Estimating Staffing for Municipal Wastewater Treatment Facilities

U.S. Environmental Protection Agency
Office of Water Program Operations
Washington, D.C. 20460

ESTIMATING STAFFING
FOR
MUNICIPAL WASTEWATER TREATMENT FACILITIES

OPERATION & MAINTENANCE PROGRAM
Office of Water Program Operations
U. S. Environmental Protection Agency
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INTRODUCTION AND STEPS 1-4

INTRODUCTION

This manual, intended for use by consulting engineers, plant management personnel, state regulatory agencies, and the EPA, describes a four-step method for preparing staffing estimates for sewage treatment plants. It covers plants with capacities of from 0.5 to 25-mgd (million gallons per day) of sewage, using primary, secondary, and advanced treatment processes. The four steps are to:

1. Develop from a Table of Adjustment for Local Conditions, factors for increasing or decreasing staffing needs relative to those for an "average" plant.

2. Develop the staffing for such an "average" plant from a number of curves that show annual manhour needs for:

    a. Supervisory, clerical, laboratory, and yard work on the basis of plant design capacity.

    b. Operation and maintenance work on the basis of both plant design capacity and types of process units or steps.

    In addition, develop from a table the operation and maintenance manhour needs for certain types of non-continuous processes on the basis of the time that the equipment for these processes is in operation.

3. Increase or decrease the annual-manhour staffing for these six types of work by using the factors taken from the Table of Adjustment for Local Conditions.

4. Break down this staffing by type of work into specific jobs.

Because of the many differences in personnel and operational efficiencies from plant to plant, the staffing estimates prepared according to this manual should not be used as rigid requirements. Step 1 permits the staffing significance of these differences to be approximated. However, the final decision on the staff required for a particular plant should be made by a person experienced with similar plants in a similar area: ultimately, a plant staffing requirement must be a matter of judgment.

STEP 1. DEVELOPING ADJUSTMENT FACTORS

The staffing adjustment factors, shown in the Table of Adjustment for Local Conditions (TALC), were developed from staffing studies of 35 treatment plants through the U. S. (These studies are discussed briefly in Appendix A.) Some experience and familiarity in treatment plant layout, design, and operations is needed to select or interpolate between the factors shown in TALC. However, TALC does not require you to be a treatment plant expert.

Enter the individual TALC factors, and their totals for each of the basic staffing categories in the first table of the Staffing Estimate Worksheet, as it is done in the sample worksheets in Appendix B. You can copy the blank worksheets in the appendix for your own use. Each of the adjustment factors is explained below.

PLANT LAYOUT

Plant layout affects operation and maintenance staffing because of the time required to walk from one piece of equipment to another. It also affects yardwork, particularly if, to keep up appearances in a residential area, grass, flowerbeds, and shrubs must be tended.

High land costs or other reasons for restricting the site area may make a plant more compact than it would ordinarily be. Sometimes, plant enlargements or the shape of available property may make the plant more extended than ordinary.

Generally speaking, if there are or were no reasons for restricting the site area during design, and if there are no extended expansion layouts or awkward site shapes that extend the layout, the layout can be considered average.

As a general rule, for a given design flow, the layout of a primary treatment plant is slightly more compact than a secondary treatment plant, and the layout of a secondary plant more compact than an advanced treatment plant. TALC accounts for this normal type of difference in the "Level of Treatment" adjustment. The "Layout" adjustment refers to unusual layout conditions.

UNIT PROCESSES

A plant where process equipment units of the same type come from different manufacturers is less efficient to maintain than a plant where all or most of the equipment of the same type is from the same manufacturer. Similarly, a plant with non-standard process equipment–such as a filter press rather than a vacuum filter for dewatering–will be less efficient to maintain and operate, as far as staffing goes, than a plant with standard equipment.

LEVEL OF TREATMENT

Higher levels of treatment require more staff and more staff training. Note that TALC decreases the advanced process maintenance staff additions, as they are given on the Step 2 curves, by 20 percent. This is because of maintenance economies of scale that can be realized when advanced processes follow secondary processes.

TYPE OF WASTE REMOVAL REQUIREMENT

Waste removal requirements generally stipulate either the percentage of wastes to be removed from the incoming sewage or the maximum concentration of wastes that will be permitted in the plant effluent. The latter requirement entails more laboratory work and greater operational care, staffing factors for which are provided by TALC. Operation and maintenance manhours added by removal standards strict enough to require advanced treatment processes are covered in the Step 2 curves for these processes.

INDUSTRIAL WASTES

Industrial waste loadings, if constant, can usually be provided for in-plant design or regular operations practices, so that these wastes do not require significant extra attention. However, when industrial waste loadings vary, either seasonally or erratically, the added attention they require adds to the operations workload. Erratic, unpredictable industrial waste loadings add also to the laboratory workload.

PRODUCTIVITY OF LABOR

The productivity of labor in a sewage treatment plant depends chiefly on two things, which are hard to quantify. One is morale–job satisfaction and pride in the plant working well. The other is the rigidity of job definitions and areas of work responsibility; too much rigidity can result in some men being overworked while others are underworked. Union contracts should thus be examined when setting the productivity factor.

In small plants, of less than about 10-mgd capacity, high morale can make a great difference in productivity. In large plants, with capacities of around 25-mgd and more, the complexity of staffing organization makes it difficult to use the factor of morale to good advantage. Labor productivity is thus usually lower in larger plants than in the better-run of the smaller plants.

As discussed in Appendix A, this manual uses 6-1/2 hours of *productive* work per man per day which amounts to 1,500 hours per year as the normal level of labor productivity.

CLIMATE

Ordinarily, the major impact of climate on most aspects of sewage treatment plant staffing is offset with proper design. Maintenance work, however, is hindered by extreme winters and TALC accounts for this. Where winters are moderate, as along the Pacific coast, the maintenance manhours indicated on the Step 2 staffing curves need no adjustment. Where winters are extreme, as in the northern continental states, the maintenance manhours indicated on the curves should be increased.

TRAINING

Generally speaking, good training makes a treatment plant staff more efficient. The Step 2 curves assume that plant personnel have the uniformly high level of training indicated by certification, but do not have the benefit of a continuing education program. Thus, as reflected in TALC, a plant can be assumed to be more efficient than indicated by the Step 2 curves if it has a continuing education program, but less efficient if its personnel do not have to be certified. Although not shown in TALC, supervisory manhours will need to be increased slightly if the plant is participating in programs similar to the government-sponsored Emergency Employment Act, Employment Supplement Program, Public Employment Program, or other similar local programs.

The effects of training may also be looked at from a monetary standpoint. Since an operator is entrusted with a very large investment—the plant itself, it is necessary to be sure that he knows how to get the most out of the plant—how to use it most efficiently. If the staff is not well enough trained to get the most out of the plant, some of the investment in the plant is being wasted.

Many training programs are available. The ones in your area can be found by asking the state or the EPA. More comments on training and training manuals can also be found in the references in the Bibliography.

AUTOMATIC MONITORING

Automatic monitoring, as the term is used in this manual, means the continuous, instrumented sensing of process variables, such as chlorine residual, dissolved oxygen, sludge density, and turbidity. It may, but in most plants today, usually does not include control functions. While it permits closer and more efficient process control, its potential for decreasing staffing needs may be offset by its requirements for frequent repair and calibration involving relatively high maintenance skills. The table does show decreasing staffing needs for increasing levels of automatic monitoring. See Appendix C for more comments on this topic.

AUTOMATIC SAMPLING

Manual collection and compositing of samples is done either by plant operators or laboratory personnel or both. Time is lost, both for the actual sampling, and the transition time between one task and another. Laboratory and operations time for such sampling can be reduced by equipment that automatically collects and composites test samples. As TALC indicates, both laboratory and operations manhours decrease as the number of automatic sampling points are increased.

OFF-PLANT LABORATORY WORK

Letting outside contracts for laboratory work reduces laboratory staffing needs. Generally such contracts are most economic when they are used for testing receiving waters–for such waste indicators as heavy metal concentrations, toxicity, and pesticides–and for testing requiring special equipment, such as coliform tests. Usually, letting laboratory contracts for process control is economic only when several treatment plants, serving a regional sewerage district, are grouped together.

OFF-PLANT MAINTENANCE

Contracts for off-plant maintenance are usually let for two types of work. One is ground and building maintenance, which can be economic even at small plants. The other is instrument and control system maintenance, which requires special skills. Some maintenance that cannot be scheduled, such as electric motor rewinding or clarifier mechanism repair, may be done by outside personnel on a job-by-job basis. In none of the plants visited in preparing this manual was all maintenance done by off-plant personnel: at the very least, preventive equipment-maintenance such as lubrication still had to be done by the plant staff.

PATTERN OF STAFFING

Commonly, night staffing is about one-third of day staffing, and weekend staffing about one-third of weekday staffing. When this ratio is lower or higher, the total staffing should be adjusted proportionately as indicated in TALC.

TALC does not answer questions about the organization of the shift staffing. This should be decided by the treatment plant administration.

A list of considerations for 24-hour staffing are given in Appendix C.

TABLE OF ADJUSTMENT FOR LOCAL CONDITIONS

LOCAL CONDITION	ADJUSTMENT		
PLANT LAYOUT	COMPACT *YARDWORK: -50 %* *OPERATIONS, MAINTENANCE: -10 %*	AVERAGE *NO ADJUSTMENT*	EXTENDED *YARDWORK: +50 %* *OPERATIONS, MAINTENANCE: +10 %*
UNIT PROCESSES	STANDARD EQUIPMENT, SAME MANUFACTURER *MAINTENANCE: -10 %*	STANDARD EQUIPMENT, DIFFERENT MANUFACTURERS *NO ADJUSTMENT*	NON-STANDARD EQUIPMENT, DIFFERENT MANUFACTURERS *OPERATIONS, MAINTENANCE: +10 %*
LEVEL OF TREATMENT	PRIMARY *SUPERVISORY, CLERICAL, OPERATIONS: -40 %* *LABORATORY: -20 %* *YARDWORK: -10 %*	SECONDARY *NO ADJUSTMENT*	ADVANCED *SUPERVISORY, CLERICAL, LABORATORY: +2 % / AWT PROCESS* *OPERATIONS: +10 %* *MAINTENANCE: -20 %* *YARDWORK: +10 %*
TYPE OF WASTE REMOVAL REQUIREMENT	PERCENTAGE OF WASTE REMOVAL SUCH AS "85 % REMOVAL OF BOD" *NO ADJUSTMENT*	AMOUNT OF WASTE IN EFFLUENT, SUCH AS "NO MORE THAN 20 MG/L BOD" *LABORATORY: +10 %* *OPERATIONS: +5 %*	
INDUSTRIAL WASTE	NONE OR CONSTANT *NO ADJUSTMENT*	SEASONAL *OPERATIONS: +5 %*	ERRATIC *LABORATORY, OPERATIONS: +10 %*
PRODUCTIVITY OF LABOR	HIGH *OPERATIONS, MAINTENANCE: -15 %*	AVERAGE (6½-HR / DAY) *NO ADJUSTMENT*	LOW *OPERATIONS, MAINTENANCE: +15 %*
CLIMATE	MODERATE WINTERS *NO ADJUSTMENT*	EXTREME WINTERS *MAINTENANCE: +10 %*	
TRAINING	CERTIFICATION AND CONTINUING EDUCATION *SUPERVISORY: -10 %* *OPERATIONS: -5 %*	CERTIFICATION BUT NO CONTINUING EDUCATION *NO ADJUSTMENT*	NEITHER CERTIFICATION NOR CONTINUING EDUCATION *SUPERVISORY, OPERATIONS: +10 %*
AUTOMATIC MONITORING	NONE *OPERATIONS: +5 %*	MONITORING ONLY *NO ADJUSTMENT*	MONITORING WITH FEEDBACK *OPERATIONS: -5 %* *MAINTENANCE: +5 %*
AUTOMATIC SAMPLING	NONE *LABORATORY, OPERATIONS: +5 %*	OF INFLUENT AND EFFLUENT *LABORATORY, OPERATIONS: -5 %*	THROUGHOUT PLANT *LABORATORY: -10 %* *OPERATIONS: -5 %*
OFF-PLANT LABORATORY WORK	NONE *NO ADJUSTMENT*	FOR RECEIVING-WATER MONITORING ONLY *LABORATORY: -10 %*	FOR ENTIRE PLANT *LABORATORY: -100 %*
OFF-PLANT MAINTENANCE	NONE *NO ADJUSTMENT*	CORRECTIVE MAINTENANCE ONLY *MAINTENANCE: -25 %*	ALL MAINTENANCE EXCEPT MINOR PREVENTIVE EQUIPMENT MAINTENANCE *MAINTENANCE: -90 %*
AGE AND CONDITION OF EQUIPMENT	RELATIVELY NEW AND/OR WELL-CARED FOR *NO ADJUSTMENT*	RELATIVELY OLD AND/OR POORLY CARED FOR *INCREASE MAINTENANCE: +10 %*	
STORM AND INFILTRATION FLOW	NO ADJUSTMENT, EXCEPT MAY INCREASE SOLIDS DISPOSAL FOR INCREASED SCREENINGS AND GRIT		
PRESENT FLOW OPERATION AT LESS THAN DESIGN FLOW	NO ADJUSTMENT, EXCEPT COMPLETELY BYPASSED UNITS MAY BE SUBTRACTED OUT		
PATTERN OF STAFFING	SMALLER NIGHT AND WEEKEND STAFF THAN ORDINARY DECREASE APPROPRIATE STAFFING PROPORTIONATELY	NIGHT STAFF: 1 FOR EVERY 3 OF DAY STAFF WEEKEND STAFF: 1 FOR EVERY 3 OF WEEKDAY STAFF NO ADJUSTMENT	LARGER NIGHT AND WEEKEND STAFF THAN ORDINARY INCREASE APPROPRIATE STAFFING PROPORTIONATELY

AGE AND CONDITION OF EQUIPMENT

Maintenance workload will increase if plant equipment is old or improperly cared for. The amount that it will increase is highly variable, but has been set at 10 percent in TALC for initial estimation.

STORM AND INFILTRATION FLOW

Storm and infiltration flows from combined, sanitary, and storm sewer systems will, up to a point, be anticipated in plant design. Staffing to meet these flows will thus, up to some point, be included in the Step 2 curves, which are based on design capacity. Storms, however, will periodically overload these combined-system plants. Extra staffing to take care of the resulting process upsets and heavy grit and solids loadings must be obtained, on an emergency basis, as needed. It is not practical to staff—and TALC, therefore, does not provide for staffing—a combined-system plant to handle these periodic peak storm loads. While personnel from other city departments may possibly be borrowed, generally plant staff can be reassigned to help during storm loading conditions.

OPERATION AT LESS THAN DESIGN FLOW

This manual assumes that a sewage treatment plant—if all equipment is operating—will require the same staff at less than design flow as it would at full design flow. If certain process units can be *totally* by-passed, then the manhours required for that particular process would become those required for the *actual* flow through the process.

STEP 2. DEVELOPING ANNUAL-MANHOUR STAFFING FOR AN "AVERAGE" PLANT

Curves D-1 through D-4 in Appendix D show the annual supervisory, clerical, laboratory, and yardwork manhours at an "average" sewage treatment plant, on the basis of plant design flow. Curves D-5 through D-33 show annual operation and maintenance manhours, also on the basis of plant design flow, for plant unit processes. They assume 24-hour, seven-day-a-week operations, with nighttime staff one-third of day staff, and weekend staff one-third of weekday staff. (See page 10 for example). The curves are valid only for plants of from 0.5 to 25-mgd and should not be extrapolated beyond that range. They do not cover collection system maintenance or off-plant (contract) laboratory work.

Using the curves, enter the annual manhours for each type of work and process unit in the second table of the Staffing Estimate Worksheet. Note how it is done in the sample worksheets in Appendix B. Remember to use design flow with the curves, not present flow. Present flow is used only for idle (bypassed) process units.

Table D-34, which follows the curves, shows operation and maintenance manhours per hour of unit operation for the process units of centrifugation, vacuum filtration, and incineration. Develop annual operation and maintenance manhours for these units and enter them also in the second table of the Staffing Estimate Worksheet.

STEP 3. APPLYING ADJUSTMENT FACTORS

This step is just arithmetic. Simply apply the totalled adjustment factors from the first table of the Staffing Estimate Worksheet to the total annual manpower estimates for each type of work in the second table of the worksheet. For instance, in the Example I sample worksheet in Appendix B, the total adjustment factor for Operations is plus 15 percent. The total annual manhours for Operations, before adjustment, is 1,468: adding 15 percent and rounding to the nearest 10 brings it to 1,690.

STEP 4. BREAKING DOWN ANNUAL MANHOURS INTO SPECIFIC JOBS

Rather than try to limit you to any given set of job titles and descriptions, this manual uses six general classifications of work. These classifications are on the worksheet and also appear in TALC. They are supervisory, clerical, laboratory, operations, maintenance, and yard. Yard includes the jobs that do not fit into the other categories: custodial, general housekeeping, operator assistance, for example.

Definitions of these six categories are given in Appendix E to help you decide what kind of men you need. Twenty-one job titles and descriptions developed in previous studies are also included in the Appendix to help you in making up your own job classification system.

The procedure, as shown in the examples, is to develop, from TALC and the curves, a column of figures giving the annual productive manhours in each of the six categories. These manhours are then divided by 1,500 to determine the number of men in each category. (Round off to the nearest one-tenth in figuring these numbers.) This second column now gives you a basis for making job assignments.

Fifteen hundred (1,500) hours per year assumes a 5-day work week, an average of 29 days for holidays, vacations and sick leave, and 6-1/2 hours per day of productive work. If conditions at your plant are significantly different, you might want to develop a different figure.

Any fractional amounts of men obtained in column two should be combined whenever possible. This would mean you might have a man performing both the supervisory and clerical jobs, or both the operations and lab work. These combinations should be reasonable—both from the standpoint of what the men have to do and what kind of men are available.

If the manual is being used on an expansion of an existing plant, every effort must be made to interface the existing personnel setup most effectively with the plant expansion.

You should work through the examples in Appendix B to acquaint yourself with the allocation procedure. For instance, Example 1 in Appendix B shows a particular 1.0-mgd trickling filter plant as calling for the following annual manhours:

Supervisory	540
Clerical	50
Laboratory	340
Yard	470
Operations	1,690
Maintenance	1,600
Total	4,690

Dividing these manhours by 1,500 gives the following breakdown:

Supervisory	0.4 men
Clerical	0
Laboratory	0.2
Yard	0.3
Operations	1.1
Maintenance	1.1
Total	3 men (to nearest half man)

A reasonable allocation among these three men here might be:

Supervisor	60% in operations 40% in supervision
Operator	50% in operations 30% in maintenance 20% in lab work
Maintenance Man	70% in maintenance 30% in yard work.

Different job titles might be used, but this tells you what kind of men you need and each man's responsibility.

It should be recognized that TALC implies a certain pattern of staffing—the median level or: 'the week night staff equal to 1/3 of the weekday staff and the weekend staff equal to 1/3 of the weekday staff.' These formulas or rules-of-thumb are best explained by an example:

Let's assume that, after working through the curves and TALC, we arrive at an estimate of 20 men. What is the median pattern of staffing for this total of 20? We know that the total of the weekday and weekend staff is 20 and that the weekend staff is 1/3 of the weekday staff, so we can write the following equations:

(weekend) + (weekday) = 20, and

1/3 (weekday) = (weekend).

Substituting, we have:

1/3 (weekday) + (weekday) = 20, and solving this:

weekday staff = 3/4 (20) = 15.

This means that the weekend staff is the remainder, or 5.

Now, we know that the total week day staff is 15, and also that the nighttime staff is 1/3 of the daytime staff. Therefore, we can write:

(daytime) + (nighttime) = 15, and

1/3 (daytime) = (nighttime).

Substituting again, we have:

(daytime) + 1/3 (daytime) = 15, and solving:

daytime staff = 3/4 (15), say 11.

The remainder of 4 is the nighttime staff.

In summary, this staffing pattern might look like this:

Weekday	
Day shift	11 men
Night shift	2
Graveyard shift	2
Weekend staff	5
Total Staff	20 men

If it is decided that the plant should be attended more often or less often than this, appropriate additions or deletions from the staff should be made. More on the question of weekend and night staffing can be found in Appendix C.

It must be remembered that the conversion of manhours to jobs is an *arbitrary* one. There can be no hard-and-fast rule on what jobs there should be at a treatment plant, so individual treatment plant administrations should not feel restricted to a specific selection of job titles or shift staffing. The staffing at a plant must be tailor-made to meet the plant's specific requirements.

Examples II, IIIA, and IIIB in Appendix B show how staffing guidelines are developed similarly for larger plants.

APPENDIX A

APPENDIX A. SOURCES AND USE OF DATA, STAFFING FOR PLANTS NOT COVERED

This manual is based on three types of data. The first type consists of general comments and information obtained from EPA Regional Offices, state and interstate water pollution control agencies, and some local regulatory agencies. The second type is data gathered during visits to 35 sewage treatment plants across the country. These plants are listed in Table A-1 and their capacities and process steps shown in Table A-2. The third type is data from EPA reports and the literature, as cited in the Bibliography.

Two kinds of information were collected during the plant visits. One kind was information on the size of staff and on its breakdown into supervisory, clerical, laboratory, yard, operation, and maintenance workers. Maintenance, to distinguish it from operations, was defined for this manual as "working on equipment to prevent failure (preventive maintenance) or repairing equipment that had failed (corrective maintenance)." Thus, cleaning the weirs and effluent channel of a clarifier were, for instance, considered to be operations, while greasing a clarifier sludge pump was considered to be maintenance.

The second kind of information collected during the visits was the operation and maintenance manhours that were spent per process unit. It was found that when these hours were totalled for the year they were consistently lower, in a ratio of about 6-1/2 to 8, than the manhours attributed directly to operation and maintenance staff members. Average operation and maintenance work productivity was thus taken to be 6-1/2 hours per day, or—when vacations, sick leaves, and holidays were taken into account—about 1,500 hours per year. The same productivity level was assumed to hold for supervisory, clerical, laboratory, and yardwork. As TALC indicates, if these conditions do not apply at your plant, you should develop a new number.

Analysis of the data showed that manhours for the six types of plant work could, for an "average" plant and most common processes, be based on design flow. Factors, which were later organized into the Table of Adjustment for Local Conditions could then be applied to account for individual plant variations from an average plant.

The manhour curves for secondary treatment processes are the most reliable because they are based on data from a large number of operating plants. The curves for primary treatment are less reliable because they are based on data from fewer plants. Most data for advanced waste treatment processes are from the South Tahoe Public Utility District plant and cover chemical coagulation and settling, lime recalcination, ammonia stripping, two-stage recarbonization, mixed-media filtration, granular carbon adsorption, and granular carbon regeneration. The unit manhour requirements given in Table D-34, for centrifugation, vacuum filtration, and incineration, are also based on limited data.

Pilot scale data or data from the literature were used for the processes of nitrification-denitrification, ion-exchange ammonia removal and demineralization, reverse osmosis, and electrodialysis.

Treatment facilities smaller than those covered by the staffing curves (below 0.5-mgd), may be of the conventional type or may be package plants or stabilization ponds. Generally these can be staffed by just one person, though sometimes a small conventional plant may require a staff of two or three. Conventional plant and package plant attendants should be trained in equipment maintenance (possibly by the equipment manufacturers), in recognizing process upsets, and in sampling procedures. Stabilization pond attendants will mainly be expected to perform maintenance duties, such as dike repair, weed control and minor maintenance on the chlorinator. Attendants at all of these small plants should have a qualified person to seek help from in the event of operational problems.

