City of Detroit
Water and Sewerage Department

Proposed Sewerage System Rates and Charges

MAY 1979

CAMP DRESSER & McKEE INC.

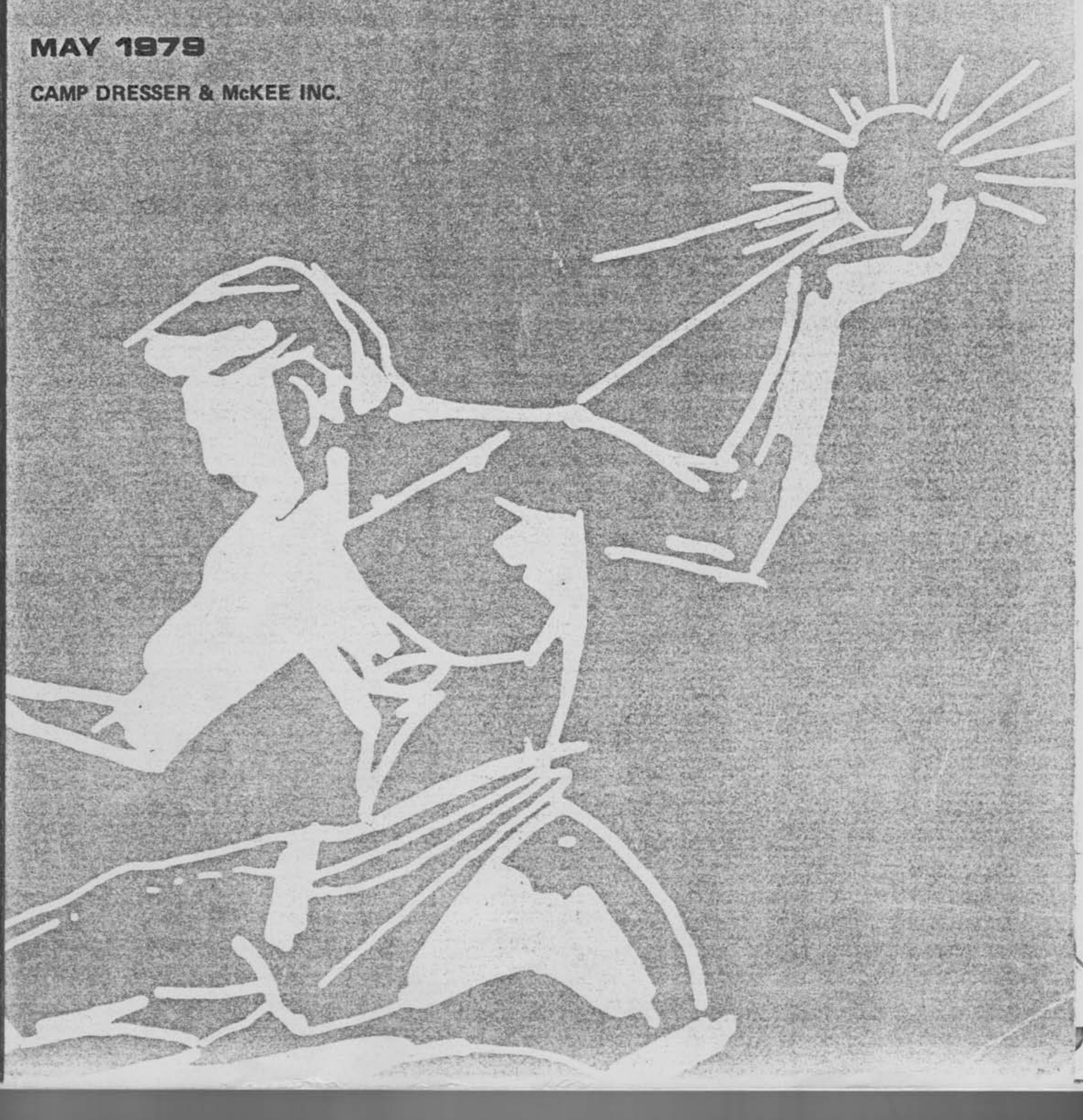

Figure II-E, on the following page, presents the process flow diagram for the plant. All influent flow is lifted at the main pumping station and flows through the bar racks and grit chambers. Phosphorus removal occurs in the primary and secondary sedimentation tanks and is enhanced by the prior addition of polymer and ferrous chloride. Floatables are skimmed from the primary sedimentation tanks and pumped to the scum incinerator for disposal.

