed disbursement schedules, hence escalation is applied up to the middle of each stage duration in order to estimate average escalated amount for the planning purpose.

TABLE V-2 Sewerage Construction Cost by Stage at 1976 Price Level
to be borne by public sector

(1,000 M$)

Description \ Stage	1st Stage (1981-1985)	2nd Stage (1986-1990)	3rd Stage (1991-1995)	4th Stage (1996-2000)	Total	Remarks
a. Public Sewers (main)	32,480 (45,700)	34,510 (61,970)	47,000 (107,720)	51,900 (151,820)	165,890 (367,210)	
b. Pumping Stations	-	4,750 (8,530)	230 (520)	200 (580)	5,180 (9,630)	
c. Treatment Plant	9,860 (13,870)	21,470 (38,550)	8,600 (19,710)	10,020 (29,310)	49,950 (101,440)	
d. Land Acquisition	5,590 (7,860)	27,800 (49,920)	8,810 (20,190)	3,200 (9,360)	45,400 (87,330)	
(A) Sub-Total	47,930 (67,430)	88,530 (158,970)	64,640 (148,140)	65,320 (191,070)	266,420 (565,610)	
(B) Contingency	9,580 (13,480)	17,700 (31,790)	12,920 (29,620)	13,060 (38,210)	53,260 (113,100)	(A)x0.20
(C) Engineering Fee						
Design	2,870 (4,040)	5,310 (9,530)	3,870 (8,880)	3,910 (11,460)	15,960 (33,910)	(A+B)x0.05
Supervision	2,870 (4,040)	5,310 (9,530)	3,870 (8,880)	3,910 (11,460)	15,960 (33,910)	(A+B)x0.05
Total	63,250 (88,900)	116,850 (209,820)	85,300 (195,520)	86,200 (252,200)	351,600 (746,530)	

TABLE V-3 Drainage Construction Cost by Stage at 1976 Price Level
to be borne by public sector

(1,000 M$)

Description \ Stage	1st Stage (1981-1985)	2nd Stage (1986-1990)	3rd Stage (1991-1995)	4th Stage (1996-2000)	Total	Remarks
a. Main Drains	46,940 (66,040)	5,050 (9,060)	17,080 (39,140)	39,220 (114,720)	108,290 (228,960)	
b. Reservoir for Initial Storm	350 (490)	-	-	-	350 (490)	
c. Reservoir for Major Storm	-	1,000 (1,790)	11,500 (26,350)	45,600 (113,390)	58,100 (161,530)	
d. Land Acquisition	4,490 (6,310)	330 (590)	630 (1,440)	-	5,450 (8,340)	
(A) Sub Total	51,780 (72,840)	6,380 (11,440)	29,210 (66,930)	84,820 (248,110)	172,190 (399,320)	
(B) Contingency	10,350 (14,560)	1,270 (2,280)	5,840 (13,380)	16,960 (49,620)	34,420 (79,840)	(A)x0.20
(C) Engineering Fee						
Design	3,100 (4,370)	380 (680)	1,750 (4,010)	5,080 (14,880)	10,310 (23,940)	(A+B)x0.05
Supervision	3,100 (4,370)	380 (680)	1,750 (4,010)	5,080 (14,880)	10,310 (23,940)	(A+B)x0.05
Total	68,330 (96,140)	8,410 (15,080)	38,550 (88,330)	111,940 (327,490)	227,230 (527,040)	

TABLE V-4 Sewerage Construction Cost by Stage at 1976 Price Level to be borne by private sector

(1,000 M$)

Description / Stage	1st Stage (1981-1985)	2nd Stage (1985-1990)	3rd Stage (1991-1995)	4th Stage (1996-2000)	Total	Remarks
a. Branch & Lateral Sewer	59,410 (83,590)	25,670 (46,090)	89,580 (205,310)	106,540 (311,650)	281,200 (646,640)	
b. House Connection	16,950 (23,850)	13,290 (23,860)	14,300 (32,770)	17,310 (50,630)	61,850 (131,110)	
(A) Sub Total	76,360 (83,590)	38,960 (46,090)	103,880 (205,310)	123,850 (311,650)	343,050 (646,640)	
(B) Contingency	15,270 (23,850)	7,790 (23,860)	20,770 (32,770)	24,770 (50,630)	68,600 (131,110)	(A)x0.20
(C) Engineering Fee						
Design	4,580 (6,440)	2,330 (4,190)	6,230 (14,280)	7,430 (21,730)	20,570 (46,640)	(A+B)x0.05
Supervision	4,580 (6,440)	2,330 (4,190)	6,230 (14,280)	7,430 (21,730)	20,570 (46,640)	(A+B)x0.05
Total	100,790 (141,800)	51,410 (92,320)	137,110 (314,250)	163,480 (478,190)	452,790 (1,026,560)	