Iowa State University's Department of Industrial Engineering is currently developing a staffing manual for the EPA that is intended specifically for plants smaller than 1-mgd (37). The preliminary draft, entitled "*Estimating Manpower Requirements and Selected Cost Factors for Small Wastewater Treatment Plants,*" is now available.

Treatment plants larger than those covered by the staffing curves were adequately covered by a previous staffing study (3). Plants of these sizes are usually in larger cities where a large skilled labor pool is available, so that it would be easier to find highly qualified personnel. Operations at some of these plants may be so complex or large, or connected with other city operations so that a special study would be warranted.

TABLE A-1

TREATMENT PLANTS VISITED – NUMERICAL CODES

No.	Name
1.	Sacramento County Northwest Plant, California
2.	City of San Leandro, California
3.	City of San Rafael, California
4.	South Tahoe PUD, California
5.	City of San Jose, California
6.	Los Angeles County Sanitation District, California
7.	City of Medford, Oregon
8.	City of Salem, Oregon
9.	City of Tualatin, Oregon
10.	North Roseburg Sanitation District, Oregon
11.	City of Durham, North Carolina
12.	City of Lebanon, Pennsylvania
13.	City of Chapel Hill, North Carolina
14.	City of Lancaster, Pennsylvania
15.	City of Stockton, California
16.	City of Dallas, Oregon
17.	Security Water and Sanitary District, Colorado
18.	East Canon Sanitation District, Colorado
19.	City of Aurora, Colorado
20.	City of Troutdale, Oregon

TABLE A-1 (continued)

No.	Name
21.	City of Portland Tyron Creek, Oregon
22.	Santee County Water District, California
23.	City of Grand Rapids, Michigan
24.	City of Boulder, Colorado
25.	City of Colorado Springs, Colorado
26.	City of Logan, Utah
27.	Metropolitan Sewer District, Louisville Hite Creek Plant, Kentucky
28.	Johnson County Main Sewer Districts Main Plant, Kansas
29.	Johnson County Main Sewer Districts Indian Creek Plant, Kansas
30.	Municipality of Metropolitan Seattle, Washington
31.	City of Glendale, Colorado
32.	City of Bellingham, Washington
33.	Richmond Sanitary District, Indiana
34.	Chatham Township, New Jersey
35.	City of Trenton, New Jersey

TABLE A-2

TREATMENT PLANTS VISITED

CAPACITY (MGD) \ PROCESS	SCREENING & GRINDING	GRIT REMOVAL	PRIMARY CLARIFICATION	ACTIVATED SLUDGE	TRICKLING FILTER	SECONDARY CLARIFICATION	CHLORINATION	STABILIZATION POND	AERATED POND	PACKAGE PLANT	LAND DISPOSAL OF EFFLUENT	ANAEROBIC DIGESTION	AEROBIC DIGESTION
0. - 0.5	9 18			9		9	9 18			18	9		
0.5 - 1	20 17 34		17 34		17 34	17 34	20 17 34	17 34	17	20		17 34	
1 - 2	10 31 19	19 31	10	19 31	10	10 31 19	10 19 31	31 19				10	31
2 - 4	16 27 6 30 30		27 6 30 30	16 27		16 27	16 27 30 30	6				6 30 30	16 27
4 - 6	13 24 6 6	3 13 24 6 6	3 13 21 22 24 6 6	3 21 22 6 6	13 24	3 13 21 22 24 6 6	3 21 24 6 16					3 13 21 6 16	22
6 - 8	4 12	12	4 12	4 12		4 12	4 12		33			12	
8 - 10	1 7 14	7 14	1 7 14	1 7 14		1 7 14	1 7 14					1 7 14	
10 - 12	2 11 29	2 11 29	2 29	2 11	2 11 29	2 11 29	2 29		29			2 11 29	
12 - 14	28 6 16	28	28 6 16	6 16	28	28 6 16	28 6 16						
14 - 16	8	8	8		8	8	8					8	
16 - 18								26					
18 - 20	32	32	32				32						
20 - 22	33 35	33 35	33 35	33	35	33 35	33 35					33 35	
22 - 24													
24 - 26													
26 and UP	5 15 23 6 30	5 15 23 30	5 15 23 6 30	5 23 6	15	5 15 23 6	5 15 23 6 30	15				5 15 23 [illegible]	

CAPACITY (MGD) \ PROCESS	DEWATERING	HEAT TREATMENT	SLUDGE INCINERATION	THICKENING	SLUDGE DRYING BEDS	SLUDGE LAGOONING	LAND DISPOSAL	RECALCINATION	CHEMICAL COAGULATION	CHEMICAL CLARIFICATION	FILTRATION	RECARBONATION	NITROGEN REMOVAL	ACTIVATED CARBON ABSORPTION
0. - 0.5						9 18					9			
0.5 - 1				17	17 34	20								
1 - 2					10						19			
2 - 4						16					27			
4 - 6	3 13	24		3	3 13 22		13 21				6			
6 - 8	4		4	4			4	4	4	4	4	4	4	4
8 - 10					14									
10 - 12	2 29			2	11		29							
12 - 14			28	28			28							
14 - 16				8			8							
16 - 18														
18 - 20			[illegible]											
20 - 22	33					35	35							
22 - 24														
24 - 26														
26 and UP	5 23		23	15 23	15				5 23	23				

APPENDIX B

APPENDIX B. USING THE STAFFING ESTIMATE WORKSHEET

The following Staffing Estimate Worksheets are completed for four treatment plants. Work them through yourself for practice, copying as many copies of the blank worksheet as you need.

EXAMPLE I: TRICKLING FILTER PLANT, 1.0 MGD

Plant I is a 17-year-old plant serving a small town of 8,000 people that has no significant industry. The town has a well-maintained separate sewer system. The plant was well designed with an average layout. The plant has not been modified extensively and was all built under a single contract. As a result, most of the equipment is from the same manufacturer. It is currently operating at full design capacity.

Regulatory requirements for 80 percent BOD and suspended solids removal are met by the trickling filter process.

Motivation is reasonably good at the plant so that productivity is average. Many of the staff are not properly trained nor certified, however, so that operations are not as efficient as they could be.

The plant has no automatic monitors or samplers, nor does it use any outside contracts for laboratory or maintenance work.

Equipment maintenance has not been a serious problem, due in part to a regular preventive maintenance program.

BY DPH

DATE FEB 2 1973

ENVIRONMENTAL PROTECTION AGENCY
STAFFING ESTIMATE WORKSHEET

PLANT EXAMPLE I

LOCATION -

TYPE TRICKLING FILTER

DESIGN FLOW 1.0 MGD

I. ADJUSTMENT FOR LOCAL CONDITIONS (SEE TALC)

LOCAL CONDITION	COMMENT	ADJUSTMENT					
		OPERATION	MAINTENANCE	SUPERVISORY	CLERICAL	LABORATORY	YARDWORK
PLANT LAYOUT	AVERAGE	–	–	–	–	–	
UNIT PROCESSES	STANDARD, DIFF.	–	–	–	–	–	
LEVEL OF TREATMENT	SECONDARY	–	–	–	–	–	
TYPE OF REMOVAL REQUIREMENT	PERCENTAGE	–	–	–	–	–	
INDUSTRIAL WASTES	NONE	–	–	–	–	–	
PRODUCTIVITY	AVERAGE		–	–	–	–	–
CLIMATE	MODERATE		–		–	–	–
TRAINING	SOME CERTIFIED	+5%	–	+5%	–	–	–
AUTO. MONITORING	NONE	+5%	–	–	–		–
AUTO. SAMPLING	NONE	+5%	–	–	–	+5%	–
OFF-PLANT LABORATORY	NONE		–	–	–	–	–
OFF-PLANT MAINTENANCE	NONE	–	–	–	–	–	–
AGE OF EQUIPMENT	WELL CARED FOR	–	–	–	–	–	–
STORM, INFILTRATION	NONE	–	–	–	–	–	–
PRESENT FLOW	AT DESIGN	–	–	–	–	–	
TOTAL		+15%	0	+5%	0	+5%	0

STAFFING ESTIMATE WORKSHEET

II. ANNUAL MANHOURS

UNIT PROCESS	OPERATION	MAINTENANCE	SUPERVISORY	CLERICAL	LABORATORY	YARDWORK
RAW SEWAGE PUMP STATION	–	330				
SCREENING	43	17				
GRIT REMOVAL	200	22				
PRIMARY CLARIFIER	230	220				
TRICKLING FILTER	380	540				
SECONDARY CLARIFIER	65	230				
CHLORINATION	130	200				
ANAEROBIC DIGESTER	180	44				
SLUDGE BEDS	240	–				
TOTAL	1,468	1,603	510	53	320	470
ADJUSTMENT (FROM I)	+220	0	+26	0	+16	0
ADJUSTED TOTAL	1,690	1,600	540	50	340	470
GRAND TOTAL 4,690						

III. STAFFING SUGGESTION

	TOTAL HOURS PER YEAR	NUMBER OF MEN*
OPERATIONS	1,690	1.1
MAINTENANCE	1,600	1.1
SUPERVISORY	540	0.4
CLERICAL	50	0
LABORATORY	340	0.2
YARDWORK	470	0.3
TOTAL	4,690	3

*ASSUMES 1500 HOURS PER YEAR PER MAN
(SEE PAGE 9)

EXAMPLE II: ACTIVATED SLUDGE PLANT, 9.5 MGD

Plant II is a 10-year-old plant serving 60,000 people in an area where winters are severe. The plant was well designed using conventional unit processes. Much of the minor equipment (pumps, etc.) is of the same manufacturer. The plant is now operating at close to design flow. Due to a well established sewer maintenance program and good enforcement of an ordinance prohibiting storm drain connections to the sanitary sewer there are no problems with infiltration or storm runoff. The plant is used for research purposes by a nearby university so there is no laboratory work done at the plant.

The state regulatory agency requires 85 percent BOD and suspended solids involved. These removals are generally exceeded by the well run activated sludge plant.

There is a small meat packing plant and dairy in town, but no seasonal industry. There is good rapport between the treatment plant operators and the plant foremen which has helped prevent operation problems.

Certification is encouraged so that all the operators are certified, but are not engaged in any regular continuing education program.

There are no automatic samplers, and the only automatic monitoring is for chlorine residual. Maintenance on this monitor is done by an outside contract.

A small amount of equipment corrective maintenance is done by contract, in addition to the maintenance on the chlorine residual monitor. The equipment is generally well cared for so that no special maintenance problems exist.

BY DPH

DATE FEB 2, 1973

ENVIRONMENTAL PROTECTION AGENCY
STAFFING ESTIMATE WORKSHEET

PLANT EXAMPLE II

LOCATION –

TYPE ACTIVATED SLUDGE

DESIGN FLOW 9.5 MGD

I. ADJUSTMENT FOR LOCAL CONDITIONS (SEE TALC)

LOCAL CONDITION	COMMENT	ADJUSTMENT					
		OPERATION	MAINTENANCE	SUPERVISORY	CLERICAL	LABORATORY	YARDWORK
PLANT LAYOUT	AVERAGE	–	–	–	–	–	–
UNIT PROCESSES	STANDARD/DIFF	–	–	–	–	–	–
LEVEL OF TREATMENT	SECONDARY	–	–	–	–	–	–
TYPE OF REMOVAL REQUIREMENT	PERCENTAGE	–	–	–	–	–	–
INDUSTRIAL WASTES	CONSTANT INFLOW	–	–	–	–	–	–
PRODUCTIVITY	AVERAGE	–	–	–	–	–	–
CLIMATE	SEVERE WINTERS	–	+10%	–	–	–	–
TRAINING	ALL CERTIFIED	–	–	–	–	–	–
AUTO. MONITORING	SOME, NO FEEDBACK	–	–	–	–	–	–
AUTO. SAMPLING	NONE	+5%	–	–	–	+5%	–
OFF-PLANT LABORATORY	NO LAB AT PLANT	–	–	–	–	-100%	–
OFF-PLANT MAINTENANCE	A LITTLE	–	-15%	–	–	–	–
AGE OF EQUIPMENT	WELL CARED FOR	–	–	–	–	–	–
STORM, INFILTRATION	NO SPECIAL PROBLEM	–	–	–	–	–	–
PRESENT FLOW	AT DESIGN FLOW	–	–	–	–	–	–
TOTAL		+5%	-5%	0	0	-100%	0

STAFFING ESTIMATE WORKSHEET

II. ANNUAL MANHOURS

UNIT PROCESS	OPERATION	MAINTENANCE	SUPERVISORY	CLERICAL	LABORATORY	YARDWORK
SCREENING, GRINDING	900	39				
GRIT REMOVAL	680	60				
PRIMARY CLARIFIER	2,000	490				
AERATION	1,500	1,700				
SECONDARY CLARIFIER	1,800	400				
CHLORINATION	330	390				
ANAEROBIC DIGESTER	860	210				
SLUDGE TRUCKING	(750)	–				
TOTAL	8,820	3,289	2,250	800	2,250	2,100
ADJUSTMENT (FROM I)	+410	-164	0	0	-2,250	0
ADJUSTED TOTAL	9,230	3,120	2,250	800	0	2,100
GRAND TOTAL 17,500						

III. STAFFING SUGGESTION

	TOTAL HOURS PER YEAR	NUMBER OF MEN*
OPERATIONS	9,230	6.2
MAINTENANCE	3,120	2.1
SUPERVISORY	2,250	1.5
CLERICAL	800	0.5
LABORATORY	0	0
YARDWORK	2,100	1.4
TOTAL	17,500	11½**

*ASSUMES 1500 HOURS PER YEAR PER MAN
(SEE PAGE 9)

** ROUNDED TO NEAREST ONE-HALF

EXAMPLE III: ACTIVATED SLUDGE PLANTS WITH RELATIVELY EXTREME STAFFING NEEDS, 20.0 MGD

Examples IIIA and IIIB show the possible effects of the TALC factors on two treatment plants of the same size and with the same process units, but differing in a number of opposite ways from an "average" plant.

Plant IIIA, due to restricted land availability, has an unusually compact layout. On the whole, it is well designed and equipped, and excellently run. Regulatory agencies require that it remove 85 percent of the BOD and suspended solids from the sewage. While its process units and other equipment are conventional, the same types of equipment have in a number of instances been supplied by different manufacturers. Fortunately, the plant has no industrial wastes to contend with, nor does it have an extreme winter to make maintenance difficult.

A progressive management insists on operator certification, provides periodic in-plant training sessions, and when possible sends personnel to short courses on sewage treatment practice and theory at a local technical school. For these and other reasons, morale and productivity are good.

Chlorine residual at the plant is monitored and chlorination is paced by automatic equipment; influent and effluent sampling is done automatically, too. All other maintenance, as well as laboratory work, is performed by the plant staff.

Plant IIIB, in sharp contrast, is a problem plant. First built 20 years ago on low-cost land in an area of severe winters, its layout was relatively extended. Then a booming economy and population forced it to expand when much of the land surrounding it was owned by industry. An awkward, inefficient process layout was thus forced upon it. By this time, too, many of its process units were obsolete.

Discharging as it does to a river, regulatory agencies stringently require that BOD and suspended solids in its effluent be kept below 15 parts per million. Meeting this requirement is difficult enough by itself, but the plant's work is complicated by the fact that it has had a history of erratic, illegal dumping of industrial wastes. Some of these wastes have contained heavy metals, so that the plant must constantly monitor its influent for heavy metal compounds and other wastes that might upset its processes. The plant has automatic sampling equipment to help in this task; it also has automatic chlorine-residual monitoring equipment, which is used to pace the chlorinator.

In part because key staff positions in the plant are political appointments, without regard for technical qualifications, the morale of most of the plant staff is low. Certification is not required and no training programs are held or even encouraged. The plant does its own laboratory and maintenance work, with the exception of contract maintenance of the automatic monitoring and sampling equipment. Many of the maintenance tasks are difficult to perform during the long, cold, and snowy winters.

BY DPH

DATE FEB. 2, 1973

ENVIRONMENTAL PROTECTION AGENCY
STAFFING ESTIMATE WORKSHEET

PLANT EXAMPLE III-A

LOCATION –

TYPE ACTIVATED SLUDGE

DESIGN FLOW 20.0 MGD

I. ADJUSTMENT FOR LOCAL CONDITIONS (SEE TALC)

LOCAL CONDITION	COMMENT	ADJUSTMENT					
		OPERATION	MAINTENANCE	SUPERVISORY	CLERICAL	LABORATORY	YARDWORK
PLANT LAYOUT	COMPACT	-10%	-10%	–	–	–	-50%
UNIT PROCESSES	STANDARD/DIFF.	–	–	–	–	–	–
LEVEL OF TREATMENT	SECONDARY	–	–	–	–	–	–
TYPE OF REMOVAL REQUIREMENT	PERCENTAGE	–	–	–	–	–	–
INDUSTRIAL WASTES	NONE	–	–	–	–	–	–
PRODUCTIVITY	AVERAGE	–	–	–	–	–	–
CLIMATE	MODERATE	–	–	–	–	–	–
TRAINING	CERT. W. EDUCATION	-5%	–	-10%	–	–	–
AUTO. MONITORING	SOME W. FEEDBACK	-5%	+5%	–	–	–	–
AUTO. SAMPLING	OF INFLUENT, EFFLUENT	-5%	–	–	–	-5%	–
OFF-PLANT LABORATORY	NONE	–	–	–	–	–	–
OFF-PLANT MAINTENANCE	NONE	–	–	–	–	–	–
AGE OF EQUIPMENT	WELL CARED FOR	–	–	–	–	–	–
STORM, INFILTRATION	NO PROBLEM	–	–	–	–	–	–
PRESENT FLOW	AT DESIGN FLOW	–	–	–	–	–	–
TOTAL		-25%	-5%	-10%	0	-5%	-50%

STAFFING ESTIMATE WORKSHEET

II. ANNUAL MANHOURS

UNIT PROCESS	OPERATION	MAINTENANCE	SUPERVISORY	CLERICAL	LABORATORY	YARDWORK
SCREENING, GRINDING	2,500	50				
GRIT REMOVAL	1,020	82				
PRIMARY CLARIFICATION	4,100	630				
AERATION	2,100	2,800				
SECONDARY CLARIFICATION	4,100	490				
CHLORINATION	450	490				
ANAEROBIC DIGESTION	1,450	350				
CENTRIFUGE (24 H/D)	2,630	1,760				
SLUDGE TRUCKING	(1,500)	–				
TOTAL	19,850	6,652	3,700	2,000	3,500	3,400
ADJUSTMENT (FROM I)	-4,963	-333	-370	0	-175	-1,700
ADJUSTED TOTAL	14,890	6,320	3,330	2,000	3,330	1,700
GRAND TOTAL 31,570						

III. STAFFING SUGGESTION

	TOTAL HOURS PER YEAR	NUMBER OF MEN*
OPERATIONS	14,890	9.9
MAINTENANCE	6,320	4.2
SUPERVISORY	3,330	2.2
CLERICAL	2,000	1.3
LABORATORY	3,330	2.2
YARDWORK	1,700	1.1
TOTAL	31,570	21

*ASSUMES 1500 HOURS PER YEAR PER MAN
(SEE PAGE 9)

BY DPH

DATE FEB. 2, 1973

ENVIRONMENTAL PROTECTION AGENCY
STAFFING ESTIMATE WORKSHEET

PLANT EXAMPLE III-B

LOCATION –

TYPE ACTIVATED SLUDGE

DESIGN FLOW 20.0 MGD

I. ADJUSTMENT FOR LOCAL CONDITIONS (SEE TALC)

LOCAL CONDITION	COMMENT	ADJUSTMENT					
		OPERATION	MAINTENANCE	SUPERVISORY	CLERICAL	LABORATORY	YARDWORK
PLANT LAYOUT	EXTENDED	+10%	+10%	0	0	0	+50%
UNIT PROCESSES	NONSTANDARD	+10%	+10%	–	–	–	–
LEVEL OF TREATMENT	SECONDARY	–	–	–	–	–	–
TYPE OF REMOVAL REQUIREMENT	BOD, SS=15 PPM	+5%	–	–	–	+10%	–
INDUSTRIAL WASTES	ERRATIC INFLOW	+10%	–	–	–	+10%	–
PRODUCTIVITY	LOW	+15%	+15%	–	–	–	–
CLIMATE	EXTREME WINTERS	–	+10%	–	–	–	–
TRAINING	NOT CERTIFIED	+10%	–	+10%	–	–	–
AUTO. MONITORING	SOME W. FEEDBACK	-5%	+5%	–	–	–	–
AUTO. SAMPLING	OF INFLUENT, EFFLUENT	-5%	–	–	–	-5%	–
OFF-PLANT LABORATORY	NONE	–	–	–	–	–	–
OFF-PLANT MAINTENANCE	NONE	–	–	–	–	–	–
AGE OF EQUIPMENT	POORLY CARED FOR	–	+10%	–	–	–	–
STORM, INFILTRATION	NO PROBLEM	–	–	–	–	–	–
PRESENT FLOW	AT DESIGN FLOW	–	–	–	–	–	–
TOTAL		+50%	+60%	+10%	0	+15%	+50%

STAFFING ESTIMATE WORKSHEET

II. ANNUAL MANHOURS

UNIT PROCESS	OPERATION	MAINTENANCE	SUPERVISORY	CLERICAL	LABORATORY	YARDWORK
SCREENING, GRINDING	2,500	50				
GRIT REMOVAL	1,020	82				
PRIMARY CLARIFICATION	4,100	630				
AERATION	2,100	2,800				
SECONDARY CLARIFICATION	4,100	490				
CHLORINATION	450	490				
ANAEROBIC DIGESTION	1,450	350				
CENTRIFUGE (24 H/D)	2,630	1,760				
SLUDGE TRUCKING	(1,500)	–				
TOTAL	19,850	6,652	3,700	2,000	3,500	3,400
ADJUSTMENT (FROM I)	+9,925	+3,990	+370	0	+525	+1,700
ADJUSTED TOTAL	29,780	10,640	4,070	2,000	4,030	5,100
GRAND TOTAL 55,620						

STAFFING ESTIMATE WORKSHEET

III. STAFFING SUGGESTION

	TOTAL HOURS PER YEAR	NUMBER OF MEN*
OPERATIONS	29,780	19.9
MAINTENANCE	10,640	7.1
SUPERVISORY	4,070	2.7
CLERICAL	2,000	1.3
LABORATORY	4,030	2.7
YARDWORK	5,100	3.4
TOTAL	55,620	37

*ASSUMES 1500 HOURS PER YEAR PER MAN
(SEE PAGE 9)

APPENDIX C

APPENDIX C. WHETHER TO PROVIDE 24-HOUR STAFFING

Effluent quality and public health and safety are the things to consider when deciding whether to staff a plant nights and weekends. Erratic influent quality; complex, easy to upset processes; stringent discharge requirements: if any of these conditions exist, then 24-hour, seven day per week staffing should be evaluated.

More specifically, these are some points to consider when determining the need for 24-hour, seven day staffing:

1. When the plant has a capacity greater than 10-mgd.

2. When the influent is highly erratic or has a large and fluctuating proportion of industrial wastes.

3. When power failures are common.

4. When full-scale, complete advanced-waste-treatment schemes are used to remove nutrients and other pollutants in addition to BOD and suspended solids. (Partial advanced waste treatment at a plant, such as chemical coagulation alone, may not require more staffing than would a strictly secondary-level plant.)

5. When equipment requiring highly specialized maintenance is used.

6. When the plant's effluent is discharged close to a downstream water intake.

7. When the plant's effluent is discharged into a small, enclosed water-contact recreational area, though this factor need influence staffing only during the recreational season.