Currently, a portion of the primary effluent is biologically treated, and the remainder is chlorinated and discharged. However, the plant is scheduled to increase to full secondary treatment of 1,050 MGD by September 1, 1980.

Both oxygen and air facilities are utilized in the activated sludge process. Following aeration, settling of biological solids occurs in the secondary clarifiers. Most of the secondary effluent is chlorinated and discharged, although a portion of the flow is recovered and recirculated throughout the plant to processes where it can be utilized. The outfall, which extends into the Detroit River, serves as the chlorination chamber.

Waste sludge is mixed, gravity thickened and stored. Dewatering is accomplished by vacuum filtration, and the sludge cake from the filters is incinerated. Recently, a portion of the filter cake has also been landfilled as an interim measure while a major sludge handling and disposal study is underway.

Component Processes

The facilities and operations at the wastewater treatment plant can be described by functional component processes. In general, these component processes match those currently used by the DWSD accounting system and are:

Primary Pumping

Rack and Grit

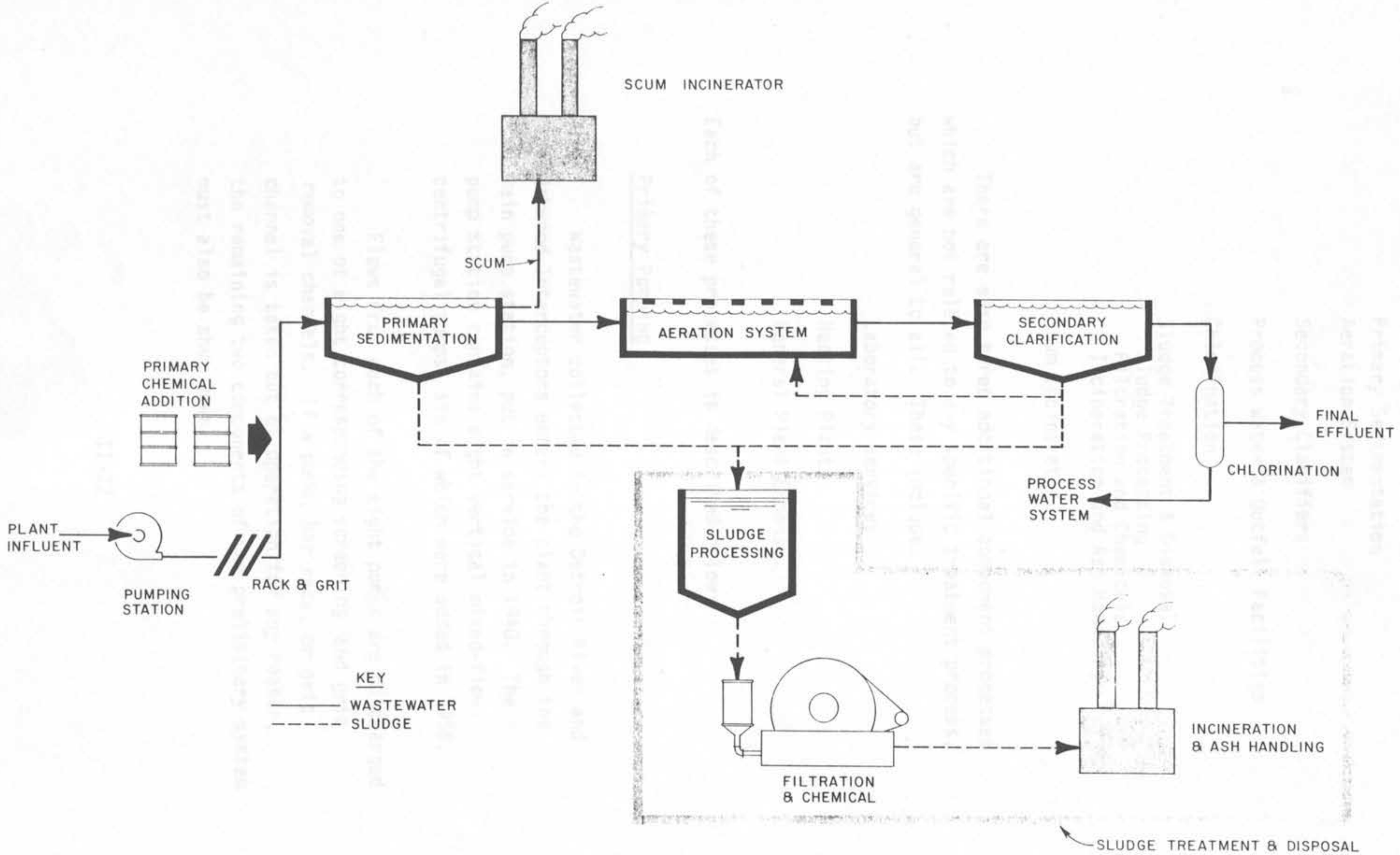

FIGURE II-E

SEWAGE TREATMENT PLANT PROCESS FLOW DIAGRAM

Primary Chemical Addition

Primary Sedimentation

Aeration System

Secondary Clarifiers

Process Water & Outfall Facilities

Chlorination

Sludge Treatment & Disposal
- Sludge Processing
- Filtration and Chemicals
- Incineration and Ash Handling

Scum Incinerator.

There are also three additional component processes which are not related to any specific treatment process, but are general to all. These include:

Laboratory Services

Heating Plant

General Plant Expense.

Each of these processes is described below:

Primary Pumping

Wastewater collected in the Detroit River and Oakwood Interceptors enters the plant through the main pump station, put in service in 1940. The pump station contains eight vertical mixed-flow centrifugal pumps, six of which were added in 1956.

Flows from each of the eight pumps are discharged to one of eight corresponding screening and grit removal channels. If a pump, bar rack, or grit channel is taken out of operation for any reason, the remaining two components of the preliminary system must also be shut down.

Rack and Grit

Bar racks with 3/4" openings are situated before each of the eight grit chambers.

The screenings are removed by a series of conveyor belts to a truckloading station for hauling to a landfill. Larger objects are removed and disposed of separately.

The current grit removal facility consists of eight mechanically cleaned grit channels. Approximately 3,120 tons of screenings and 18,780 dry tons of grit were removed from the plant in fiscal year (FY) 1977.*