Note: In above table branch & lateral sewer costs include the costs of all sewers which are branched from the main sewers for which costs will be recovered from the adjacent land owners. The house connection costs cover the facilities lying withing private property and the portions of connection pipe that lie within the public rights of way.

TABLE V-5 Drainage Construction Cost by Stage at 1976 Price Level
to be borne by private sector

(1,000 M$)

Description \ Stage	1st Stage (1981-1985)	2nd Stage (1986-1990)	3rd Stage (1991-1995)	4th Stage (1996-2000)	Total	Remarks
(A) Network of Minor Drain	39,840 (56,050)	19,050 (34,210)	34,230 (78,450)	62,900 (183,990)	156,020 (352,700)	
(B) Contingency	7,960 (11,210)	3,810 (6,840)	6,840 (15,690)	12,580 (36,790)	31,190 (70,530)	(A)x0.20
(C) Engineering Fee						
Design	2,390 (3,360)	1,140 (2,050)	2,050 (4,700)	3,770 (11,030)	9,350 (21,140)	(A+B)x0.05
Supervision	2,390 (3,360)	1,140 (2,050)	2,050 (4,700)	3,770 (11,030)	9,350 (21,140)	(A+B)x0.05
Total	52,580 (73,980)	25,140 (45,150)	45,170 (103,540)	63,020 (242,840)	205,910 (465,510)	

TABLE V-60 Operation and Maintenance Cost at 1976 Price Level

(1,000 M$/year)

Element of System	Stage	1st Stage (1981-1985)	2nd Stage (1986-1990)	3rd Stage (1991-1995)	4th Stage (1996-2000)
Sewerage	Sewer(main)	330	350	470	560
		(460)	(620)	(1,070)	(1,630)
	" (small)	720	310	1,080	1,300
		(1,010)	(550)	(2,470)	(3,800)
	Pumping Station	-	110	30	20
			(190)	(60)	(50)
	Treatment Plant	250	310	260	270
		(350)	(550)	(590)	(780)
Drainage	Drain(main)	550	740	930	1,210
		(830)	(1,320)	(2,130)	(3,530)
	" (small)	280	450	610	830
		(390)	(800)	(1,390)	(2,420)
Total		2,170	4,440	7,820	12,010
		(3,040)	(7,070)	(14,780)	(26,990)

Note: No costs for house connections are provided in above table since the ownerships of those house connections are to be vested in individual household owners who will be obliged to maintain and control their house connections at their own expenses.

4.3 Potential Sources of Capital & Operation Revenue

The substantial amount of capital is normally required for the project which involves the extensive construction as sewerage and drainage works. It is therefore necessary for the Government to consider the specific arrangement to generate the funds to meet the capital requirements for the construction as well as operation of the systems after completion.

The viability of the project is largely dependent on adequately arranged source of funds including less burdensome long term and low interest loans, the Government's grant, equitable sewer use charge and other revenue projections. The specific arrangement for funding would be needed during the early years of the programme when there is virtually no means to generate revenue through services.

In previous table the costs for the element (A) to be brone by public sector indicates the costs to be financed by the Government's own capital source or arrangement of external loan either from multilateral or bilateral lending agency and the costs for the element (B) are to be recovered from developers and those individuals who will receive the direct benefits from systems construction including household and property owners.

The followings are potential sources of capital for construction and revenue required for operation of the systems.

(1) Capital Sources from Public Sector

(a) Long-term Loans

Prior to the construction, the funding arrangement will be necessary through one of several alternative sources, loans from Federal Government or Stage Government, multi-lateral and bi-lateral lending agency.