8. When the plant's effluent is discharged into a shell fishery.

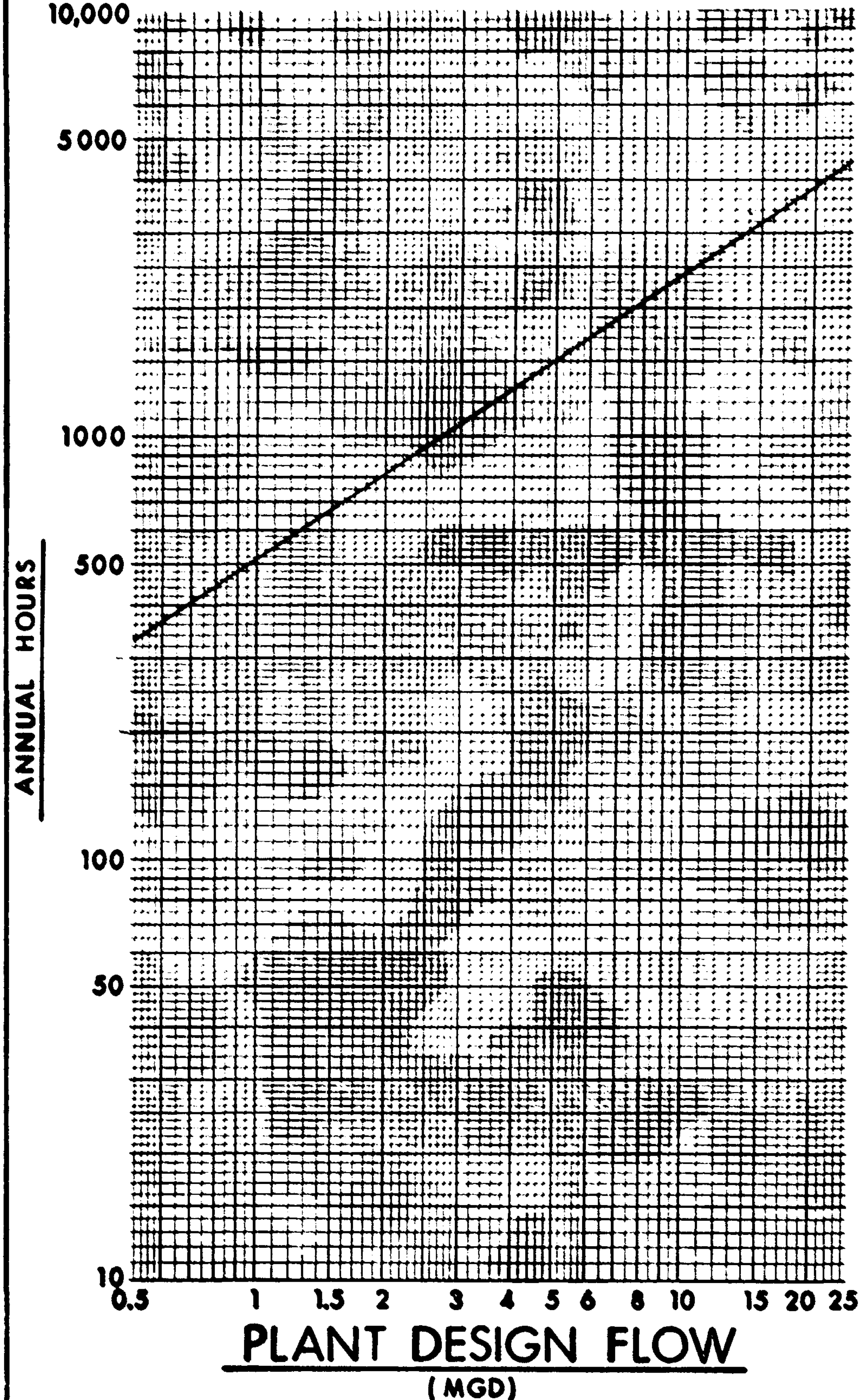
9. When the effluent flow is very high in proportion to the receiving water flow.

Automatic monitors and controls may be used to improve operation and reduce staffing needs—especially nighttime staffing. The present state of the art in instrumentation is such that, although better operation and control may be achieved through the use of these monitors and control systems, increases in maintenance and meter calibration time can offset any savings anticipated in staff. In addition, highly trained and specialized personnel are required to repair and maintain these instruments. These points should be kept in mind when evaluating the use of automatic monitors and controls against 24-hour staffing.

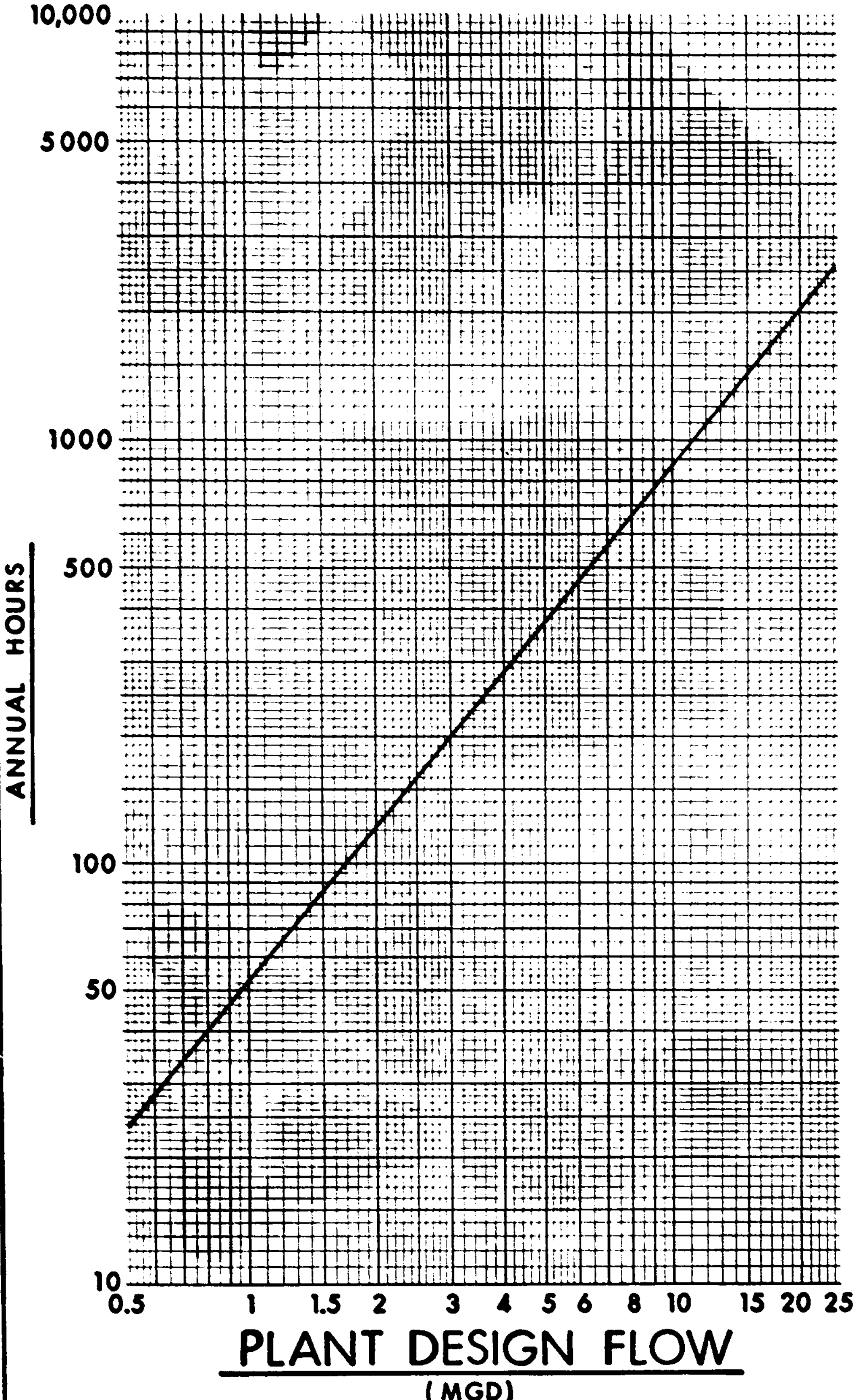
This is not to say that the option of automatic monitors should not be carefully examined. On the contrary, the potential in this field is enormous. The art and science of reliable instrumentation is advancing rapidly. No doubt the future will see more reliable and maintenance-free systems.

APPENDIX D

SUPERVISORY AND ADMINISTRATIVE

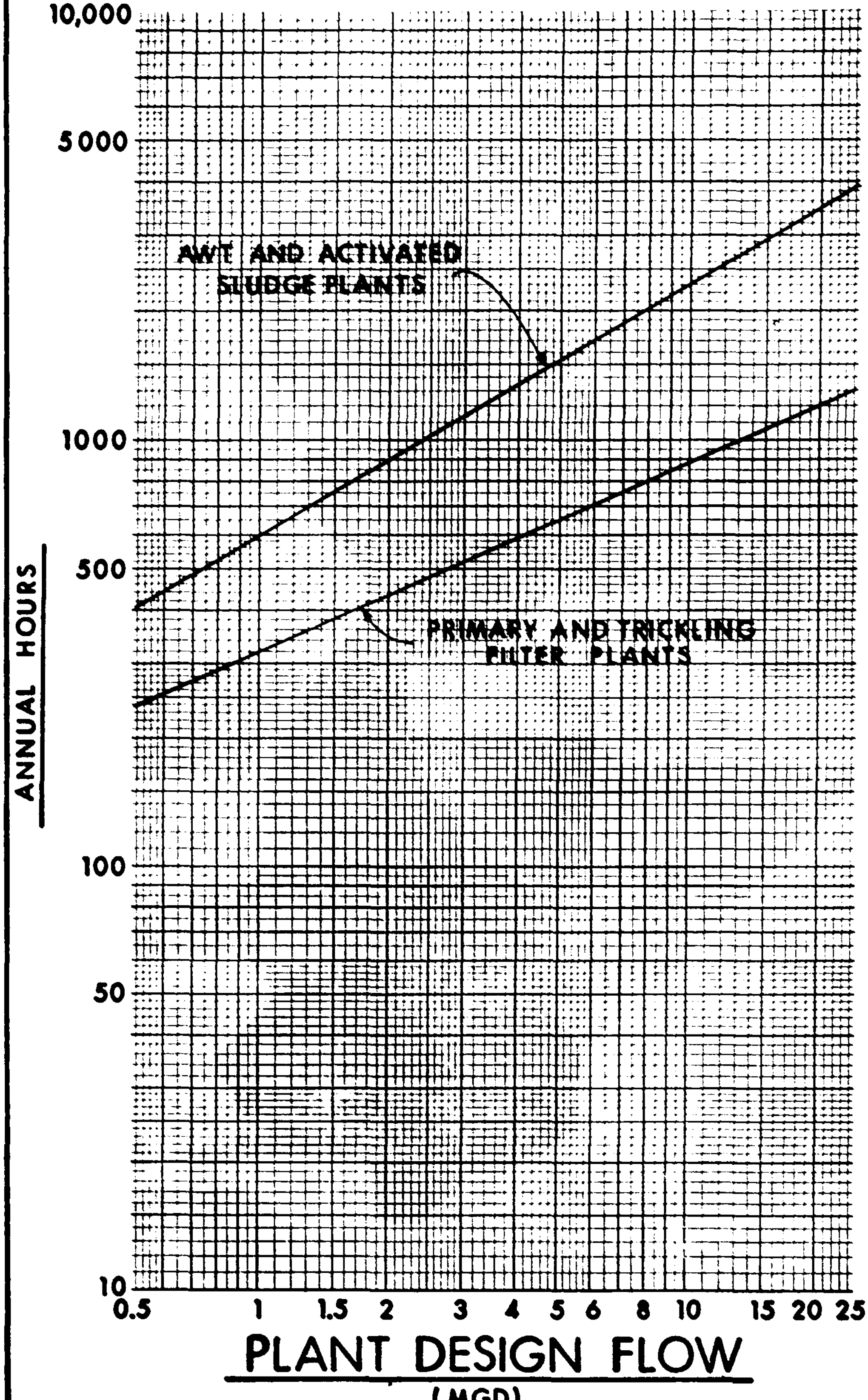


INCLUDES WORK DONE BY SUPERVISOR AS WELL AS SUPERVISION FOREMEN AND OPERATORS.



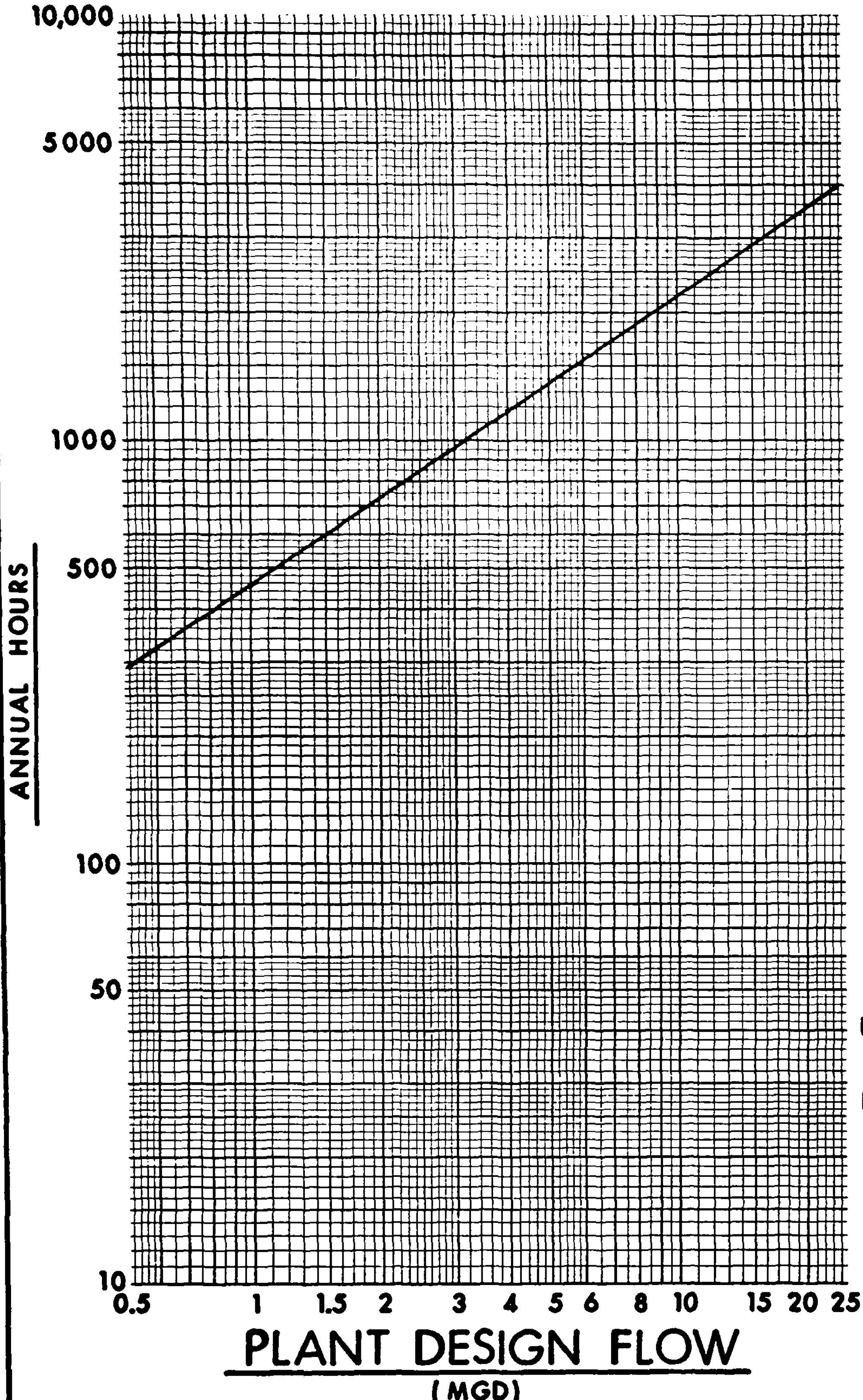
CLERICAL

INCLUDES THAT DONE BY OFFICE STAFF AS WELL AS BY FIELD STAFF.



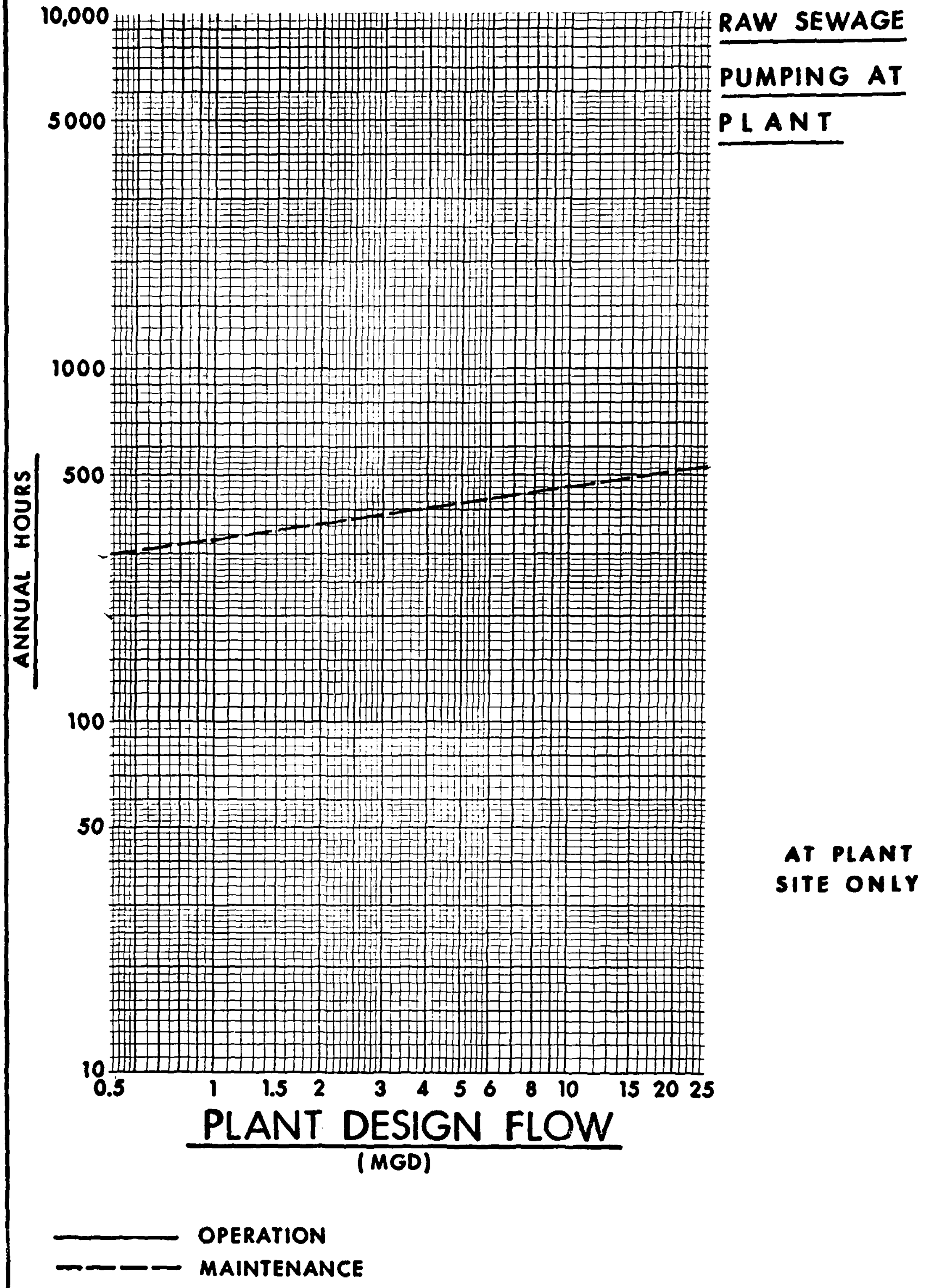
LABORATORY

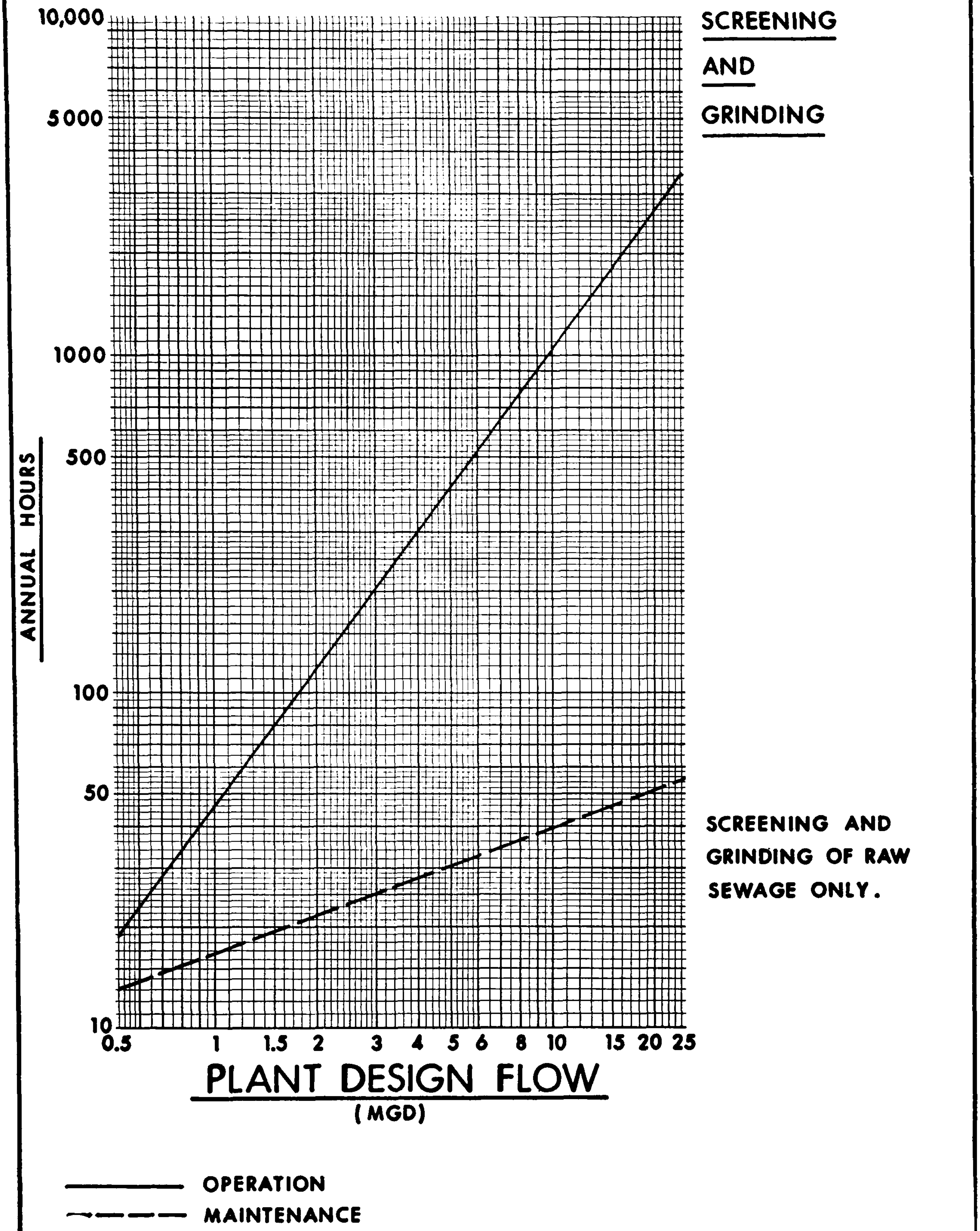
INCLUDES LAB WORK DONE BY LAB STAFF AS WELL AS OPERATORS.