Primary Chemical Addition

The existing phosphorus removal system consists of pickle liquor (ferrous chloride) and polymer feeding and storage facilities. Ferrous chloride is added to react with phosphorus to form an insoluble iron compound which may be removed with settled primary sludge. Anionic polymer is used to aid in the coagulation of the iron-phosphorus floc. Approximately 1,696 tons of phosphorus were removed in FY 1977.

Primary Sedimentation

Removal of suspended and floating material is accomplished in twelve rectangular and two circular primary clarifiers of below-ground reinforced concrete construction. Two additional circular clarifiers will be added in the near future, bringing total primary capacity to 1200 MGD.

Aeration

There are four aeration basins currently existing·

* Note: The DWSD fiscal year runs from July 1 to June 30.

One of the existing basins is an air activated sludge process and is designed for a flow of 150 MGD while each of the remaining three is covered and utilizes a pure oxygen system with a design average flow of 300 MGD.

In FY 1977 approximately 332 MGD was treated in the secondary facilities.

Secondary Clarifiers

Presently, there are twenty-one operating secondary clarifiers. Four more are under construction, which, when completed, will provide a total secondary clarifier capacity of 1050 MGD.

Process Water

The process water system, comprised of screened final effluent, is designed to supply the water requirements of portions of the sewage treatment plant where the water required could be of less than potable quality.

The process water system is supplied from the secondary effluent chlorination contact channel.

Chlorination

The existing disinfection system is a conventional gaseous chlorine system. Four railroad sidings are used to park tank cars from which liquid chlorine is fed to eleven evaporators (one steam and ten hot water), where the liquid is converted to gas. The chlorine gas is mixed with water and fed to the plant effluent as an aqueous solution.

Sludge Treatment and Disposal

Sludge treatment and disposal consists of a series of processes which collect, dewater and incinerate or otherwise dispose of solids generated during primary and secondary treatment. There are three subcomponents to sludge handling and disposal:

(a) Sludge Processing: gravity thickening, blending and storage

(b) Filtration: dewatering by vacuum filtration

(c) Incineration

Each subcomponent is described in detail as follows:

(a) Sludge Processing

Sludge processing consists of gravity thickening, blending and storage. Sufficient operational flexibility has been built in to allow the process flow through the unit processes to be changed, and to allow a variety of sludge mixtures (primary, air- and oxygen-activated) to be processed.