It is desirable to arrange the loans of long term and low interest to support the viability of the Project with deferred repayment of principal to mitigate the cash flow problem in early years of construction while there are no means to raise the funds through connections to the sewerage system. The World Bank and Asian Development Bank are examples of multi-lateral sources of loans. The recent loans provided by both World Bank and Asian Development in Malaysia indicates interest rate 8 - 9%, and repayment terms of 20 years with grace period of 5 years. The World Bank has recently been providing loans to Malaysia with favorable terms. Bi-lateral loan agreements are also considered to be made with U.S.A. Japan, Germany, Canada and others that have aid programmes for developing nations, sometimes with more favorable conditions than those from the multi-lateral sources.

(b) Government Grant

Since the sewerage and drainage works include the construction of the systems such as treatment and disposal facilities which provide community benefits accruing to the population at large, some form of support from Government is relevant similar to other public works for infrastructure development such as road construction.

The direct grant from the Government will enable the construction of downstream disposal and other major facilities earlier than would be effectuated through the funds raised by other means.

In addition to direct grant, there are indirect grants in various forms such as interest-free advances, advance payment of direct benefit charges against Government properties or the establishment of special favorable loan terms from Government sources, and setting up a revolving fund to assist houseowners who may have difficulty in paying the required cash for the connection and relevant plumbing costs.

(2) Capital Sources from Private Sector

The capital to be obtained from the individuals who will receive the direct benefits from the systems usage will significantly contributes to reduce the amount of loan required for development project and decrease the financial burden on the Government. There are several alternative methods to raise such capital.

(a) Benefit Assessments

Benefit assessments are basically applied to cover the costs for branch and lateral sewers and drains which provide benefits to the property served by improving the marketability and value of the properties. The assessments can be levied against all property owners based on front footage, or the area of property or assessed value, or annual equivalent rental value of the properties.

(b) House Connection

The full costs of connecting a property to a branch or lateral sewer including relevent replumbing costs are recovered by individual houseowners since the benefits derived from

such connection accrue to the properties connected only. The specific arrangement will be necessary, however, for the collection method of charge as well as legal enforcement to prevent a delayment of connection resulting from house-owners' reluctancy to the connection.

(c) Developers Contribution

The infrastructure systems including sewerage and drainage system should preferably be developed prior to the other constructions on the new housing and industrial development areas, otherwise, it will cause inconvenience and extra costs such as rebuilding and remodelling of existing systems. In order to avoid such inconvenience, the developers are commonly required to construct such infrastructure systems when they develop the areas. The costs incurred from such constructions can be compensated by including such costs in their sale prices of lands. Therefore, incumbent developers in this proposed Project will be fully responsible for the construction of branch and lateral sewers and drains as well as house connections. The installment of the systems can be made either by developers' own capital or by the Government who may recover the costs from the developers.

(3) Potential Sources of Operation Revenue

The well planned revenue sufficient to sustain the Project on a financially viable base will be necessary during the whole life of the Project. The revenues are basically required to meet the costs for operation and maintenance of the system including administration expenses plus long term debt service payment. Among the several methods commonly applied to raise the revenue, the well suited to the proposed Project with simple, logical practicable, enforceable and equitable nature should be selected.

(a) Service Charge

The service charges are applied to individual users of the systems on proportion to the use they make. In calculating the charge there are following methods available in some cities in the world.

i) Pedestal Charge

The flat rate is multiplied by the numbers of water closet (WC) pedestal in the households to calculate the charge on the theory that the waste volume is linked with pedestal. The collection of the charge is administratively easy, but, it does not appear that the waste discharge is closely related to the pedestal, and, more adequate method should be considered.

ii) Fixture-unit Charge

The numbers of water fixtures, such as faucets, water heaters, air coolers, and flush toilets, are multiplied by flat rate so as to provide the revenue required based on the theory that volume of waste discharge is related to the volume of water consumption, hence to the numbers of fixtures. The households which have many fixtures do not necessarily consume much water and more rational method should be considered.

iii) Per Capita Charge

The charge is calculated multiplying the numbers of residents or employees in the households or commercial property by a flat rate fee based on the theory that volume of waste discharge proportionate to the numbers of residents. This method has also a disadvantage in obtaining the accurate waste discharge as same as above method.

iv) Water Rate Surcharge

The water rate surcharge is service charge related to water use which is calculated by adding a fixed rate to metered water consumption. This method would appear to be the best alternative satisfying the required nature for recommendable method as mentioned above. The volume of waste discharge is closely related to water consumption which is accurately metered. The collection of the charge is enforceable by cutting-off the water supply in the event of non-payment. The collection of charge can be made without difficulty in combination of billing procedure for water supply already in existence. There will be certain cases where water consumption is difficult to measure as consumers draw water from private sources (wells). However, the most water in the Project area is supplied by pipe, and there will be no setback in adopting this method.