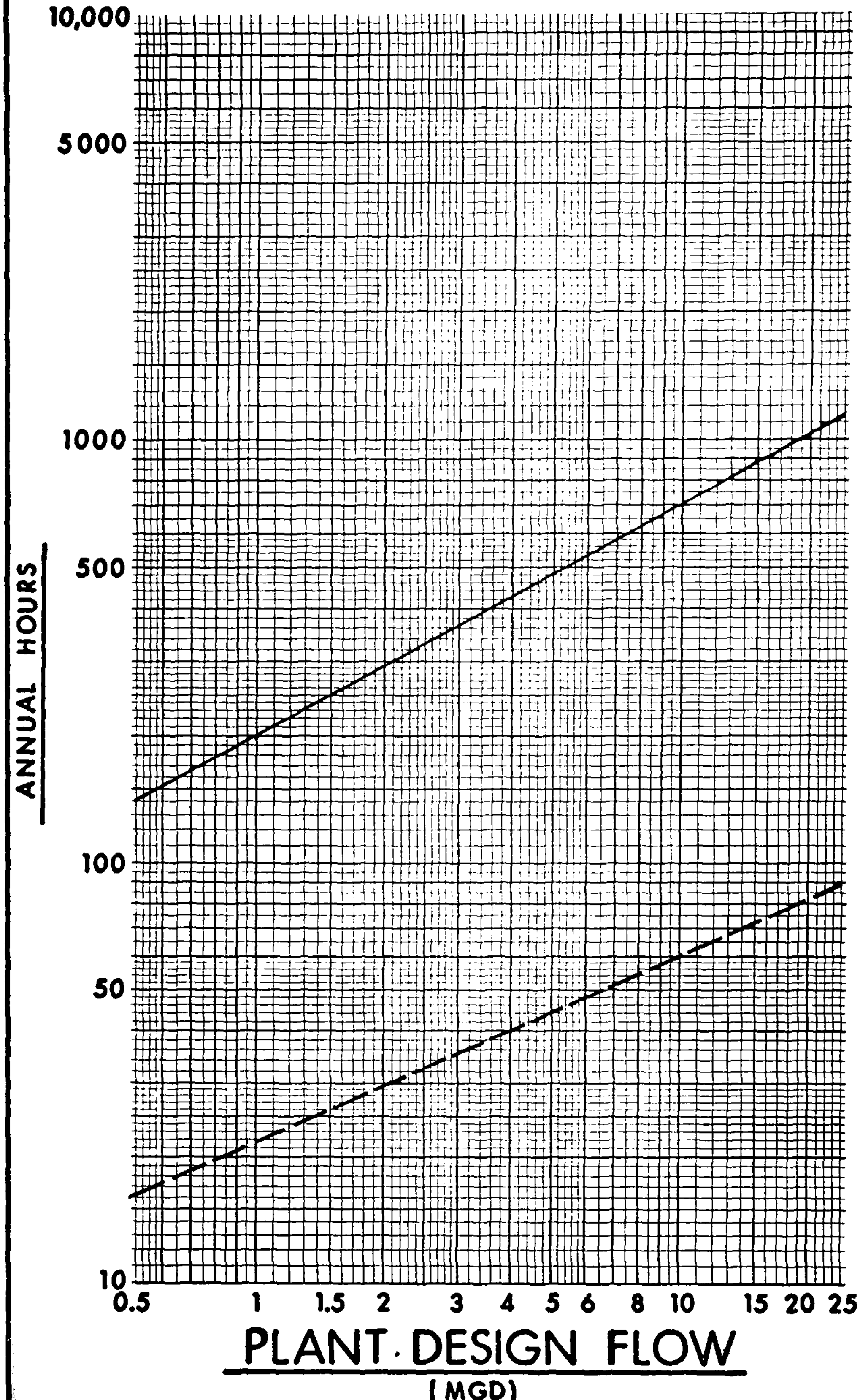


YARDWORK

INCLUDES CUSTODIAL AND JANITORIAL WORK BOTH INSIDE AND OUTSIDE.


10,000
5000
1000
500
100
50
10
ANNUAL HOURS
0.5
1
1.5
2
3
4
5
6
8
10
15
20
25
RAW SEWAGE PUMPING AT PLANT
AT PLANT SITE ONLY
PLANT DESIGN FLOW
(MGD)
OPERATION
MAINTENANCE


10,000
5000
1000
500
100
50
10
ANNUAL HOURS
0.5
1
1.5
2
3
4
5
6
8
10
15
20
25
PLANT DESIGN FLOW
(MGD)
SCREENING AND GRINDING
SCREENING AND GRINDING OF RAW SEWAGE ONLY.
OPERATION
MAINTENANCE

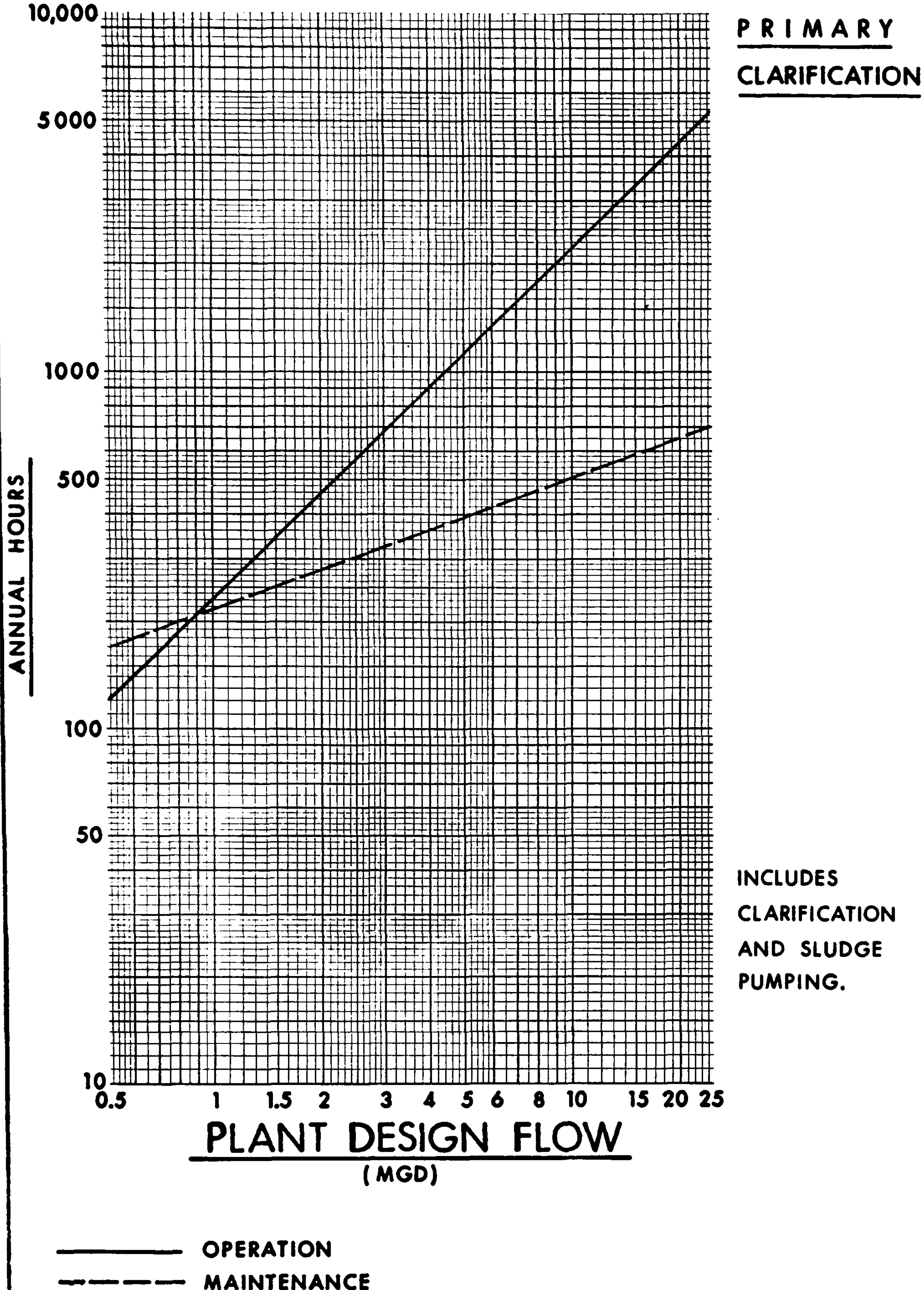


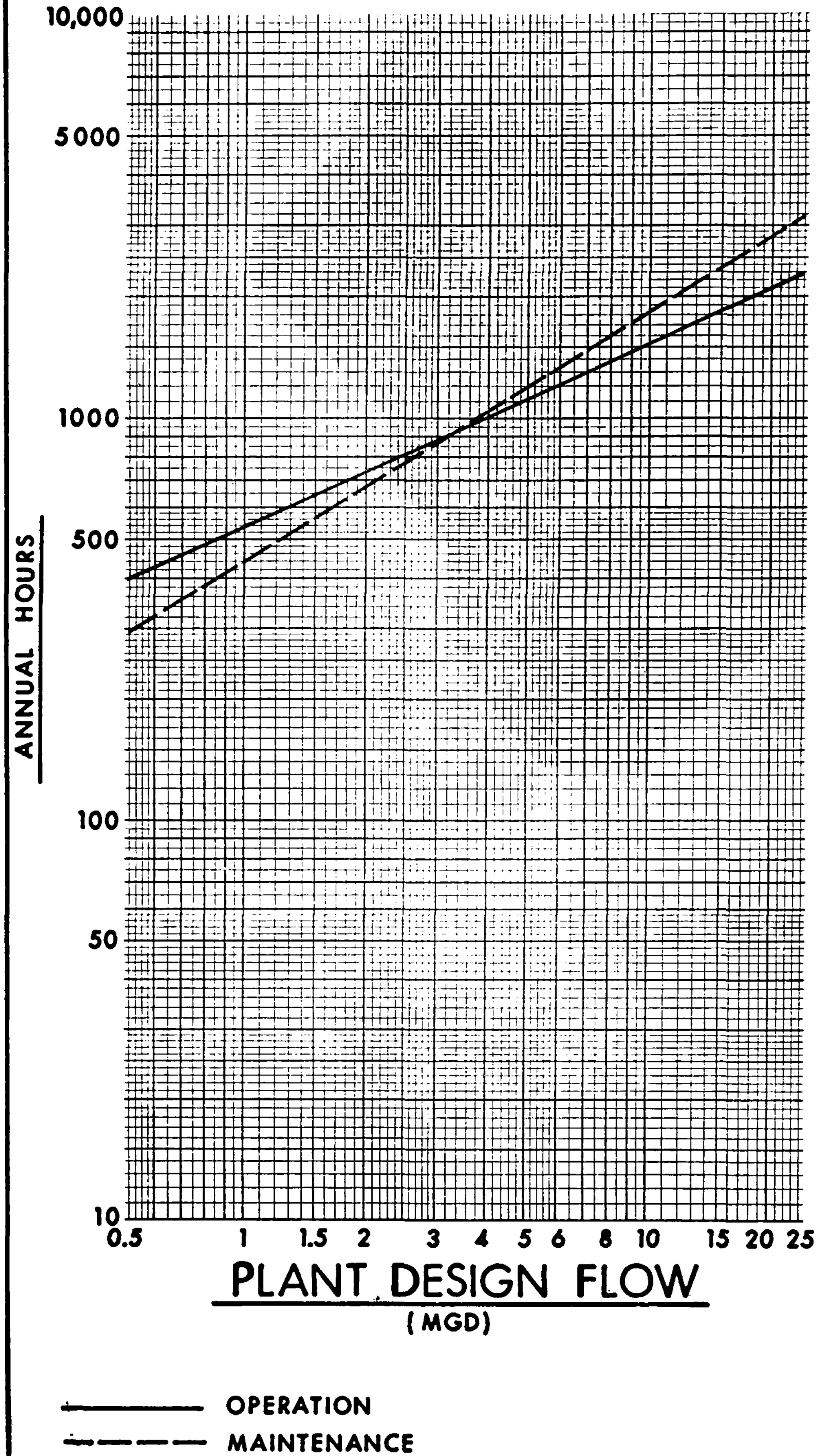
GRIT REMOVAL

INCLUDES GRIT REMOVAL PROCESS, BUT NOT TRANSPORTATION TO THE FINAL DISPOSAL SITE.

——— OPERATION

– – – – MAINTENANCE

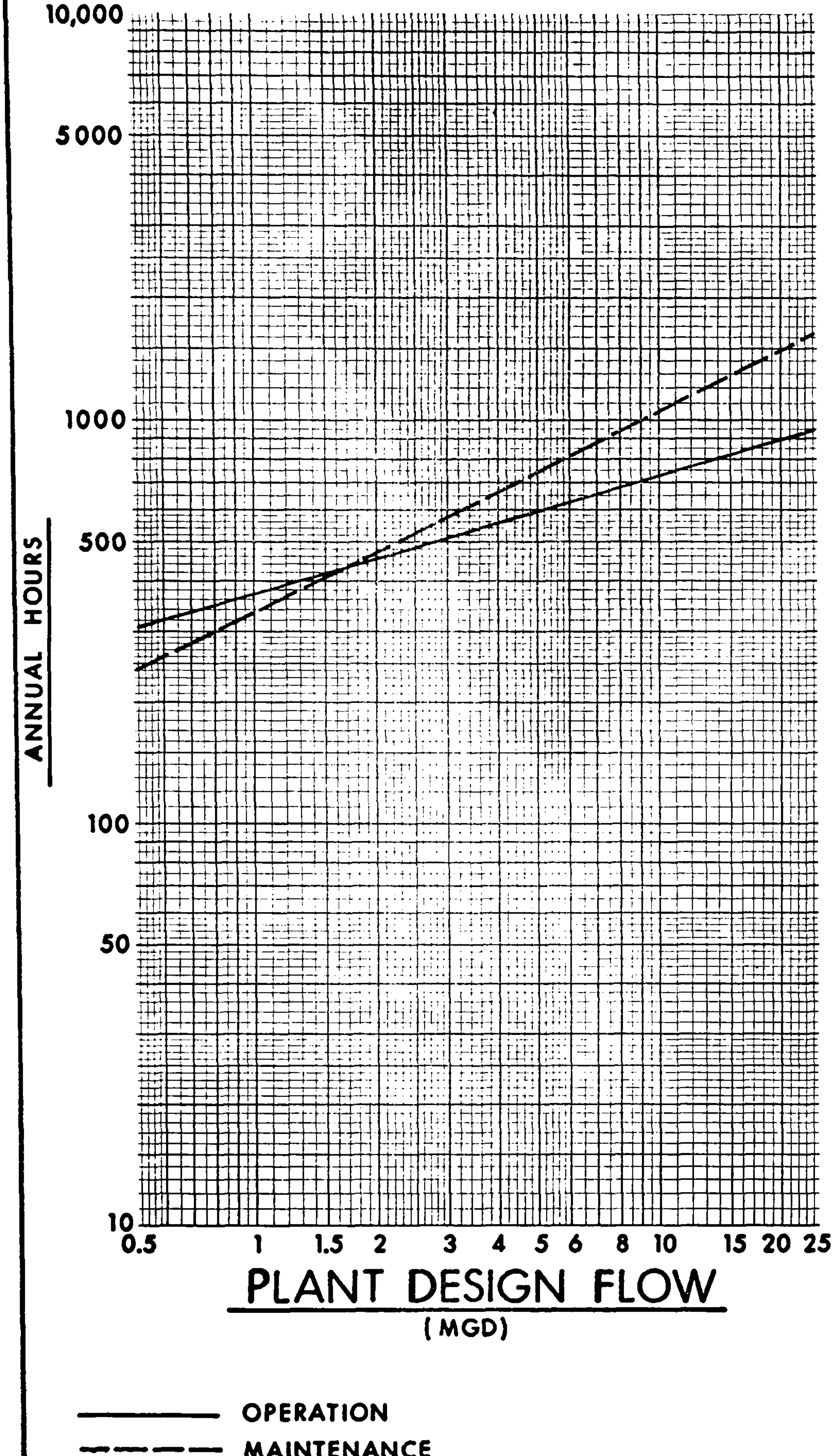

10,000
5000
1000
500
100
50
10
ANNUAL HOURS
0.5
1
1.5
2
3
4
5
6
8
10
15
20
25
PLANT DESIGN FLOW
(MGD)
PRIMARY
CLARIFICATION
INCLUDES CLARIFICATION AND SLUDGE PUMPING.
OPERATION
MAINTENANCE



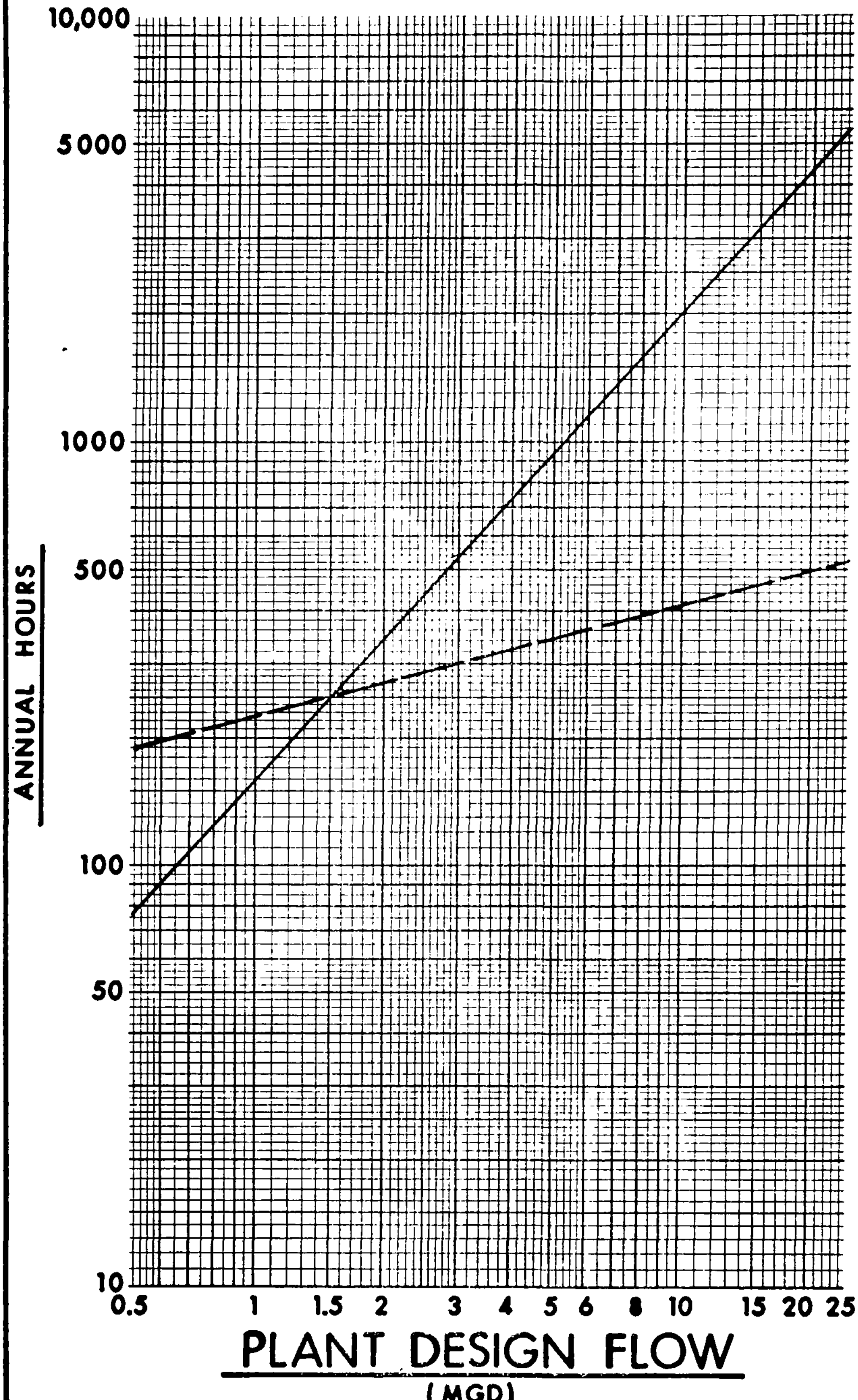
AERATION

INCLUDES AERATION EQUIPMENT.

TRICKLING FILTERS



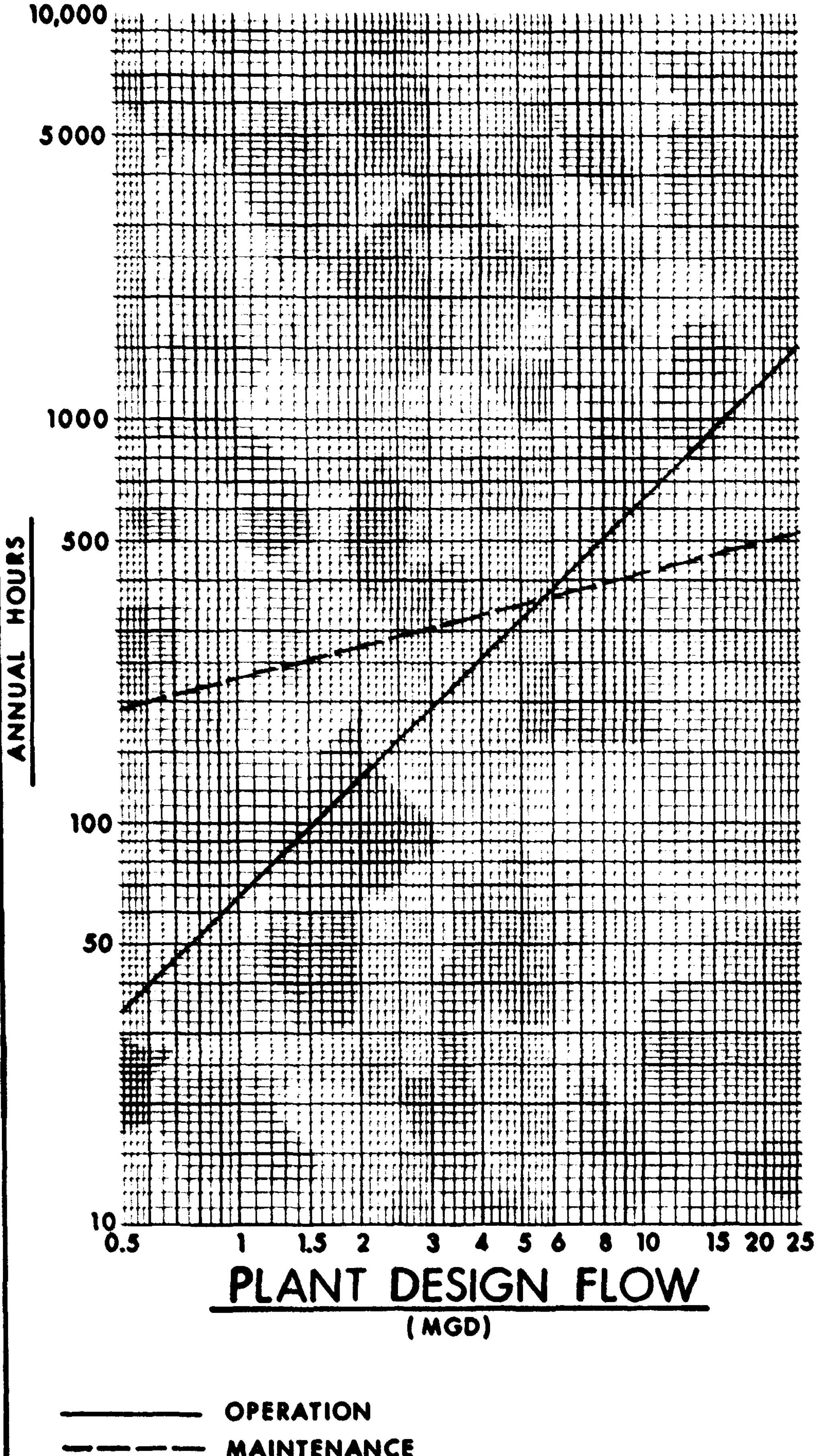
INCLUDES TRICKLING FILTER PROCESSES.