Gravity thickening is accomplished by admitting sludge into a tank which has suitable quiescent conditions so that the solids settle out by gravity. A continuous flow of liquid flows over the weirs in the tank and is returned to the Oakwood Interceptor. The thickened sludge that collects at the bottom of the tanks is drawn off and pumped to either the sludge blending or storage tanks.

There are two sludge blending tanks presently in operation. Four circular and two rectangular tanks are used for sludge storage.

Overflows from the storage tanks flow by gravity to the Oakwood Interceptor. Sludge from the circular storage tanks normally flows by gravity to the Sludge Complex II vacuum filters. Sludge from the rectangular storage tanks is transferred to the Sludge Complex I vacuum filters.

(b) Filtration

Filtration refers to the method by which sludge is mechanically dewatered. There are a total of 28 vacuum filters in two areas (known as Complex I and Complex II) which receive sludge, after it has been processed, at a solids content of less then 5 percent and produce a sludge cake with an estimated solids content of approximately 20 percent.

(c) Incineration

The sludge cake generated by dewatering in Complexes I and II is transported via a conveyor system to Incineration Complexes I and II for burning. There are currently six sludge incinerators in Complex I and eight in Complex II, all capable of operating with natural gas or No. 2 fuel oil.

Scum Incineration

At the scum incinerator building, the scum is dewatered in a grease separator. The scum is skimmed into a hopper and then pumped to the incinerator.

The water hearth incinerator consists of a vertical, cylindrical unit, lined with high temperature brick and steel "pot" with a flotation tank mounted in the bottom of the unit.

Primary scum and grease can also be sent to the sludge incinerators in Complex I.

Sewage Treatment Plant
Influent Characteristics

This section describes the treatment plant influent characteristics of pollutant parameters used for waste surcharge purposes. The pollutants are 5-day biochemical oxygen demand (BOD), total suspended solids (TSS), and total phosphorus (P). Concentrations of these pollutants are expressed in milligrams per liter (mg/l).

Daily records of wastewater loading to the sewage treatment plant were obtained and analyzed for FY 78. The parameters specifically reviewed were flow, BOD, TSS, and P. The results of the analysis are shown on Table II-E, below, which also **shows** additional recent historic data.

BOD, TSS and P daily loadings obtained from the plant were adjusted for 1978, substituting monthly average values for reported values greater than two standard deviations above the mean. In this way, random errors caused by variations in sampling and laboratory analysis techniques were taken into account. It should be noted that there is no influent flow meter at the plant, and flow is calculated using main pump station wet well elevations and pumping times. The relationship between these variables is empirical, and some error in the reported flows may result.

TABLE II-E

AVERAGE SEWAGE TREATMENT PLANT INFLUENT CHARACTERISTICS

PERIOD	FLOW (mgd)[3]	BOD (mg/l)[4]	TSS (mg/l)[4]	P (mg/l)[4]
FISCAL YR 1978[1]	661	124	207	5.52
CALENDAR YR 1976[2]	698	111	241	4.7
CALENDAR YR 1975[2]	722	99	203	5.0
CALENDAR YR 1974[2]	659			

Notes: [1]1978 data from analysis of daily plant records.

[2]1974, 75, 76 data as reported in the Segmented Facilities Plan, Book VII, WCT-112 Wastewater Characteristics.

[3]Million gallons per day

[4]Milligrams per liter

Allocation of System Components to Sewage Parameters

As noted in the following chapter, Public Law 92-500, the Water Pollution Control Act Amendments, and subsequent amendments thereto, require that the recipients of EPA construction grants establish:

- A user charge system which distributes the cost of operation and maintenance of the sewerage system to each user (or user class) in proportion to the user's contribution to the total sewage loading of the system - with factors such as strength, volume and delivery flow characteristics being considered.

- An industrial cost recovery system which provides that each industrial user shall pay an amount equal to its share of the Federal grants divided by the expected life of the grant-funded works, or 30 years, whichever is the lesser. Factors such as volume, strength and delivery flow characteristics are to be considered in the determination of the industrial user's share.

Thus, in order to meet Federal proportionality requirements it is necessary that the costs of operation and maintenance be distributed to sewage parameters. In the case of the Detroit treatment facility and its tributary lines and pumping stations, these parameters are:

- Volume (Q)
- Biochemical Oxygen Demand (BOD)
- Total Suspended Solids (TSS)
- Phosphorus (P).

The first step in this process is to allocate the capital construction and operation and maintenance costs, by system component.