(b) Annual Subsidies from Government

The self-supporting system without any Government subsidies is most desirable in operation of public utility systems, including sewerage and drainage systems, but, it depends ultimately on the ability of the users to pay the required charge of the system who may be liable to substantial burden. In as much as the amount of revenue collectable from the users is limited to defray not necessarily to cover all the expenses for operation and maintenance expenses, and debt service payment, certain amount of Government subsidies will be justified as a social costs for improvement of public health and sanitation as well as protection of water pollution of the area at large.

4.4 Preliminary Financing Plan

The components of the recommended financial plan are presented below and summarized in TABLE V-7 to provide basic guideline by which future financial projections can be made at the stage of feasibility study.

(1) Long term international or domestic loan with low interest and longer grace period to cover the initial construction costs.

(2) Government grant for the construction of major facilities especially for construction of treatment plants and disposal facilities, and subsidies to cover balance of annual revenue and actual expenditure.

(3) Benefit assessments against property owners to cover the costs for branch and lateral sewers and drains in the form best suited to the locality (either one of the assessments based on front footage, area of property, assessed value, or annual equivalent rental value of the properties).

(4) Direct payments by household owners of the full costs of house connections (including pipes in public right of way) and conversion of plumbing systems in the household wherever necessary.

(5) Water rate surcharge based on water consumption with specific rate on quality of trade waste to meet the costs for operation and maintenance and debt service payments.

(6) Developers' contribution for the construction of branch and lateral sewers and drains as well as individual house connections in the development area.

TABLE V-7

Preliminary Financing Plan for Sewerage and Drainage Program up to the Year 2000

Elements	Required Funds by Stage (1,000 M$)					Suggested Sources of Funds
	1st stage	2nd stage	3rd stage	4th stage	Total	
Construction of Public Main Sewers and Drains, Treatment Plant, Pumping Station, Reservoirs, and Land Acquisition	131,580 (185,130)	125,260 (224,900)	123,850 (283,850)	198,140 (579,690)	578,830 (1,273,570)	Long term loan & Government grant.
Construction of Branch & Lateral Sewers & Drains and House Connection	153,370 (215,780)	76,550 (137,470)	182,280 (417,790)	246,500 (721,030)	658,700 (1,492,070)	Benefit assessments against property owners, developers' contribution for branch & lateral sewers and drains. Direct payments by household owners of house connection.
Annual System Operation and Maintenance Costs excluding debt service payments	2,170/yr (3,040/yr)	2,270/yr (4,030/yr)	3,380/yr (7,710/yr)	4,190/yr (12,210/yr)		Water rate surcharge based on water comsumption & Government subsidies.

Note: The figures are on 1976 price level, and those figures in brackets include 5% escalation per annum as indicated in detail by foot note of TABLE V-1.

1) LIST OF ABBREVIATIONS

2) CONVERSION TABLES

3) GLOSSARY (DEFINITIONS OF TERMS)

1) LIST OF ABBREVIATIONS

(a) Unit

cu m	-	Cubic meters
cu m/day	-	Cubic meters per day
cu m/cap/day	-	Cubic meters per capita per day
cu m/sec	-	Cubic meters per second
g/cap	-	Grams per capita
g/day	-	Grams per day
ha	-	Hectares
IG	-	Imperial gallon
IGD	-	Imperial gallons per day
kg	-	Kilograms
km	-	Kilometers
l/day	-	Liters per day
l/cap/day	-	Liters per capita per day
m	-	Meters
mg/l	-	Milligrams per liter
MIGD	-	Million imperial gallons per day
mm	-	Millimeters
ppm	-	Parts per million
sq m	-	Square meters
yr	-	Years

(b) Organization

DID	-	Drainage and Irrigation Department
EG	-	Engineering Department, Local Government of Penang Island
EPU	-	Economic Planning Unit, Prime Menister's Department Federal Government
LD	-	Labour Department, PSG
MHD	-	Medical and Health Department, PSG
MPSP	-	Majlis Perbandaran Seberang Perai (Municipal Council Province Wellesley)