SECONDARY CLARIFICATION ACTIVATED SLUDGE

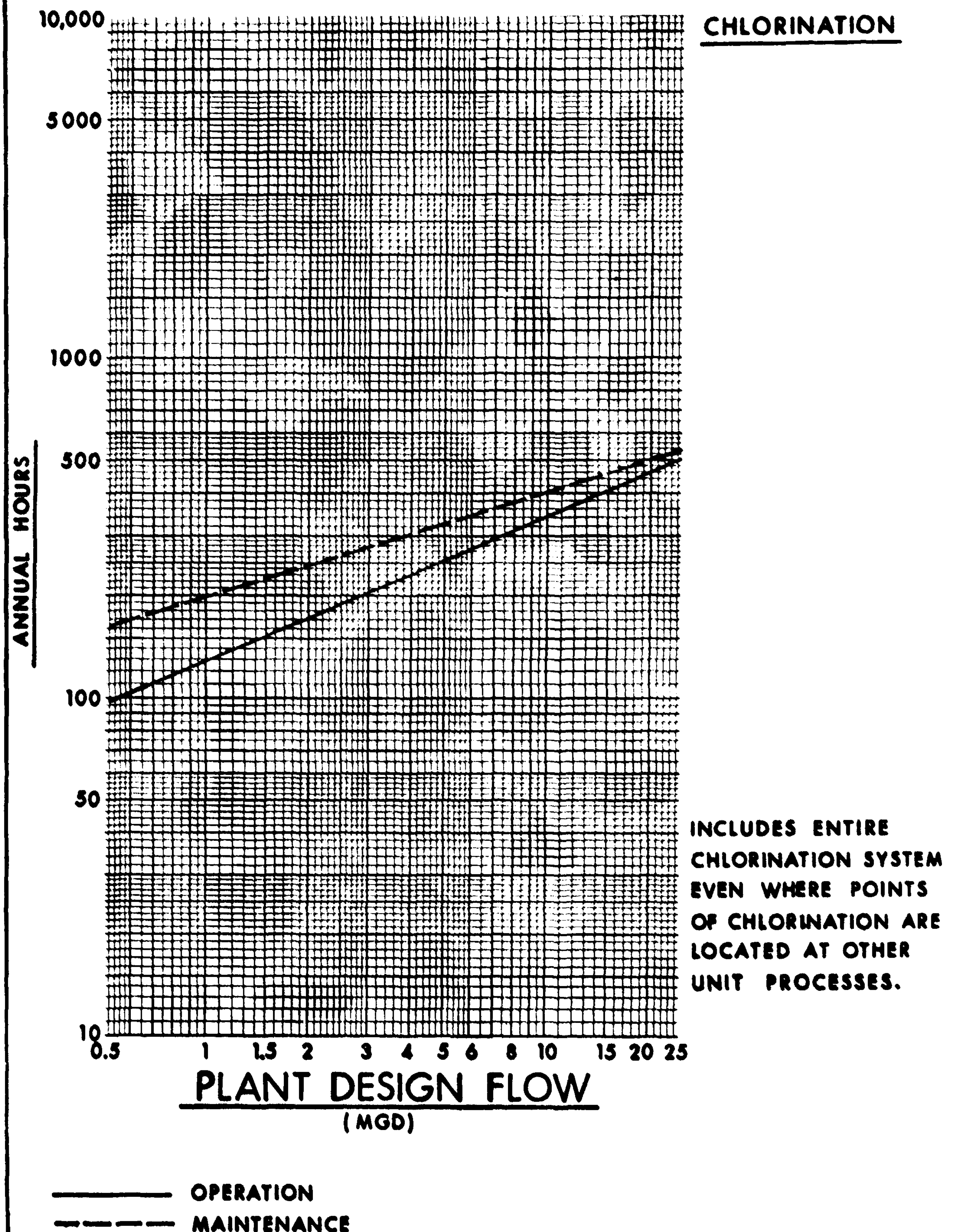
INCLUDES CLARIFICATION RECYCLE AND WASTE SLUDGE PUMPING.

——— OPERATION
– – – – MAINTENANCE



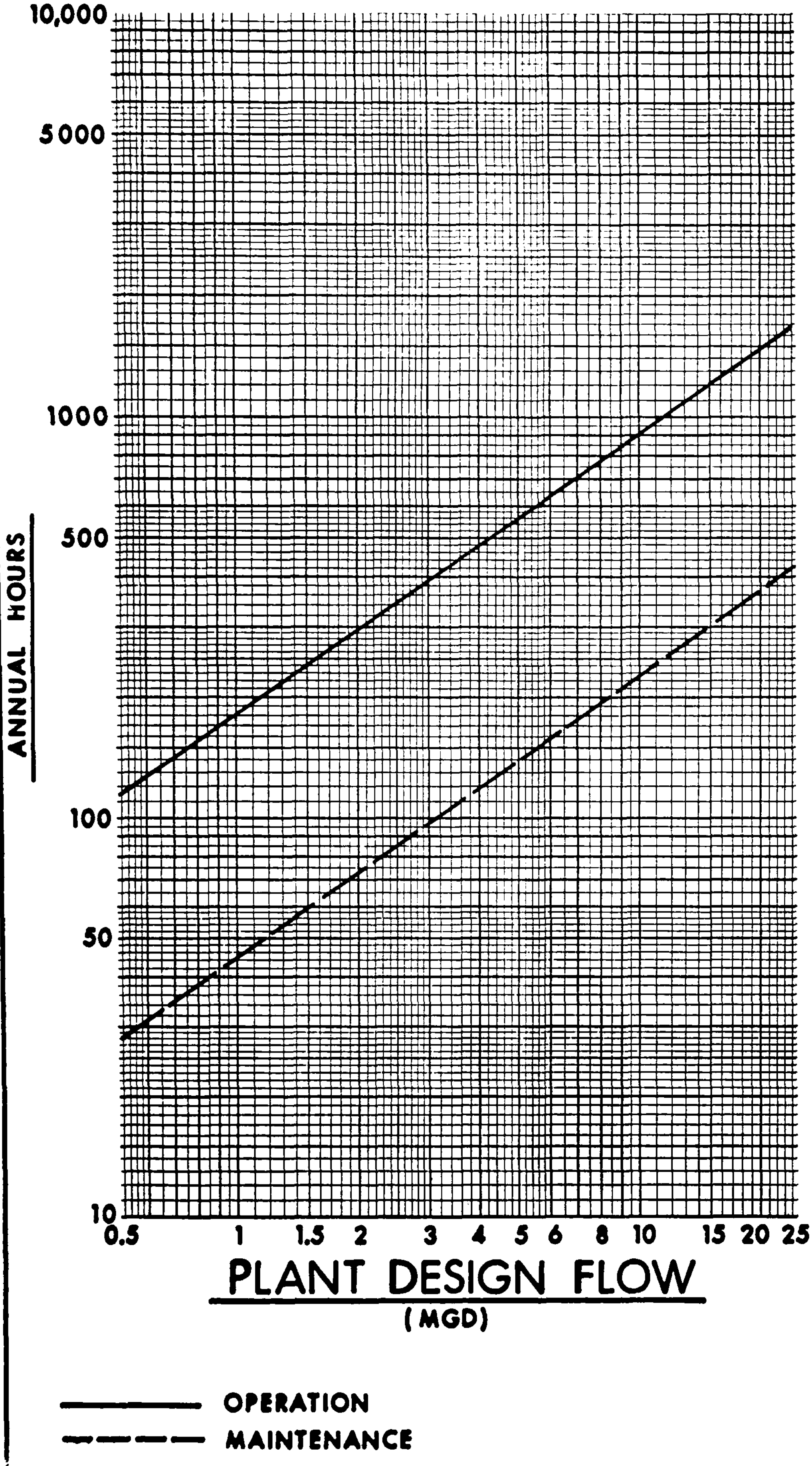
SECONDARY CLARIFICATION TRICKLING FILTRATION

INCLUDES CLARIFICATION RECYCLE AND WASTE SLUDGE PUMPING.



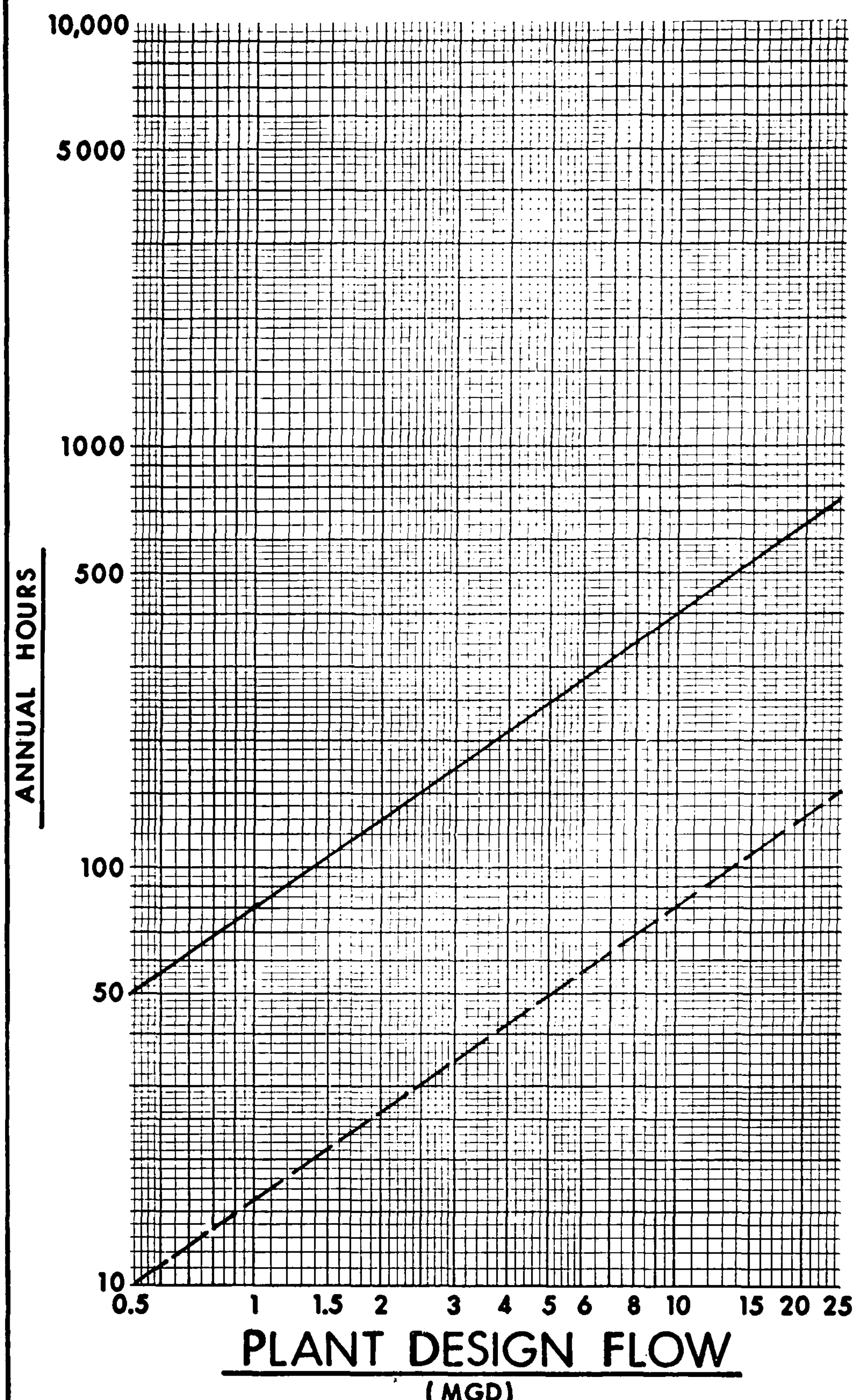
CHLORINATION
10,000
5000
1000
500
100
50
10
ANNUAL HOURS
0.5
1
1.5
2
3
4
5
6
8
10
15
20
25
PLANT DESIGN FLOW
(MGD)
INCLUDES ENTIRE CHLORINATION SYSTEM EVEN WHERE POINTS OF CHLORINATION ARE LOCATED AT OTHER UNIT PROCESSES.
OPERATION
MAINTENANCE

ANAEROBIC DIGESTION



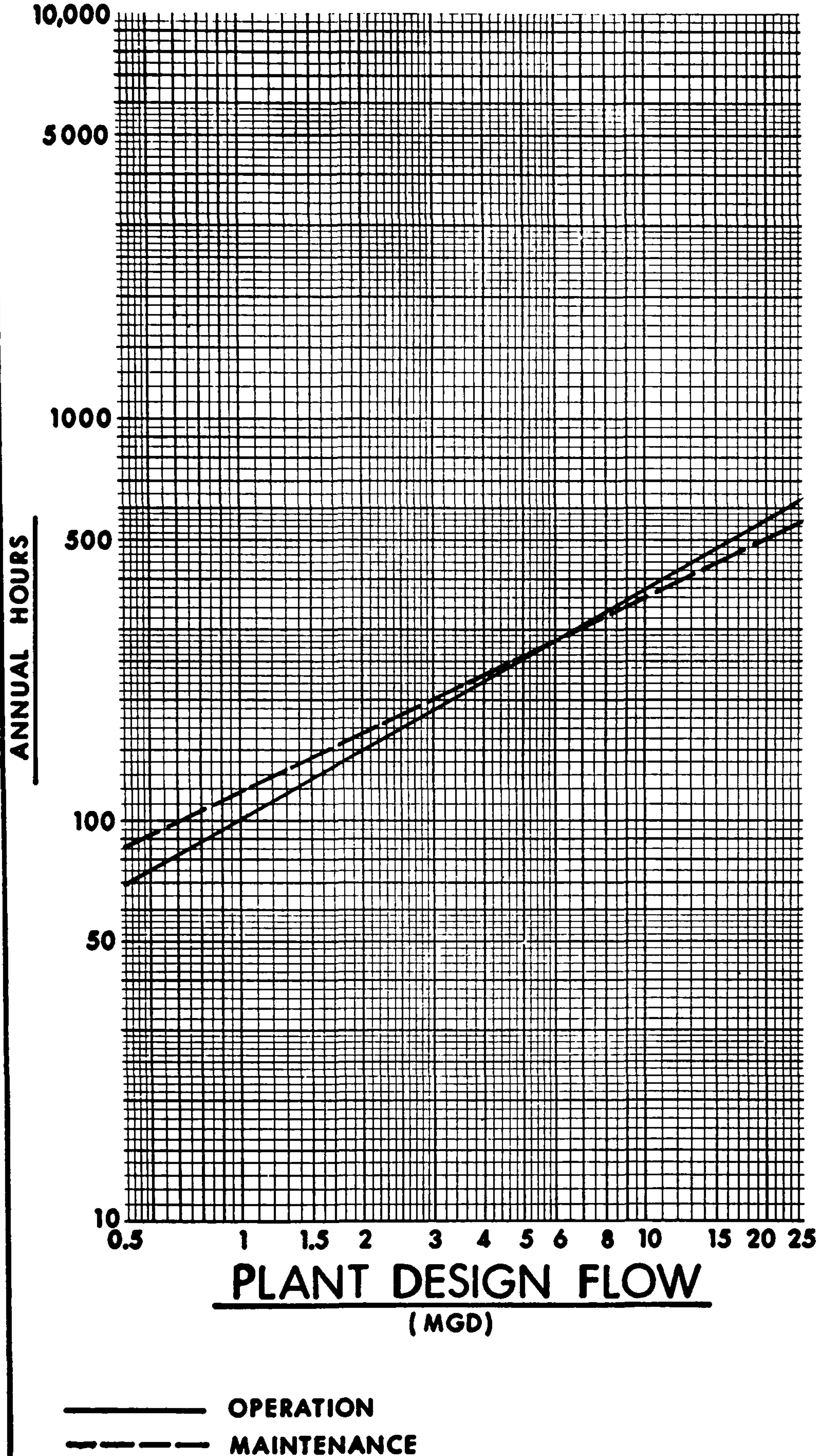
INCLUDES DIGESTION, HANDLING OF WASTE GAS, AND REMOVAL OF SLUDGE TO NEXT UNIT PROCESS.

AEROBIC DIGESTION



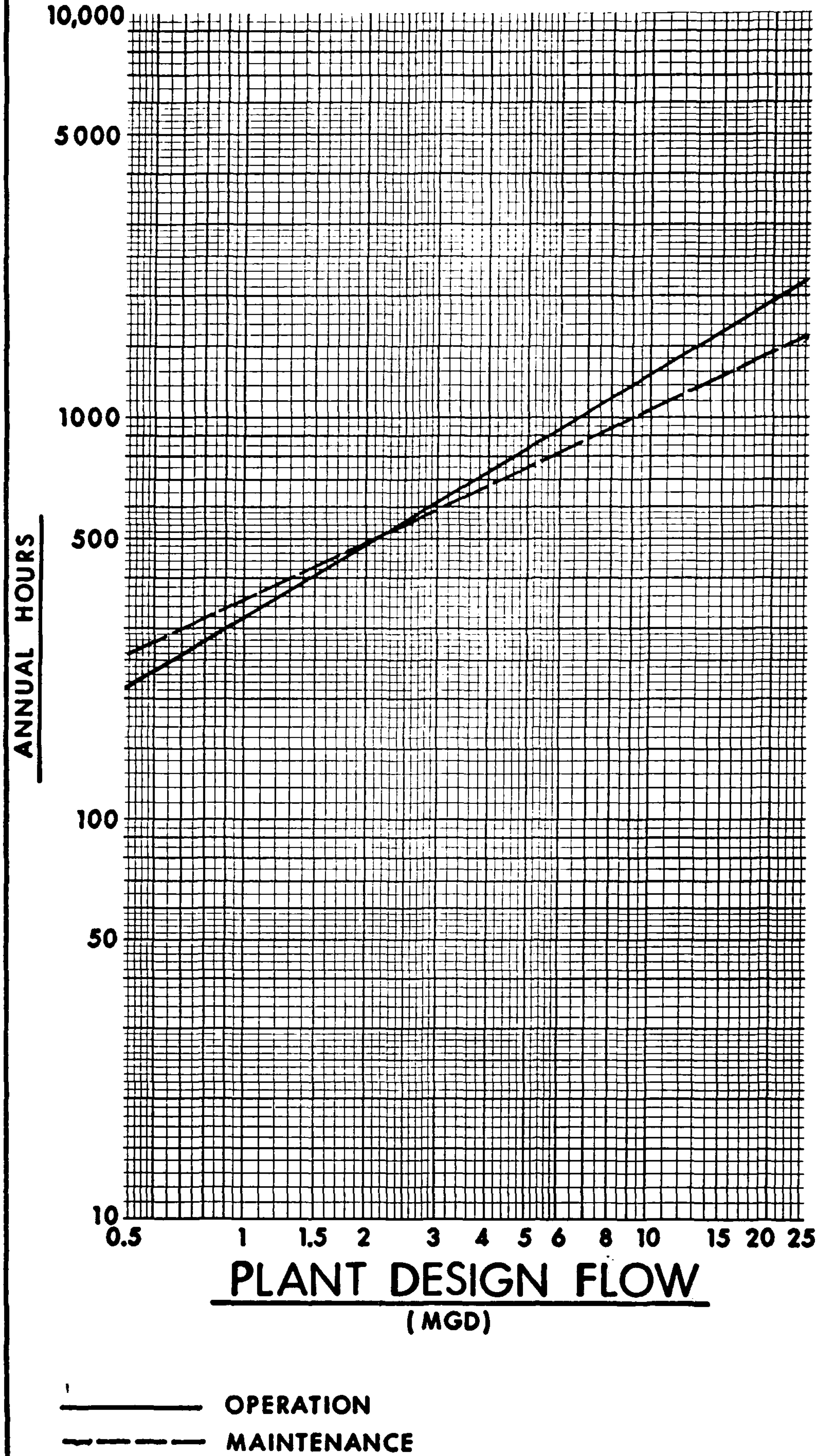
INCLUDES DIGESTION AND REMOVAL OF SLUDGE TO NEXT UNIT PROCESS.

——— OPERATION
– – – – MAINTENANCE



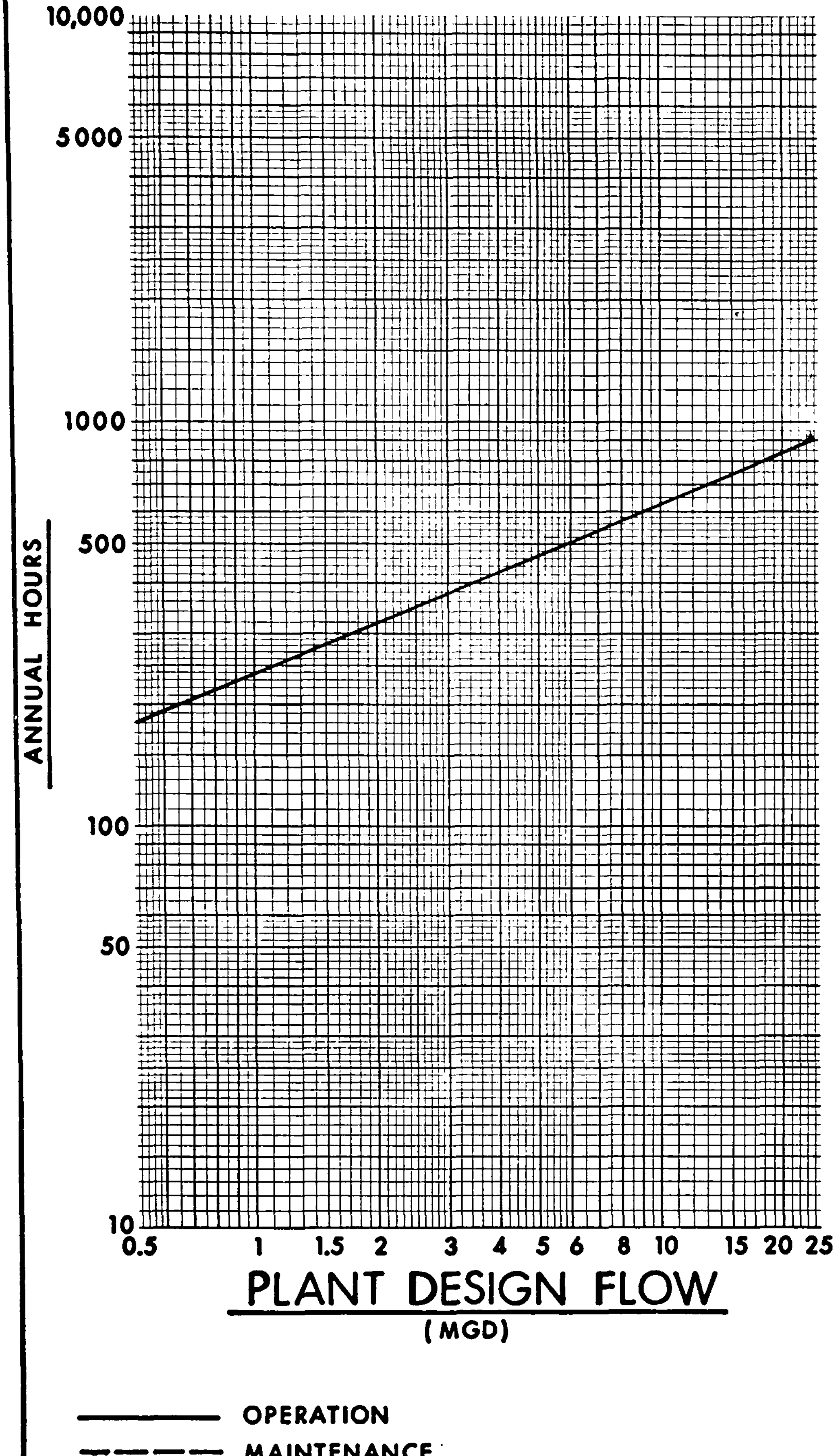
GRAVITY THICKENING

INCLUDES THICKENING AND REMOVAL OF SLUDGE TO THE NEXT UNIT PROCESS.