The approach used in this report to allocate component costs to sewage parameters was to maintain a consistent, logical methodology which, when used to calculate rates and charges, will result in equitable and reasonable distributions to system customers according to their usage of the system.

Allocation of Capital Construction Costs

Capital construction costs are allocated according to the criteria used for the design of the system component. For example, pumping station facilities are designed (and pumps are sized) primarily on the basis of flow; therefore, the associated capital costs would be allocated to the flow parameter (Q).

The concept of allocating capital construction costs to design criteria is based on the following:

- Design criteria may, or may not, be related directly to the function performed
- However, size and configuration are set by these criteria and, therefore, they become the basic determinants of cost.

Design assumptions are based on compliance with the Consent Judgment which sets December 31, 1979 effluent limitations (30-day average), treating up to 1000 MGD, of:

BOD	30 mg/1
TSS	30 mg/1
Total Phosphorus (as P)	2.5 mg/1 (1.0 mg/1 beginning 12/31/81)

By implication, "30/30" limitations require full secondary treatment. By September 1, 1980 the plant must provide secondary treatment for 1050 MGD.

Table II-F, on the following page, presents the capital cost allocations to the sewage parameters for which the system is designed.

TABLE II-F

ALLOCATION OF CAPITAL CONSTRUCTION COSTS
TO SEWAGE PARAMETERS

System Component	Q	BOD	TSS	P
	Sewage Parameters			
Pumping Station	100%			
Interceptors and Sewers	100%			
Sewage Treatment Plant				
Pumping Station	100%			
Rack and Grit	100%			
Primary Chemical				100%
Primary Sedimentation	90%		10%	
Aeration System	20%	80%		
Secondary Clarification	65%	35%		
Process Water and Outfall	85% (1)			
Chlorination	100%			
Sludge Treatment and Disposal		15%	70%	15%
Scum Incineration	100%			
Average for Sewage Treatment Plant (2)	56%	16%	21%	7%

Notes:

(1) Remainder (15 percent) is not directly allocable.

(2) Based upon the weighted average debt payments during the rate period of all the directly allocable treatment plant components.

A number of components, being of a general nature, are not directly allocable. Accordingly, their costs are to be distributed to the parameters in accordance with the ratio of each parameter's allocable treatment plant capital costs to the total allocable treatment plant costs. These components are:

- Process Water (15 percent)
- Laboratory Services
- Heating Plant
- Plant Administration Facilities.

The derivation of the percentages is described below:

1. Pumping Stations: Pumps are sized according to flow considerations. Auxiliary equipment and housing are keyed to pump size.

2. Interceptors and Sewers: Volume requirements set size.

3. Rack and Grit: These facilities are sized primarily by flow considerations. The fact that large objects and grit are removed is irrelevant for allocation purposes because the material removed is not a component of TSS.

4. Primary Chemical Addition: As a direct result of P removal, TSS is also reduced; however, feed pumps, chemical storage tanks, solution mixing tanks and auxiliary equipment and buildings have all been sized according to the rate and concentration of P to be removed.

5. Primary Sedimentation: 87 percent of the capital costs have been for structures, and 13 percent for equipment. Primary sedimentation tank structures are designed primarily according to hydraulic loading parameters, and the equipment is chosen and

sized by both flow and solids considerations. Therefore, allocation on the basis of 90 percent of the capital costs being attributed to flow and 10 percent to TSS is believed reasonable.

6. Aeration System: The aeration basins and supporting structures account for 64 percent of the capital costs of this component, with equipment, such as pumps, blowers and oxygen generators, comprising the rest. BOD is the primary design parameter for the structures (mixed liquor suspended solids concentration being the major factor), and equipment design is determined by both BOD and flow considerations. An approximate 50/50 split of the equipment design to BOD and Q yields the final allocation of 80 percent BOD and 20 percent flow.

7. Secondary Clarifier: The secondary clarifier structures, which account for 65 percent of the capital costs of this component, are designed according to flow considerations. The equipment, 35 percent of capital costs, is designed to handle secondary return and waste activated sludges, which are primarily BOD-related. Therefore, 65 percent of the costs are allocated to Q and 35 percent to BOD.

8. Process Water & Outfall: An analysis of these components has shown that 85 percent of the total capital costs are attributable to the outfall and 15 percent to process water facilities. The design of the outfall was based on flow (Q) considerations. However, the process water system contributes to many unit processes and to general plant cleanup, thereby making its portion (15 percent of capital costs) non-directly allocable.