PDC	-	Penang Development Corporation
PSG	-	Penang State Government
PWA	-	Penang Water Authority
PWD	-	Public Works Department, PSG
SEPU	-	State Economic Planning Unit, PSG
TCP	-	Town and Country Planning, PSG
WHO	-	World Health Organization

(c) Others

BBMA	-	Butterworth/Bukit Mertajam Metropolitan Area
BOD	-	Biochemical oxygen demand (5day, 20 centigrade)
COD	-	Chemical oxygen demand
CPI	-	Consumer Price Index
DMP	-	Design Master Plan
DO	-	Dissolved oxygen
GNP	-	Gross National Products
HP	-	Hume Pipe
M$	-	Malaysian Dollars
NEP	-	New Economic Policy
pH	-	Hydrogen ion potential
PMP	-	Preventative Master Plan
PV	-	Permanganate Value
PW	-	Province Wellesley
RCP	-	Reinforced concrete pipe
RL	-	Reduced Level
SMP	-	Second Malaysia Plan
SOD	-	Survey Ordinance Datum
SS	-	Suspended Solids
TMP	-	Third Malaysia Plan
VCP	-	Vitrified clay pipe

2) CONVERSION TABLES

TABLE - 1 Length (1)

m	cm	Yards	Feet	Inches
1	100	1.0936	3.2808	39.370
0.01	1	0.0109	0.0328	0.3937
0.9144	91.440	1	3	36
0.3048	30.480	0.3333	1	12
0.0254	2.540	0.0278	0.0833	1

TABLE - 2 Length (2)

km	Yards	Miles
1	1,093.61	0.62137
0.00091	1	-
1.60934	1,760	1

TABLE - 3 Area

ha	sq km	Acres	sq mile	sq m	sq ft
1	0.0100	2.471	0.00386	10,000	107.640
100	1	247.10	0.3861	-	-
0.4047	0.004047	1	0.00156	-	-
259	2.590	640	1	-	-
-	-	-	-	1	10.764
-	-	-	-	0.09290	1

1 sq ft = 144 sq in 1 sq in = 0.006946 sq ft

TABLE - 4 Volume

Liters	cu m	cu ft	Imp.gal.(IG)
1	0.001	0.03531	0.220
1,000	1	35.31	220
28.317	0.02832	1	6.231
4.546	0.004546	0.1605	1

TABLE - 5 Weight

Kg	t	Ounces (OZ)	lb
1	0.001	35.27	2.2046
1,000	1	3.257×10^{4}	2,204.6
0.02835	2.835×10^{-5}	1	0.06250
0.4536	4.536×10^{-3}	16	1

TABLE-6 Velocity

m/sec	km/hr	ft/sec	mile/hr
1	3.600	3.2808	2.237
0.2778	1	0.9113	0.6214
0.3048	1.0973	1	0.6818
0.4470	1.6093	1.4667	1

TABLE - 7 Rate of Flow

l/sec	cu m/hr	cu m/sec	Imp.gal./min	cu ft/hr	cu ft/sec	Imp.MGD	cu m/day
1	3.6	0.001	13.198	127.13	0.03531	0.01901	86.4
0.2778	1	2.778×10^{-4}	3.666	35.31	9.810×10^{-3}	5.279×10^{-3}	24
1,000	3,600	1	1.3198×10^{4}	1.2713×10^{5}	35.31	19.01	86,400
0.07578	0.2728	7.577×10^{-5}	1	9.632	0.002676	1.440×10^{-3}	6.547
7.866×10^{-3}	0.02832	7.866×10^{-6}	0.10381	1	2.778×10^{-4}	1.495×10^{4}	0.6796
28.32	101.94	0.02832	373.7	3,600	1	0.5383	2,447
52.61	189.41	0.05261	694.4	6,688.2	1.858	1	4,546
0.01157	$4,167 \times 10^{-2}$	0.1157×10^{-4}	0.1528	1.471	4.087×10^{-4}	2.200×10^{-4}	1

3) GLOSSARY

(DEFINITIONS OF TERMS)

* Activated Sludge Process

A process for achieving biological stabilization of sewage based on use of activated sludge generated under aerobic conditions maintained by included aeration in a reaction chamber, with the effluent subsequently settled and part of the sludge returned to the reaction chamber.