FLOTATION THICKENING

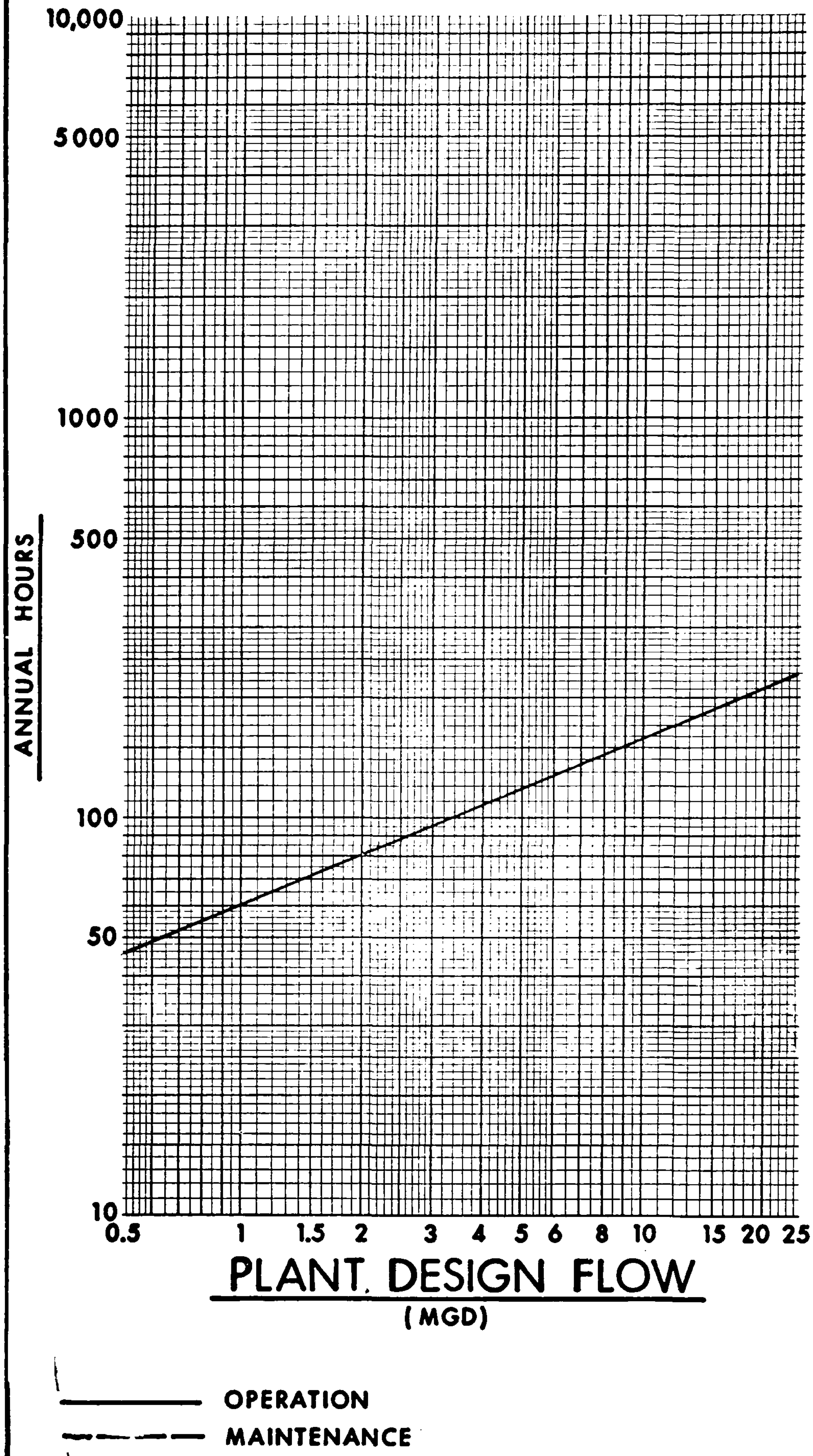
INCLUDES THICKENING AND REMOVAL OF SLUDGE TO THE NEXT UNIT PROCESS.



SLUDGE

DRYING BEDS

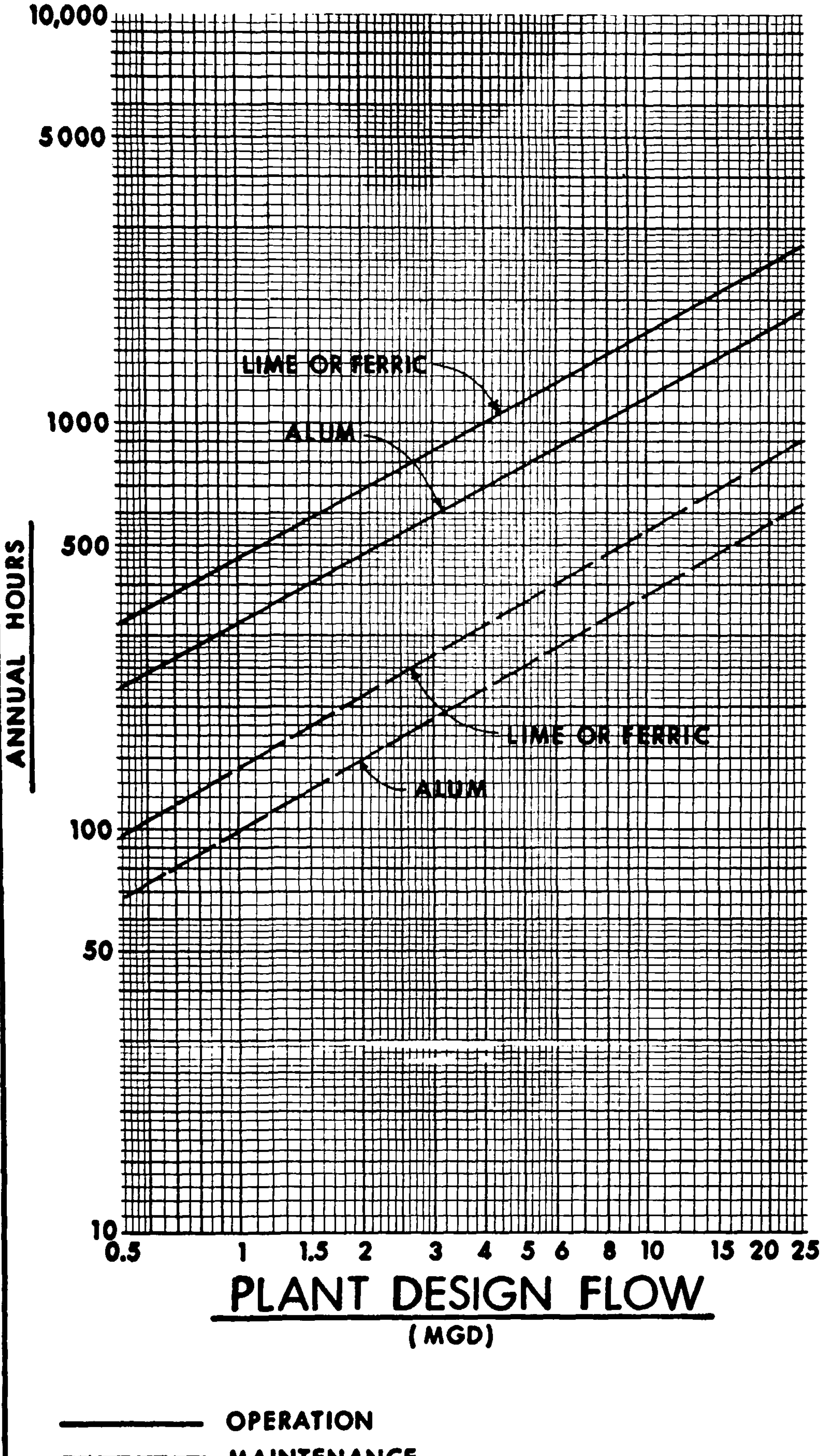
INCLUDES DRYING ON BEDS AND PERIODIC REMOVAL OF SOLIDS.



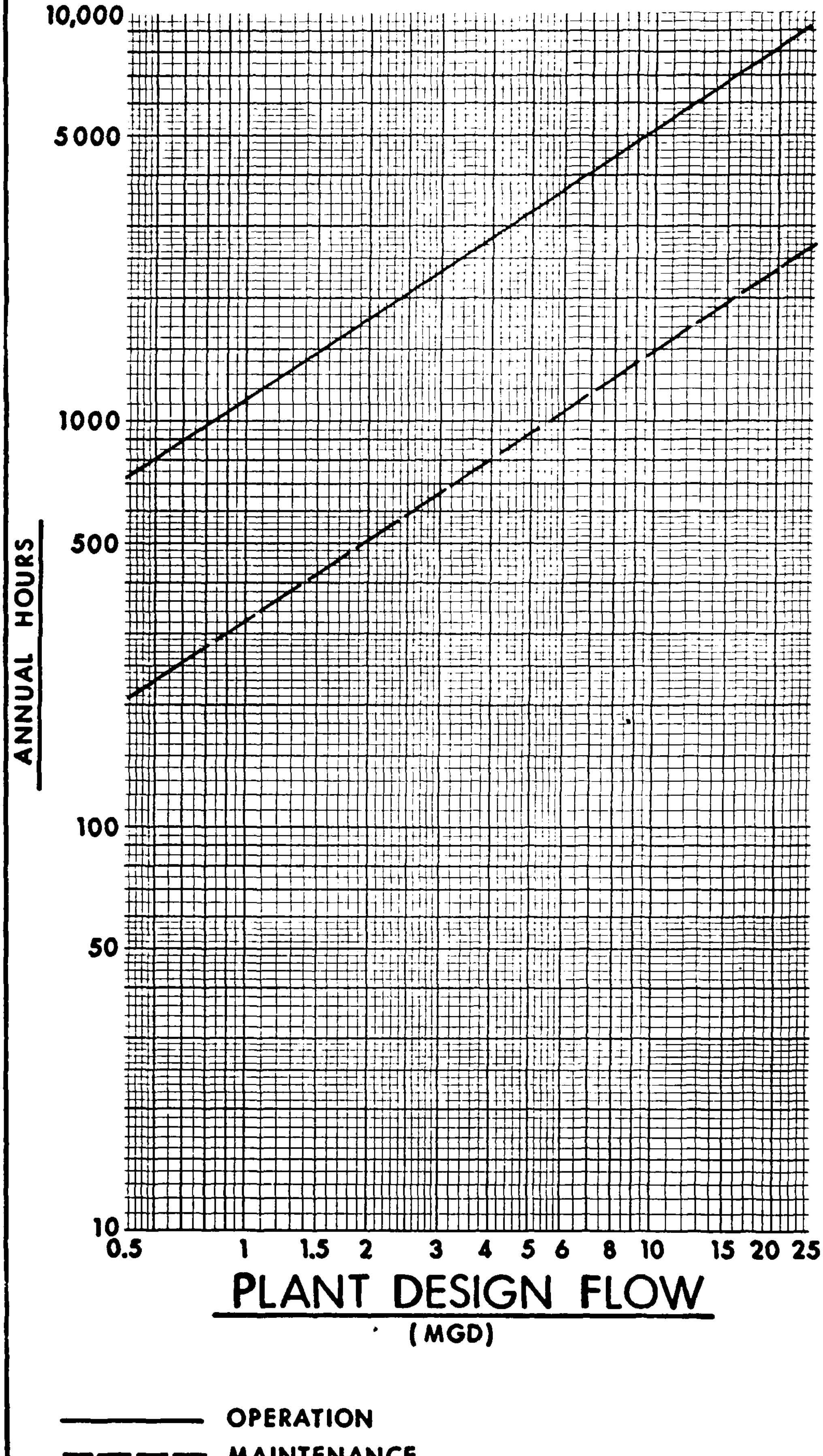
SLUDGE LAGOONS

INCLUDES LAGOONING AND PERIODIC REMOVAL OF SOLIDS.

SEPARATE CHEMICAL COAGULATION AND SETTLING



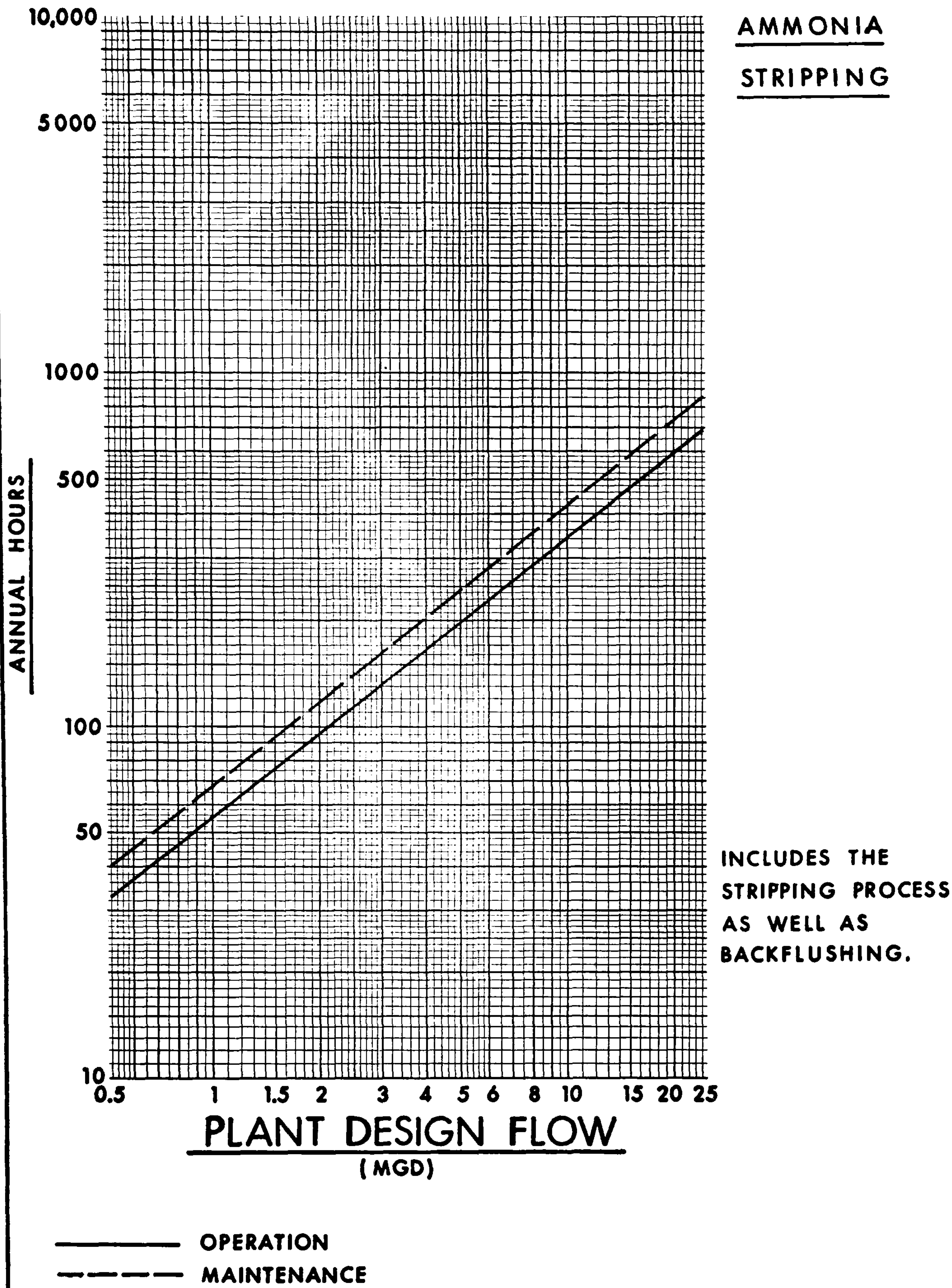
INCLUDES CHEMICAL STORAGE, HANDLING, MIXING, COAGULATION, CLARIFICATION, AND PUMPING OF WASTE SLUDGE. SEPARATE FROM PRIMARY AND SECONDARY SEDIMENTATION.



LIME

RECALCINATION

INCLUDES THE RECALCINATION PROCESS AND TRANSPORTATION OF THE LIME TO STORAGE.


AMMONIA
STRIPPING
10,000
5000
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ANNUAL HOURS
0.5
1
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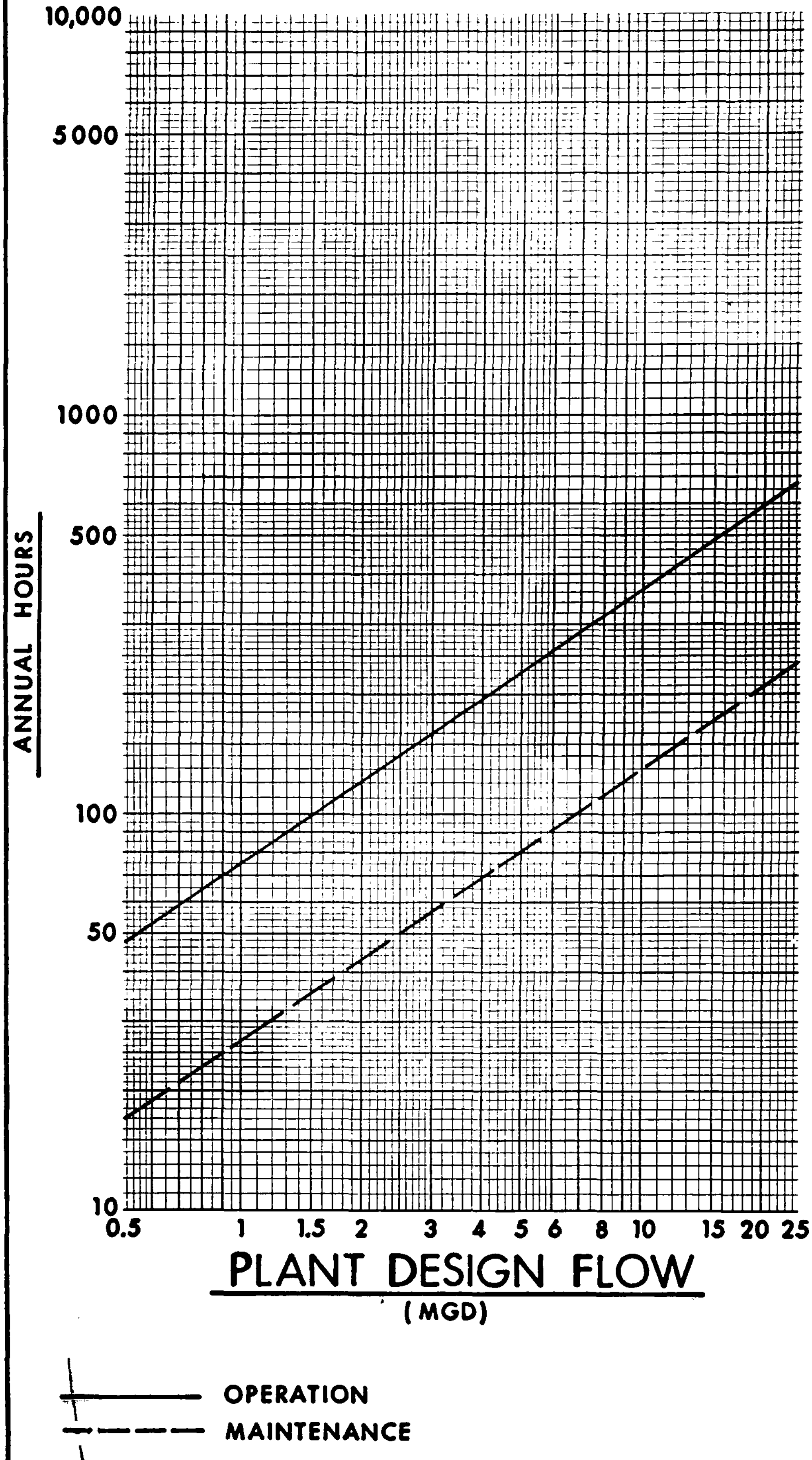
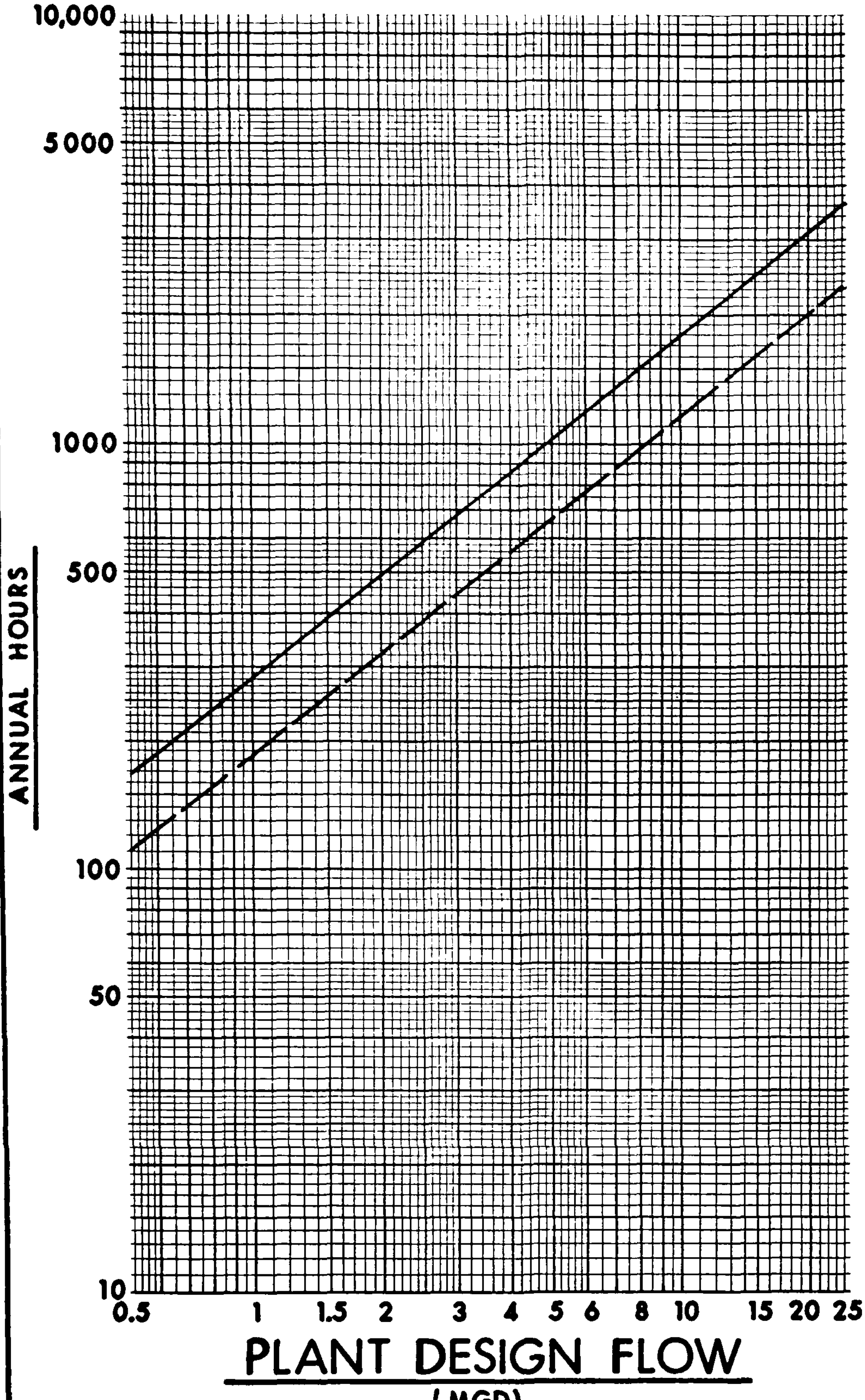
8
10
15
20
25
PLANT DESIGN FLOW
(MGD)
INCLUDES THE STRIPPING PROCESS AS WELL AS BACKFLUSHING.
OPERATION
MAINTENANCE