10. Sludge Treatment & Disposal: The facilities contained in this component are designed and sized according to the type and amount of sludge to be processed. Since

the plant began operations as a primary facility in 1940, secondary treatment and phosphorus removal have been added, thereby altering the characteristics of the sludge.

The sizing of facilities is a function of the rate of solids loading. However, relating solids loading to the plant input parameters of BOD, TSS and P is difficult because the parameters are not mutually exclusive, i.e., TSS has a BOD component, and soluble BOD may become a suspended solid during the activated sludge process. Phosphorus occurs in soluble and insoluble forms, the latter contributing to TSS.

Therefore, operational values over a period from December 1977 to September 1978 have been analyzed to link the makeup of sludge solids to the input parameters. The following presents the results of the analysis based upon average FY 78 input values and assuming January 1, 1980 operational conditions.

TSS = 70%
BOD = 15%
P = 15%

The way these results should be interpreted is:
The sludge solids upon which the component designs are based, are, by weight, 70 percent input TSS, 15 percent input BOD and 15 percent input P.

11. Scum Incinerator: This component is designed to incinerate the floatables skimmed off the clarifiers. The concentration of floatables is generally related to flow.

Allocation of Operation and Maintenance (O&M) Cost

Operation and Maintenance (O&M) costs are allocated to the sewage parameters on the basis of function and utilization.

This functional method contrasts with the design-based method used to allocate capital costs to the sewage parameters. Table II-G, on the following page, presents the O&M cost allocations to the sewage parameters for which the system is utilized.

A number of accounts are general in nature and thus not directly allocable. Their costs are distributed to the parameters in accordance with the ratio of each parameter's directly allocable O&M costs to the total directly allocable Sewage Treatment Plant O&M costs. These accounts are:

- Process Water and Outfall
- Laboratory Services
- Heating Plant
- Plant Administrative Facilities.

The derivation of the percentages is described below:

1. Pumping Stations: Pumps function to convey flow against the forces caused by gravity and friction. Pumps and appurtenances are entirely flow related functionally.

2. Interceptors and Sewers: Facilities function to convey flow.

3. Rack and Grit: Facilities function to remove particles and material of sizes larger than suspended solids. Because the large objects and grit removed in this component primarily originate outside of industrial, commercial and residential sources (i.e., urban runoff, street cleaning), allocation to flow is the most equitable alternative.

4. Primary Chemical Addition: Although primary chemicals indirectly aid in primary TSS reduction, the overwhelming reason for introduction of this component is phosphorus removal.

TABLE II-G

ALLOCATION OF O&M COSTS TO

SEWAGE PARAMETERS

System Component	Q	BOD	TSS	P
Pumping Stations	100%			
Interceptors and Sewers	100%			
Sewage Treatment Plant				
Pumping Station	100%			
Rack and Grit	100%			
Primary Chemical				100%
Primary Sedimentation			80%	20%
Aeration System		100%		
Secondary Clarification		25%	65%	10%
Process Water and Outfall (1)				
Chlorination	100%			
Sludge Treatment and Disposal		15%	70%	15%
Scum Incineration	100%			
Average for Sewage Treatment Plant (2)	17%	30%	39%	14%

Notes:

(1) Not directly allocable

(2) Based upon the weighted average O&M costs of all directly allocable treatment plant components

5. Primary Sedimentation: Analysis of primary sludge has shown that of the estimated 375 tons per day (T/D) produced using FY 78 average input values, an estimated 298 T/D is attributable to the TSS input parameter and 77 T/D to P. These figures yield the approximate percentage values of 80 percent TSS and 20 percent P.

6. Aeration System: This component, which primarily includes blowers, oxygen generating equipment and aeration tanks, functions solely to facilitate microbial digestion of organic pollutants. Aeration system O&M costs are thus allocated to BOD.

7. Secondary Clarification: This component, along with the aeration system, serves as the heart of the activated sludge process utilized for secondary treatment. The secondary clarifiers remove suspended solids, much of which are biomass floc generated in the aeration system. However, other solids are removed as well and analysis has shown that of the 395 T/D of secondary sludge (generated assuming FY 78 average input values and January 1, 1980 operating conditions), 104 T/D is attributable to the BOD input parameter, 258 T/D to TSS and 33 T/D to P. After taking into account variations in input parameters, the following allocations are recommended: 25 percent to BOD, 65 percent to TSS and 10 percent to P.