* Aeration

The bringing about of intimate contact between air and a liquid by one or more of the following methods: (a) spraying the liquid in the air, (b) bubbling air through the liquid, (c) agitating the liquid to promote surface absorption of air.

* Aerated Lagoon

A natural or artificial wastewater treatment pond in which mechanical or diffused-air aeration is used to supplement the oxygen supply.

* Aerobic

Requiring, or not destroyed by, the presence of free elemental oxygen.

* Aerobic Bacteria

Bacteria that require free elemental oxygen for their growth.

* Amortization

The annual payments required to repay the principal amount of a loan in given number of years.

* Anaerobic Digestion

The degradation of organic matter brought about through the action of micro-organisms in the absence of elemental oxygen.

* Benefit-Cost Ratio

A theoretical economic concept, usually expressed by relating the present value of the stream of capital costs and annual expenses of the project.

* Biochemical Oxygen Demand (BOD)

Abbreviation for biochemical oxygen demand. The quantity of oxygen used in the biochemical oxidation of organic matter in a specified time, at a specified temperature, and under specified conditions.

* Box Culvert

A culvert with a rectangular cross section.

* Branch Sewer

A sewer which receives wastewater from a relatively small area. and discharges into a main sewer serving more than one branch-sewer area.

* Coefficient

A numerical quantity, determined by experimental or analytical methods, interposed in a formula which express the relationship between two or more variables to include the effect of special conditions or to correct a theoretical relationship to one found by experiment or actual practice.

* Chlorination

The application of chlorine to water or wastewater, generally for the purpose of disinfection, but frequently for accomplishing other biological or chemical results.

* Coliforms

An important parameter for assessing the level of pollution in receiving waters, based on measuring the concentration of coliform bacteria, which is a rough index of the probable level of contamination by human excreta.

* Collecting System

A system of sewers and appurtenances for the collection, transportation, and pumping of sewage and industrial wastes.

* Combined Sewer

A sewer receiving both surface runoff and sanitary and/or industrial wastewater.

* Concentration Time

The period of time required for storm runoff to flow from the most remote point of a catchment or drainage area to the outlet or point under consideration. It is not constant, but varies with depth of flow and condition of channel.

* Culvert

A closed conduit for the free passage of surface drainage water under a high-way, railroad, canal, or other embankment.

* Demographic Characteristics

The vital statistics of a population, such as births, deaths, marriages, rate of growth, age distribution, literacy and levels of education, skills and/or income.

* Depreciation

The amount which must be charged against profits each year in a series which will equal the original purchase price of a given asset at the end of its useful life expectancy.

* Discount Rate

The compound rate of interest which measures the difference between two values separated by one or more successive periods of time. The rate is applied to the ultimate value to determine the present value of the series at any prior point in time.

* Design Rainfall

The rainfall estimate corresponding to an enveloping depth - duration curve for the selected frequency, often referred to as the "Design Storm".

* Discharge

As applied to a stream or conduit, the rate of flow, or volume of water flowing in the stream or conduit at a given place and within a given period of time.

* Dissolved Oxygen

The oxygen dissolved in water, wastewater, or other liquid, usually expressed in milligrams per liter, parts per million, or percent of saturation. Abbreviated - DO.

* Domestic Wastewater

Wastewater derived principally from dwellings, business buildings, institutions and the like. It may or may not contain ground water, surface water or storm water. Also called sanitary sewage.

* Drainage Basin

An area from which surface runoff is carried away by a single drainage system. Also called catchment area, watershed, drainage area.

* Feasibility Study

A compilation of the economic benefits of a proposed project for comparison with engineering and other estimates of total costs to determine the relative merits of the project vis-a-vis other potential social investments.

* Force Main

A pressure pipe joining the pump discharge at a water or wastewater pumping station with a point of gravity flow.

* Gradient

The rate of change of any characteristic per unit of length or scope. The terms is usually applied to such terms as elevation, velocity, pressure.

* Head

The height of the free surface of fluid above any point in a hydraulic system; a measure of the pressure or force exerted by the fluid.

* House Connection

The pipe carrying sewage from the building to a public sewer. Also called Building Sewer and House Sewer.

* Hydraulic Gradient

The slope of the hydraulic grade line; the rate of change of pressure head; the ratio of the loss in the sum of the pressure head and position head to the flow distance. For open channels, it is the slope of the water surface and is frequently considered barallel to the invert. For closed conduits under pressure, it is the slope of the line jointing the elevations to which water would rise in pipes freely vented and under atmospheric pressure. A positive slope is usually one which drops in the direction of flow.