TWO - STAGE RECARBONATION



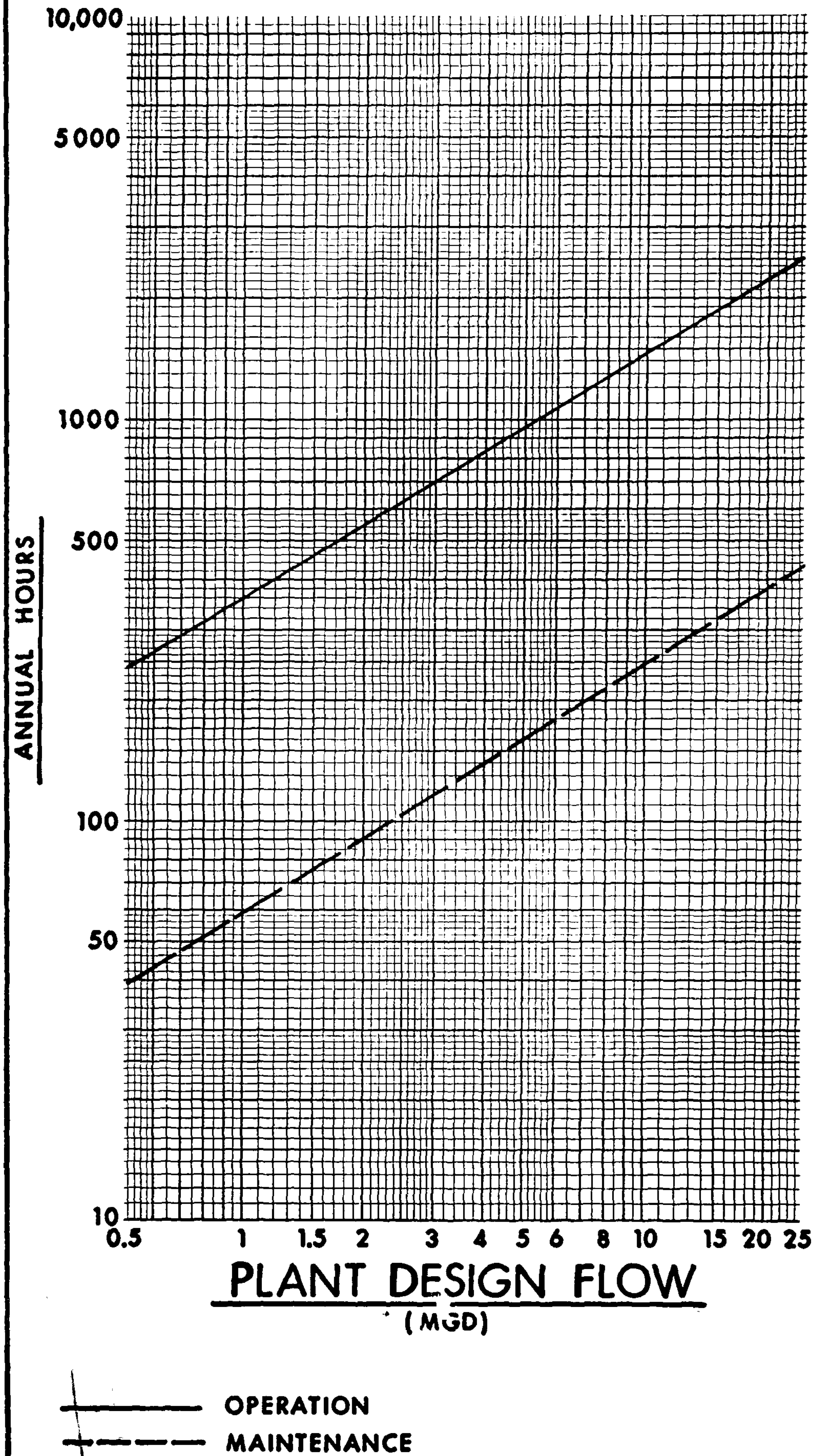
INCLUDES THE RECARBONATION PROCESS, AND REMOVAL OF LIME SLUDGE FROM THE REACTION BASIN.



MIXED MEDIA FILTRATION

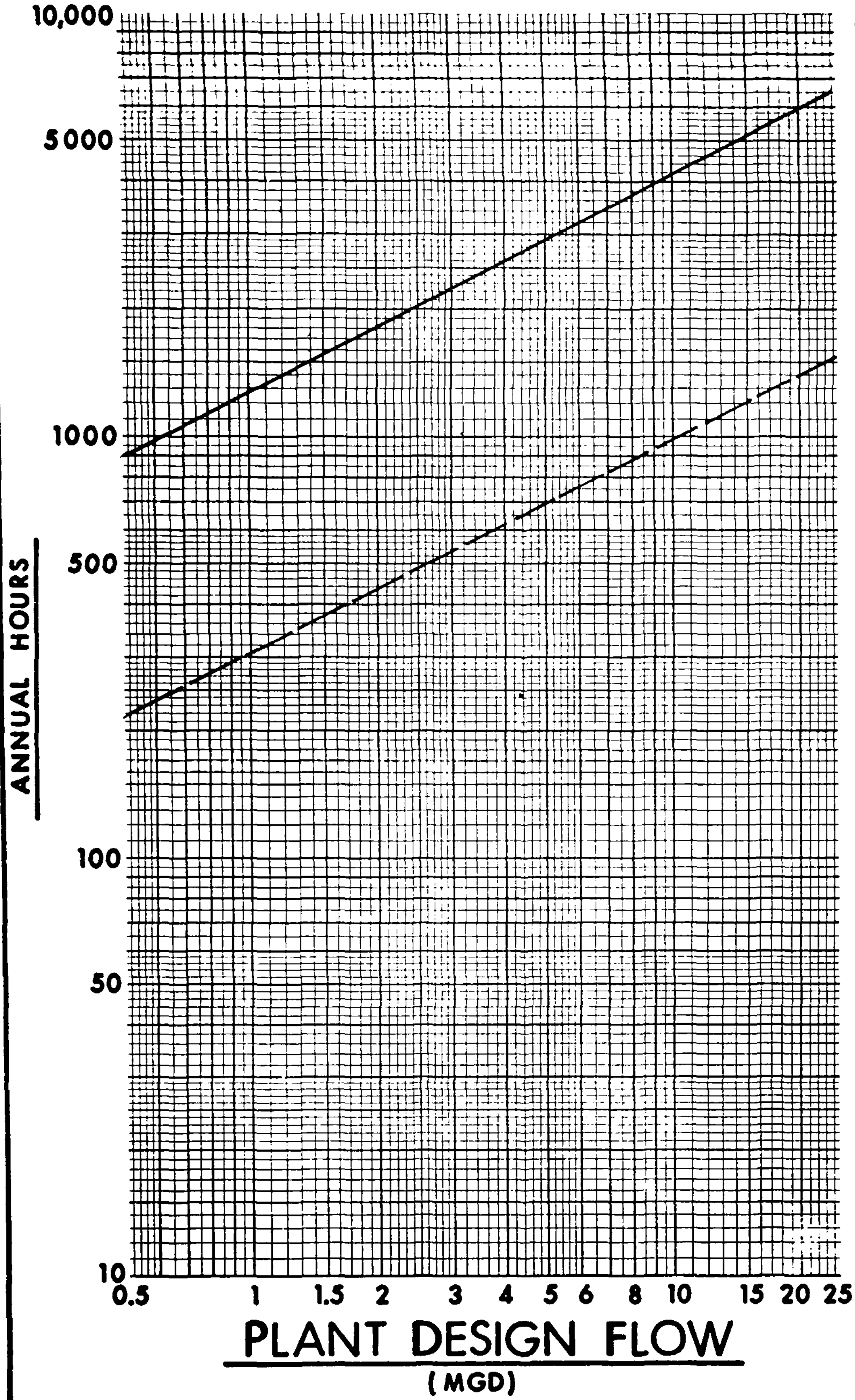
ENTIRE PROCESS.

OPERATION
MAINTENANCE



GRANULAR CARBON ADSORPTION

ENTIRE PROCESS.

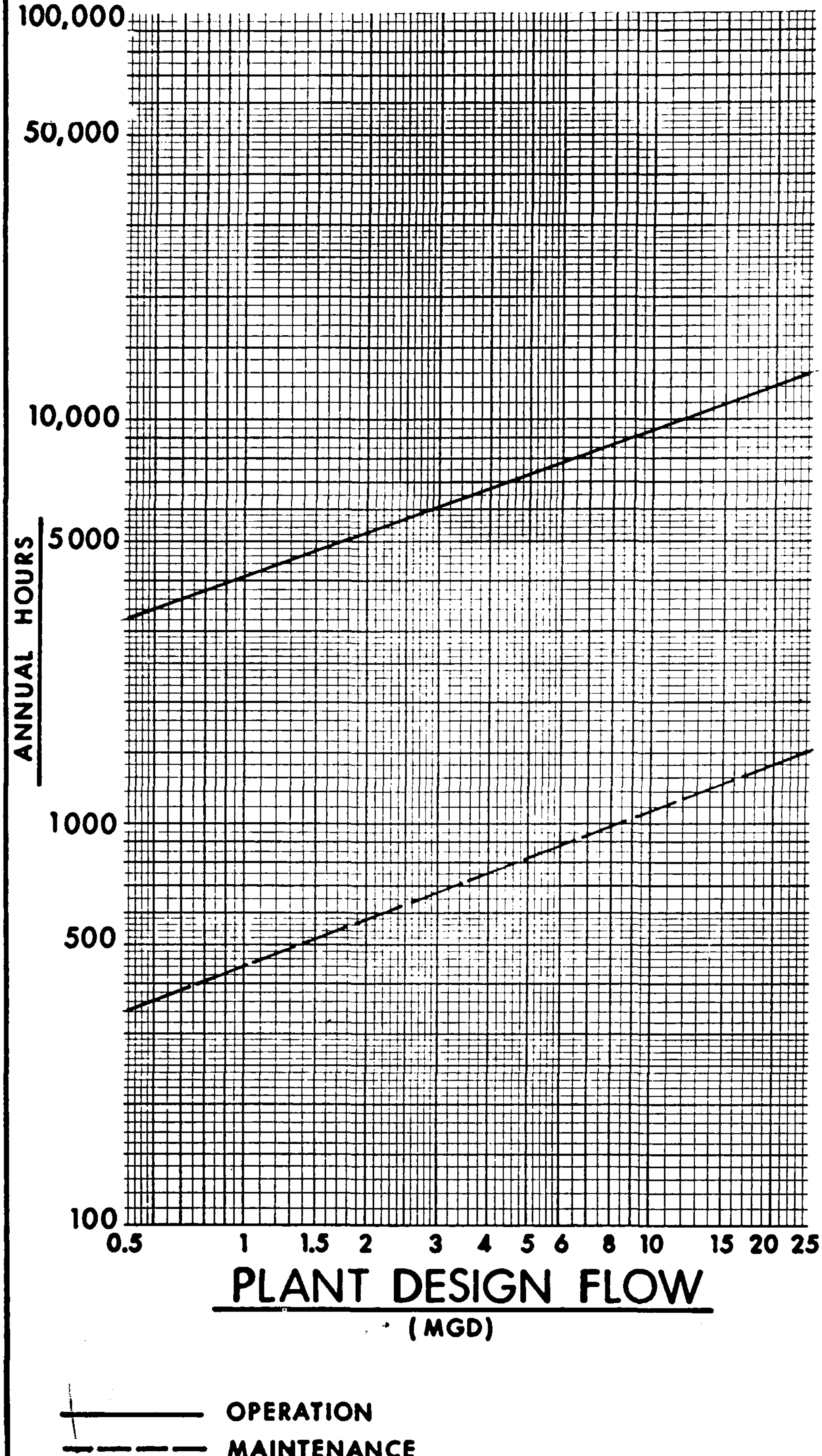


GRANULAR CARBON REGENERATION

INCLUDES REGENERATION AND TRANSFER OF SPENT AND REGENERATED CARBON.

——— OPERATION

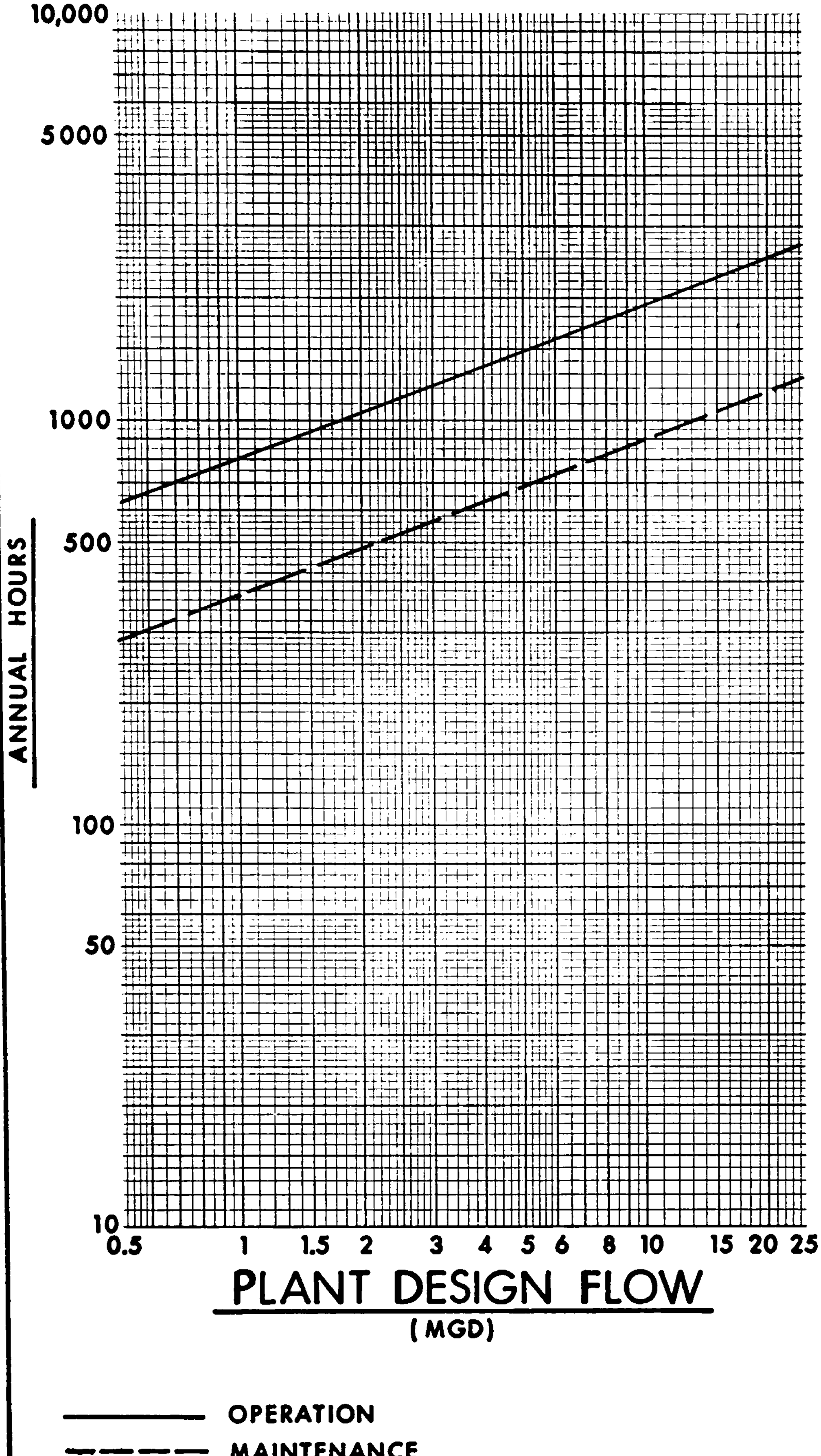
– – – – MAINTENANCE



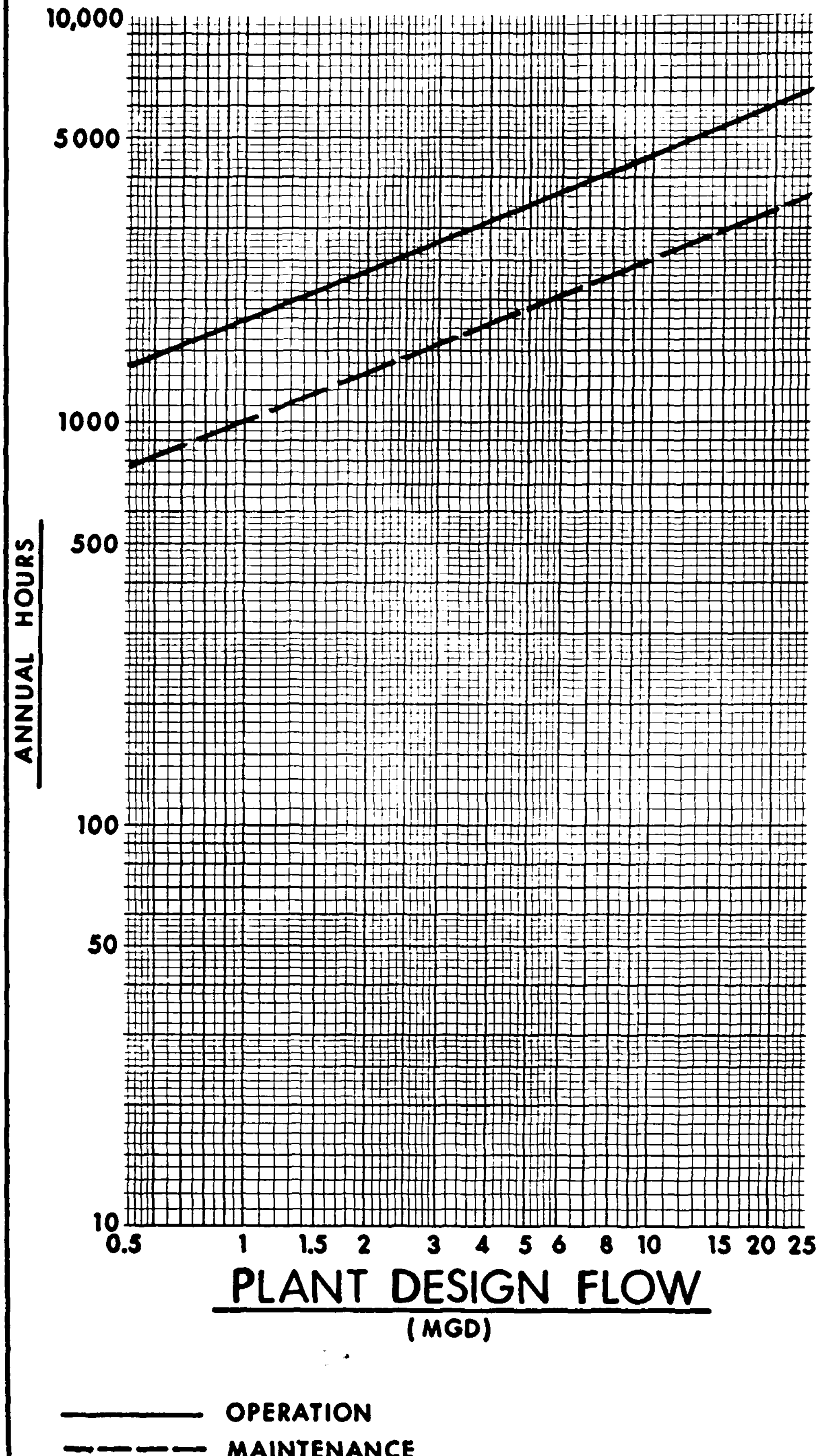
NITRIFICATION DENITRIFICATION

ENTIRE PROCESS.

AMMONIA REMOVAL BY SELECTIVE ION EXCHANGE

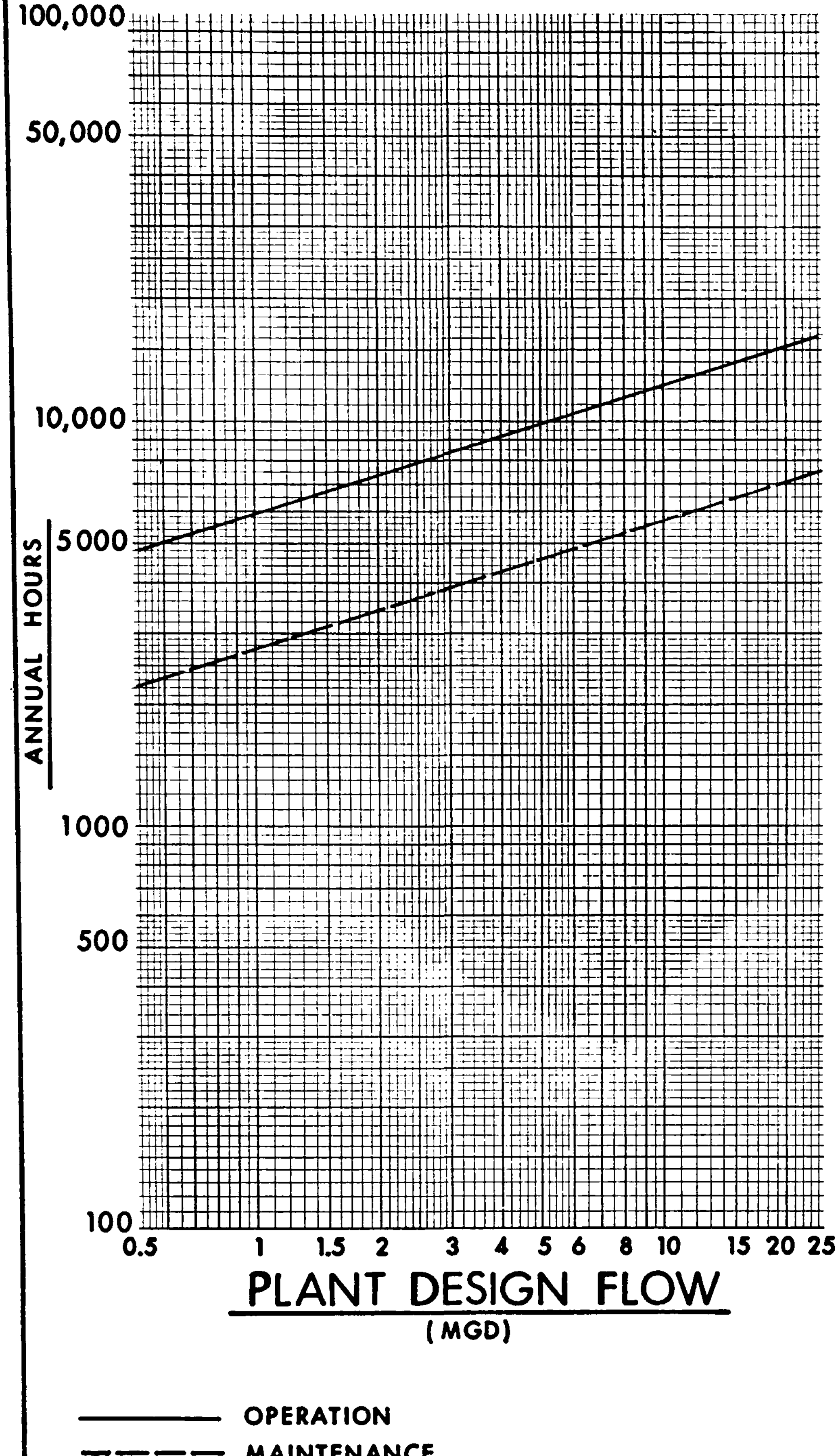


INCLUDES REMOVAL PROCESS AND REGENERATION OF THE ZEOLITE.