8. Process Water and Outfall: O&M costs in this process include water purchased and electric power. In recent years, these expenses, attributable to the process water system, have accounted for approximately 98 percent of the total O&M costs of this component. Because the process water system contributes to functions throughout the plant, it is a non-directly allocable expense. The remaining 2 percent of this component's O&M costs, which

CDM

environmental engineers, scientists, planners, & management consultants

CAMP DRESSER & McKEE

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(E)

MEMORANDUM

TO COOPERS & LYBRAND - STEVE HOUGHAM

FROM CDM - LES CURTIS

SUBJECT DETROIT SEWER RATE METHODOLOGY

DATE SEPTEMBER 3, 1980

Attached is one copy of the 38-page report incorporating what are believed to be the final corrections based on the Settlement Agreement. This document will serve as the basis for the testing of the system.

Please note that the resulting rates do not necessarily match those now in effect. This is largely due to rounding errors and adjustments made during the settlement negotiations.

The attached document replaces the prior Methodology that had been given to you as a "preliminary" report.

Please let me know if you have any questions regarding the method or content.

cc: William Carney - DWSD ✓
William Krause - DWSD

Page 14 - 15 mile - Hayes Creek allocated to common flow in debt service

DETROIT SEWER RATE METHODOLOGY

I. Bases for Allocations

A. Capital Costs -

ALLOCATION OF CAPITAL CONSTRUCTION COSTS TO SEWAGE PARAMETERS

Direct

System Component	Q	BOD	TSS	P	FOG
Pumping Station	100%				
Interceptors and Sewers	100%				
Sewage Treatment Plant					
Pumping Station	100%				
Rack and Grit	100%				
Primary Chemical				100%	
Primary Sedimentation	85 ~~%~~		10%		5%
Aeration System	20%	80%			
Secondary Clarification	65%	35%			
Process Water and Outfall	85% (1)				
Chlorination	100%				
Sludge Treatment and Disposal (3)		15%	70%	15%	
Scum Incineration	~~100%~~				100
Average for Sewage Treatment Plant (2)	~~%~~ 53%	16%	21%	7%	3

Notes:

(1) Remainder (15 percent) is not directly allocable, and is allocated per note (2) below

(2) Based upon the weighted average debt payments during the rate period of all the directly allocable treatment plant components. Will vary year to year.

(3) Percentages can change based on sludge makeup

Bmb
RFC

DRESSER & McKEE Environmental Engineers Boston, Mass. CLIENT ____ PROJECT ____ DETAIL ____ JOB NO ____ DATE CHECKED ____ CHECKED BY ____ PAGE 6 DATE ____ COMPUTED BY CW

B. Operation & Maintenance Costs

ALLOCATION OF O&M COSTS TO SEWAGE PARAMETERS

System Component	Q	BOD	TSS	P	FC
Pumping Stations	100%				
Interceptors and Sewers	100%				
Sewage Treatment Plant					
Pumping Station	100%				
Rack and Grit	100%				
Primary Chemical				100%	
Primary Sedimentation			70%	20%	1C
Aeration System		100%			
Secondary Clarification		25%	65%	10%	
Process Water and Outfall (1)					
Chlorination	100%				
Sludge Treatment and Disposal		15%	70%	15%	
Scum Incineration	~~100%~~				10
Average for Sewage Treatment Plant (2)	16%	30%	39%	14%	1°

Notes:

(1) Not directly allocable

(2) Based upon the weighted average O&M costs in the rate year of all directly allocable treatment plant components

cover labor and supplies, are assumed to be attributable to the process water system as well. It is assumed that the outfall O&M expense is negligible.

9. Chlorination: This component functions to disinfect treated wastewater. O&M costs for chlorination are related in total to flow.

10. Sludge Treatment & Disposal: The function performed by the components in this unit process is sludge handling and removal. Specific processes include mixing, dewatering, storage, conditioning, incineration and ash removal. The proper allocation of these process costs is to the plant input parameters as they ultimately contribute to the makeup of the sludge which is processed. Following this methodology, the parameter allocations, using FY 78 average plant input values and assuming January 1, 1980 operating conditions, are the same as used for the capital allocations: 70 percent to TSS, 15 percent to BOD, and 15 percent to P.

11. Scum Incinerator: This component is utilized for disposal of floatables removed in the treatment process. The O&M cost of this component is allocated to flow.