* Industrial Wastes

The liquid wastes from industrial processes, as distinct from domestic or sanitary wastes.

* Infiltration

(1) The flow or movement of water through the interstices or pores of a soil or other porous medium. (2) The quantity of groundwater that leaks into a pipe through joints, porous walls, or breaks. (3) The entrance of water from the ground into a gallery. (4) The absorption of liquid by the soil, either as it falls as precipitation or from a stream flowing over the surface.

* Infrastructure

The basic structures and facilities upon which the economic activities of a community or region are dependent, such as roads, railways, school systems, water and power supply and other public utilities. Sometimes referred to as Social Overhead Capital.

* Initial Storm

The storm having a return period of 2 or 5 years.

* Inlet

(1) A surface connection to a drain pipe. (2) A structure at the diversion end of a conduit. (3) The upstream end of any structure through which water may flow. (4) A form of connection between the surface of the ground and a drain or sewer for the admission of surface or storm water. (5) An intake.

* Invert

The floor, bottom, or lowest portion of the internal cross section of a closed conduit. Used particularly with reference to aqueducts, sewers, tunnels, and drains. Originally, it referred to the inverted arch which was used to from the bottom of a masonry-lined sewer.

* Land Use

The culture of the land surface, which affects the social and economic conditions of a region and which determines the amount and character of the runoff and erosion. Existing or zoned economic use of land, such as residential, industrial, farm, commercial.

* Pumping Station

A wastewater pumping station that lifts the wastewater to a higher elevation when the continuance of the sewer at reasonable slopes would involve excessive depths of trench, or that raises wastewater from areas too low to drain into available sewers. These stations may be equipped with pneumatic ejectors, centrifugal pumps, or other pumps.

* Main Sewer

A sewer that receives many tributary branches and serves a large teritory. Also called Trunk Sewer. In small systems, a sewer to which one or more branch sewers are tributary.

* Major Storm

The storm having a return period of 100 years.

* Manhole

An opening in sewer provided for the purpose of permitting a man to enter or leave the sewer.

* Metropolitan Area

The area which was defined to be urbanized within around 20 years from the basic year.

* Micro and Macro Drainage

Storm water systems are commonly considered as divided into local/smaller conduit systems (micro-drainage), which discharge into larger conduits or systems (macro-drainage).

* Municipality

The officials governing such a community as city, town, etc.

* Outfall Sewer

A sewer which receives the sewage from a collecting system and carries it to a point of final discharge. See Pipe Outlet.

* Open Channel

Any natural or artificial waterway or conduit in which water flows with its surface exposed to the outside atmosphere.

* Outlet

Downstream opening or discharge end of pipe, culvert or canal.

* Overland Flow

The flow of water over the ground before it enters some defined channel.

* Oxidation Pond

A basin used for retention of wastewater before final disposal, in which biological oxydation of organic material is effected by natural or artificially accelerated transfer of oxygen to the water from air.

* pH

The reciprocal of the logarithm of the hydrogen-ion concentration in grams per liter of solution. Neutral water, for example, has a pH value of 7 and a hydrogen-ion concentration of 10^{-7}.

* Pipe Outlet

A pipeline which conveys the effluent from a reservoir, sewage treatment plant, or other structure to its point of discharge.

* Present Value

The economic method which recognizes and quantifies the values of differences in time. Benefits or costs which are expected to be received or incurred at a future date are worth less than those which can be enjoyed

or must be paid currently. Present value at any point in time is determined by applying a given discount rate to the ultimate value for the appropriate number of years.

* Public Sewer

All sanitary sewers, except house connections.

* Primary Treatment

(1) The first major (some times the only) treatment in wastewater treatment works, usually sedimentation. (2) The removal of a substantial amount of suspended matter but little colloidal and no dissolved matter.

* Rainfall Intensity

Amount of rainfall occuring in a unit of time, converted to its equivalent in millimeters per hour at the same rate.

* Rainfall-Intensity Curve

A curve that expresses the relation on rate of rainfall and their duration. Each curve is generally for a period of years during which time the intensities shown will not, on the average, be exceeded more than once.