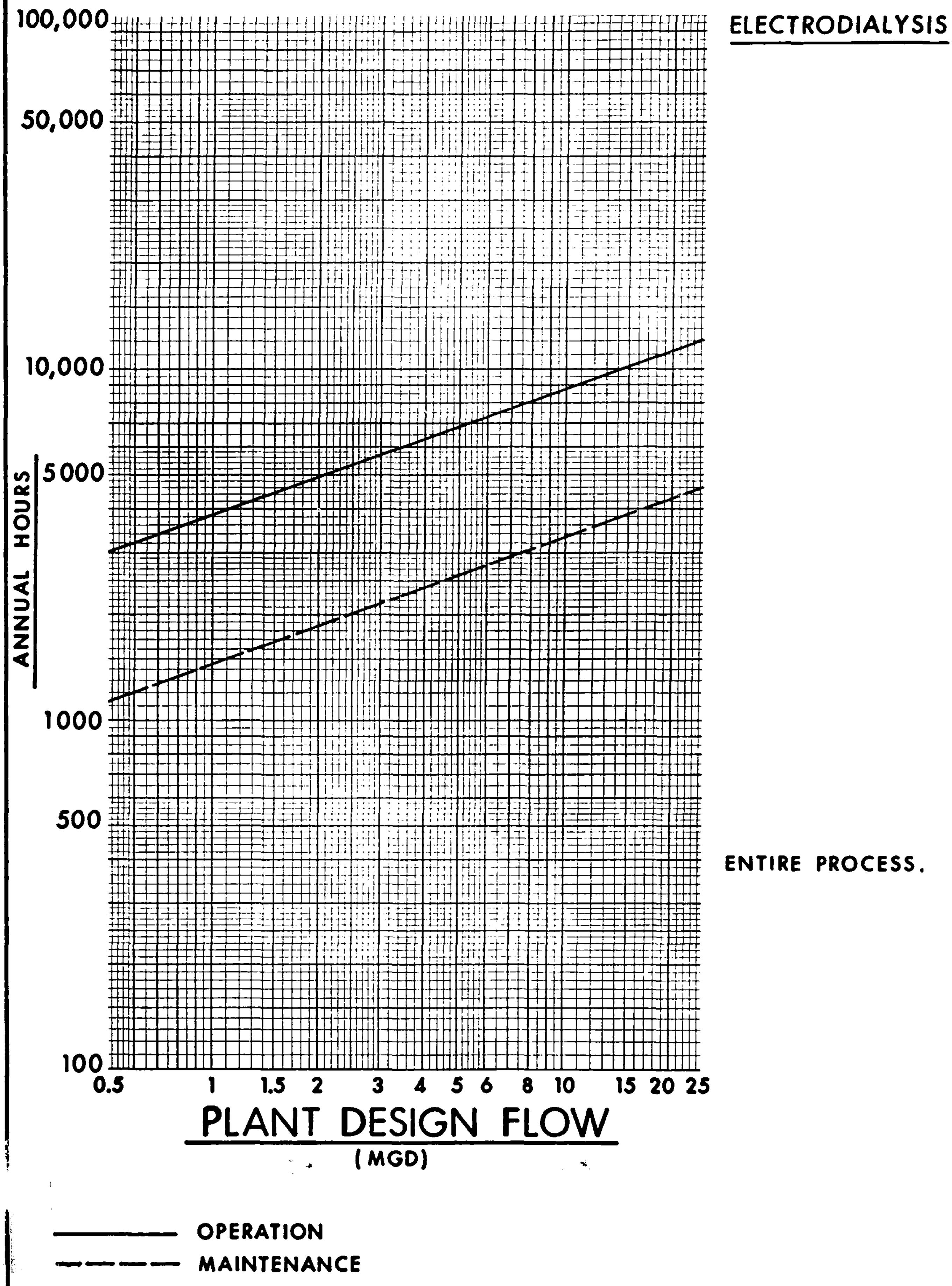
DEMINERALIZATION BY ION EXCHANGE

INCLUDES REMOVAL PROCESS AND REGENERATION OF RESIN.



REVERSE OSMOSIS

ENTIRE PROCESS.


ELECTRODIALYSIS
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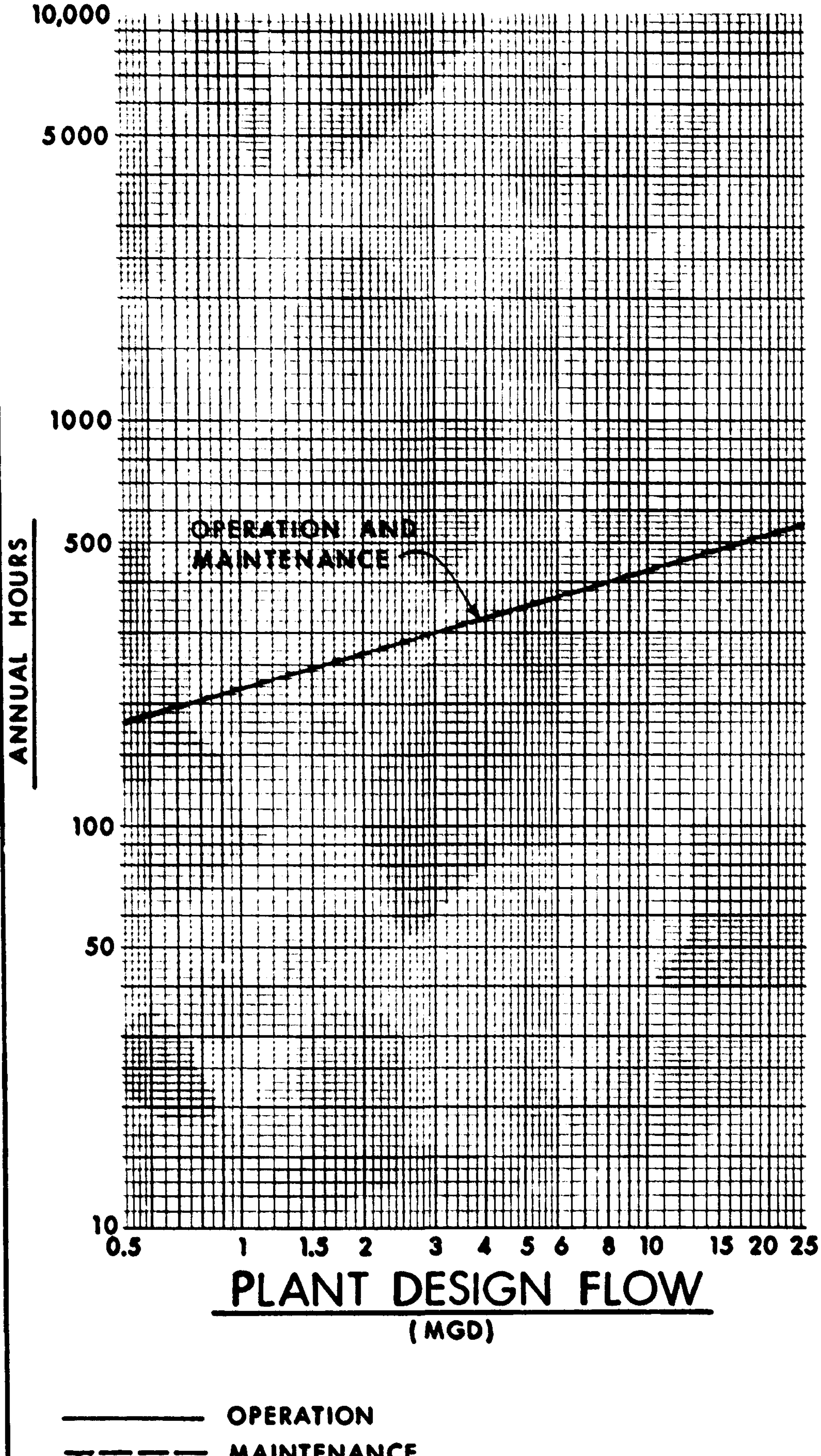
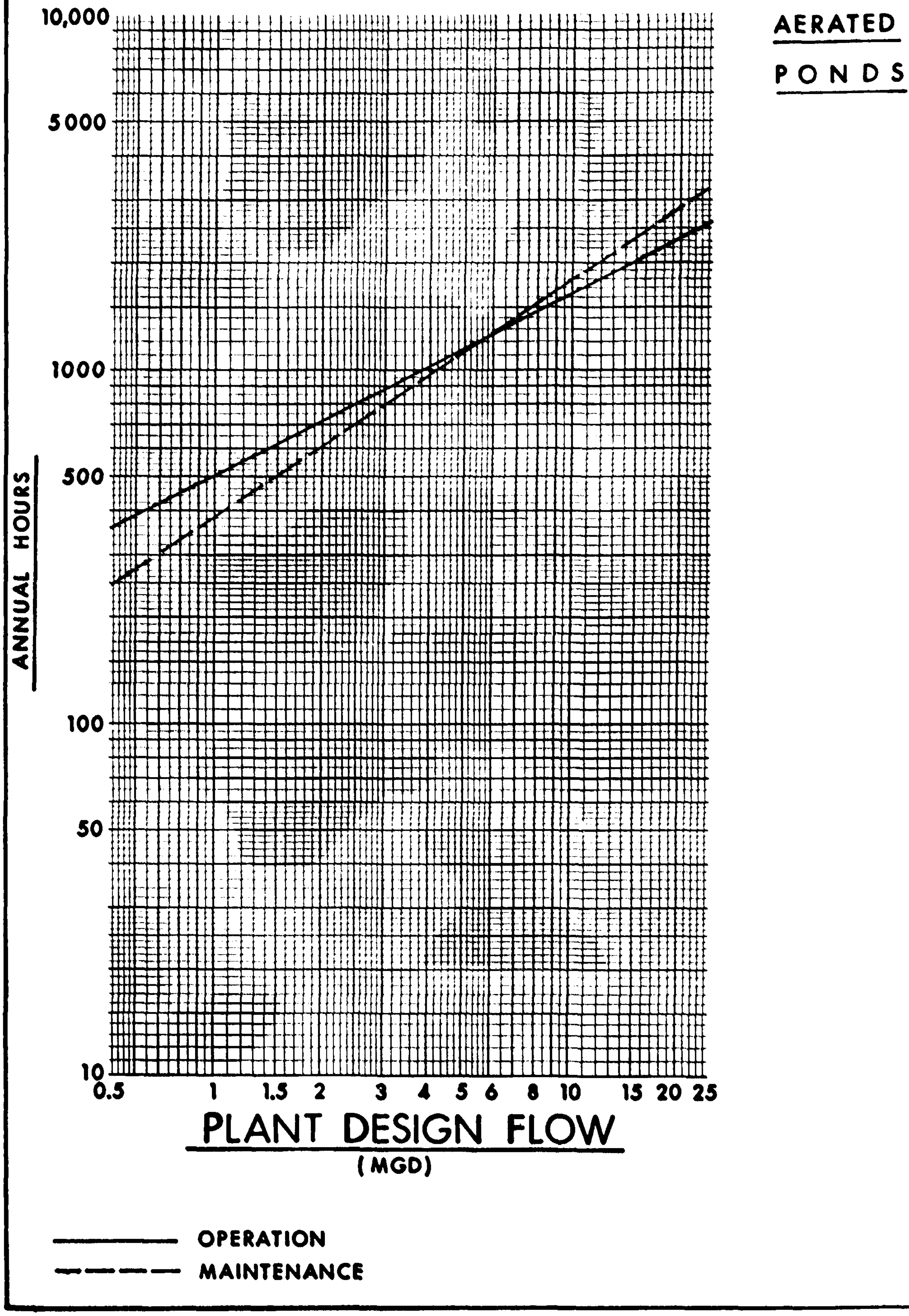
25
PLANT DESIGN FLOW
(MGD)
ENTIRE PROCESS.
OPERATION
MAINTENANCE

STABILIZATION PONDS





AERATED
PONDS
ANNUAL HOURS
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PLANT DESIGN FLOW
(MGD)
OPERATION
MAINTENANCE

TABLE D-34
UNIT MANHOUR REQUIREMENTS†

CENTRIFUGATION		
	Operation	0.3 hours/hour of operation
	Maintenance	0.2 hours/hour of operation
VACUUM FILTRATION		
	Operation	0.6 hours/hour of operation
	Maintenance	0.3 hours/hour of operation
INCINERATION		
	Operation	0.2 hours/hour of operation
	Maintenance	0.2 hours/hour of operation

† The requirements shown are for single units of equipment. For three or more of these units, of whatever mix, reduce the operation and maintenance requirements by half. For instance, one centrifuge, one vacuum filter, and one incinerator would require a total of about 0.35, rather than 0.7, hours of maintenance per hour of operation.

APPENDIX E

APPENDIX E. TASK DESCRIPTIONS

The following six pages are general descriptions of the six tasks or general classifications of work at a plant. The descriptions are in the form of lists of different jobs, or activities, performed under each task. The list is not meant to be complete by any means, but should give you a good idea of the difference between each task, and what is supposed to be done under them.

These task descriptions are not the same as job descriptions; they do not tell you who reports to whom, or who tells who what to do. They *do* tell you what a man engaged in a particular task would be doing or should know how to do. Anything beyond that is left to the job descriptions themselves.

The various activities, or jobs, listed for each task can be combined in almost any reasonable way to make up your own job descriptions. "One man's meat is another man's poison"—and this certainly holds true for job descriptions. This is why TALC and the worksheet do not hold you to any one set of job descriptions—they allow you to make up your own. To help you in this, twenty-one job titles developed by others in the past (3) are listed along with some indication of approximately what jobs go under which general tasks. The final pages of this appendix are an example of a thorough description of the job title 'superintendent' taken from (3).

OPERATIONS TASK

Included in this task are various activities that are commonly identified with the mechanics of plant operation. The following are examples:

- o Operation of process equipment, valves, pumps, engines, and generators.
- o Cleaning of clarifier weirs, bar screens, and other items necessary for proper unit process function.
- o Taking sewage samples as required.
- o Operation of electrical controls (timers, etc.)
- o Monitoring of gauges, meters, and control panels.

- o Recognition of process upsets, and of critical conditions in unit processes.

- o Determination of treatment process condition using lab data and meter and gauge readings.

- o Mixing of any chemicals required in treatment.

- o Inspection of plant for overall process condition.

MAINTENANCE TASK

Maintenance has been divided into two types: preventive and corrective maintenance. These can be defined as "what you do to keep equipment from breaking (preventive), and what you do to fix broken equipment (corrective)."Some of the activities you might perform in both types of maintenance are the following:

- o Lubricate equipment and check for equipment malfunctions.

- o Replace packing in pumps and valves.

- o Service and replace bearings in motors and other equipment.

- o Install and start up new equipment.

- o Clean out pipes (sludge lines).

- o Do some minor plumbing.

- o Do some welding and cutting.

- o Calibrate and repair meters and gauges (although this is sometimes done by an electrician or by outside contract).

- o Set up and maintain a regular program of lubrication and replacement of critical parts (bearings).

- o Inspect and service mechanical and electrical control systems (timers, level controllers, etc.).

SUPERVISORY TASK

This task includes all activities that are necessary for the administration and management of the entire plant. Every plant must have someone who performs the supervisory task. His exact title is unimportant, except that it should differentiate him from the remainder of the staff. Some of the individual activities involved in this task are the following:

- Regular inspection of plant operation and maintenance.
- Analysis and evaluation of the functions performed under the other five tasks.
- Organization and direction of the activities of the plant staff.
- Organization and direction of training programs.
- Formulation of budget and control of expenditures.
- Development of plans and procedures to insure efficient operation and maintenance.
- Reporting to authorities on the operation and expenditures of the plant.
- Maintenance of good public relations.
- Preparation of work schedules, shift staffing, and operation.
- Evaluation of operation and maintenance records.

CLERICAL TASK

This task includes all record keeping and secretarial activities necessary in a plant—the "paper work" task. Some of the jobs included under "paper work" are:

- The maintenance of operation and maintenance records.
- The maintenance of shift logs and meter readings.
- The filling out of regulatory agency forms: discharge reports, operation reports, staff reports.
- The maintenance of reports on operating expenditure.

And, further:

- Composition of routine correspondence and the handling of routine inquiries from the public.
- Operation of office machinery: typewriters, calculators, etc.
- Maintenance of financial records.
- Posting, filing and sorting of various reports and records.

LABORATORY TASK

Work in the laboratory is highly specialized and requires considerable training and experience. In small plants, this task may be handled by those spending time at either the supervisory or operations tasks. Thus the supervisor might also be the laboratory technician. Some of the activities involved in laboratory work are the following:

- Collection of samples (sewage and receiving water).
- Performance of laboratory analyses—both simple and complex.
- Assembling and reporting of data from tests.
- Evaluation of data in terms of plant process performance.
- Preparation of common chemical reagents and bacteriological media.
- Recommending process changes based on laboratory data.
- Reporting to regulatory agencies on the operation of the plant.

YARDWORK

This task is a catch-all. It includes custodial work, janitorial work, gardening and minor maintenance tasks. Almost anything that does not fit in the other five tasks could conceivably go here. Some of the most common activities included in yardwork are listed below:

- Driving, loading and unloading of sludge trucks and other equipment.
- Gardening: cutting grass, trimming shrubs, watering, etc.

- Removing of snow, ice and ponded water.
- Washing of equipment and tools.
- Cleaning and polishing of floors, walls, furniture, etc.
- Serving as night watchman.

RELATIONSHIPS OF JOB TITLES TO TASKS

Task	Job Title
Operations	Operations Supervisor
	Shift Foreman
	Operator II
	Operator I
	Chemist
	Laboratory Technician
Maintenance	Maintenance Supervisor
	Mechanic Maintenance Foreman
	Mechanic II
	Mechanic I
	Electrician II
	Electrician I
	Maintenance Helper
	Automotive Equipment Operator
	Laborer
	Painter
	Storekeeper
	Custodian
Supervisory	Superintendent
	Assistant Superintendent
	Clerk Typist
	Operations Supervisor
	Shift Foreman
	Maintenance Supervisor
	Mechanical Maintenance Foreman
	Chemist
	Laboratory Technician

Task	Job Title
Clerical	Clerk Typist
Laboratory	Chemist Laboratory Technician
Yardwork	Laborer Painter Storekeeper Custodian

This list should give you an idea of what portions of tasks to put under which job titles. The list tells you that a man engaged in one of the tasks in the left column will do some or all of the corresponding jobs listed in the right column. An important point to notice here is the overlap. This is a good example illustrating the difficulty of using rigid job titles. For example, a "chemist" may in fact do supervisory work, or he may just do laboratory work.

SAMPLE OCCUPATION DESCRIPTION

Title: SUPERINTENDENT, WASTEWATER TREATMENT PLANT

JOB DESCRIPTION

Responsible for administration, operation, and maintenance of entire plant. Exercises direct authority over all plant functions and personnel, in accordance with approved policies and procedures. Inspects plant regularly. Analyzes and evaluates operation and maintenance functions; initiates or recommends new or improved practices. Develops plans and procedures to insure efficient plant operation. Recommends plant improvements and additions. Coordinates data and prepares or reviews and approves operation reports and budget requests. Controls expenditure of budgeted funds and requests approval for major expenditures, if required. Recommends specifications for major equipment and material purchases. Organizes and directs activities of plant personnel, including training programs. Maintains effective communications and working relationships with employees, government officials, and general public.

QUALIFICATIONS PROFILE

1. Formal Education

   College degree in sanitary, civil, chemical, or mechanical engineering highly desirable. Minimum high school graduate or equivalent, plus 5 to 7 years practical experience in treatment plant operations, depending upon size and complexity of plant.

2. General Requirements

   a. Knowledge of processes and equipment involved in wastewater treatment, including basic chemical, bacteriological, and biological processes.

   b. Understanding of managerial, administrative, and accounting practices and procedures involved in successful plant operation.

   c. Knowledge of industrial wastes and their effects on treatment processes and equipment.

d. Ability to prepare or supervise preparation of clear, concise reports and budget recommendations.

e. Ability to plan, direct, and evaluate plant operation and maintenance functions.

f. Ability to establish and maintain effective communication and working relationships.

3. General Educational Development

a. Reasoning

(1) Apply principles of logic to define problems, collect and analyze data, and draw valid conclusions. Deal with a variety of concrete and abstract variables.

(2) Interpret a wide variety of technical instructions, in book, manual, and mathematical or diagrammatic form.

b. Mathematical

Perform ordinary arithmetical, algebraic, and geometric procedures in standard, practical applications.

c. Language

(1) Write and edit operation reports.

(2) Evaluate and interpret engineering and other technical data.

(3) Interview applicants and employees.

(4) Establish and maintain communications with employees, government officials, and the public.

4. Specific Vocational Preparation

a. Completion of operator training course or equivalent training and experience.

b. Five to 7 years experience in wastewater treatment plant operation, depending upon size and complexity of plant and educational background. Minimum of one year supervisory experience.

5. Aptitudes-Relative to General Working Population

a. Intelligence	Highest third excluding top 10 percent
b. Verbal	Highest third excluding top 10 percent
c. Numerical	Highest third excluding top 10 percent
d. Form Perception	Middle Third
e. Spatial	Middle Third
f. Clerical Perception	Middle Third
g. Motor Coordination	Middle Third
h. Finger Dexterity	Middle Third
i. Manual Dexterity	Middle Third
j. Eye-Hand-Foot Coordination	Middle Third
k. Color Discrimination	Middle Third

6. Interests

Prefer working with people in situations involving organization and supervision of varied activities.

7. Temperament

Prefer situations involving the direction, control, and planning of an entire activity or the activity of others.

8. Physical Demands

Sedentary work, except for regular plant inspection trips.

9. Working Conditions

Largely inside. Occasional exposure to weather, fumes, odors, dust, and risk of bodily injury. Possible exposure to toxic conditions.

ENTRY SOURCES

Assistant Superintendent, Operations Supervisor, Shift Foreman, or Chief Chemist; depending on individual qualifications and size and complexity of plant.

PROGRESSION TO:

Similar position in larger or more complex plant.

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