* Rational Method

A method of estimating the runoff in a drainage basin at a specific point and time by means of the rational runoff formula. For each drainage area, the rainfall rate under a stated intensity-duration relationship, the fraction that will appear as runoff, and the basin area above the specific point are estimated. Their products is the flow. This method is used to estimate storm runoff in urban areas and flood flows in streams.

* Roughness Coefficient

A factor in the Chezy, Darcy-Weisbach, Hazen-Williams, Kutter, Manning, and other formulae for computing the average velocity of flow of water in the conduit or channel, which represent the effect of roughness of the confining material on the energy losses in the flowing water.

* Runoff

(1) That portion of the earth's available water supply that is transmitted through natural surface channels. (2) That part of the precipitation which runs off the surface of a drainage area and reaches a stream or other body of water or a drain or sewer.

* Runoff Coefficient

The ratio of the maximum rate of the runoff to the uniform rate of rainfall with a duration equaling or exceeding the time of concentration which produced this rate of runoff.

* Sanitary sewer

A sewer which carries liquid and water-carried wastes from sanitary conveniences of residences, commercial buildings, industrial plants, and institutions, together with quantities of ground, storm and surface water which are not admitted intentionally.

* Sanitary Wastewater

(1) Domestic wastewater with storm and surface water excluded. (2) Wastewater discharging from the sanitary conveniences of dwellings (including apartment houses and hotels), office buildings, industrial plants, or institutions. (3) The water supply of a community after it has been used and discharge into a sewer. Also called sanitary sewage.

* Secondary Treatment

The treatment of wastewater by biological or chemical methods after primary treatment by sedimentation.

* Separate System

A system of sewers and drains in which sanitary wastewater and storm water are carried in separate conduits.

* Septic Tank

A settling tank in which settled sludge is in immediate contact with the wastewater flowing through the tank and the organic solids are decomposed by anaerobic bacterial action.

* Sewage

The spent water of a community. Term now being replaced in technical usage by the preferable term wastewater.

* Sewage Works

All-inclusive term for wastewater collection, pumping, treatment, and disposal facilities. Term declining in use.

* Sewer

A pipe or conduit that carries wastewater or storm water drainage.

* Sewerage

System of piping, with appurtenances, for collecting and conveying wastewater from source to discharge. Term declining in use.

* Stabilization Lagoon

A shallow pond for storage of wastewater before discharge. Such lagoons may serve only to detain and equalized wastewater composition before regulated discharge to a stream, but often they are used for biological oxidation.

* Stabilization pond

A type of oxidation pond in which biological oxidation of organic matter is effected by natural or artificially accelerated transfer of oxygen to the water from air.

* Storm Sewer

A sewer that carries storm water and surface water, street wash and other wash waters, or drainage but excludes domestic wastewater and industrial wastes. Also called storm drain.

* Storm Water

The excess water running off from the surface of a drainage area during or immediately after a period of rain. It is that portion of the rainfall and resulting surface flow that is excess of that which can be absorbed through the infiltration capacity of the surface of the area.

* Storm-water System

System of drains and appurtenances for conveying the runoff from street surfaces.

* Sub-main Sewer

A arbitary term used for relatively large branch sewers.

* Term

The period of time stated in the loan contract by the end of which the loan must be fully repaid.

* Tidal River

A river in which flow and water surface elevation are effected by the tides. Such effect usually occurs in the lower stretch near the mouth, where the gradient is very flat. In some streams, the effect may extend a hundred or more kilometers upstream from the mouth.

* Time Lag

(1) Referring to discharge or water level, the time elapsing between the occurrence of corresponding changes in discharge or water level at two points in a river. (2) Referring to runoff of rainfall, the time between the center of mass, or beginning, or rainfall to the peak, or center of mass, of runoff.

* Useful Life Expectancy

The period of time during which a piece of equipment a building or other physical asset is expected to render the service or perform the function for which it is intended, at an acceptable level of efficiency, with ordinary maintenance and under operating conditions expected in the given situtation. Technical and financial planning assumes that the asset will have to be replaced at the end of its expected useful life.

* Wastewater

The spent water of a community. From the standpoint of source, it may be a combination of the liquid and watercarried wastes from residences, commercial buildings, industrial plants, and institutions, together with any groundwater, surface water, and storm water that may be present. In recent years, the ward wastewater has taken precedence over the work sewage.