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WATER MANAGEMENT PROJECT

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WATER TREATMENT PLANT OPERATION (RAPID SAND FILTER)

A TRAINING/JOB MANUAL

BY

VERE WILLIAMS

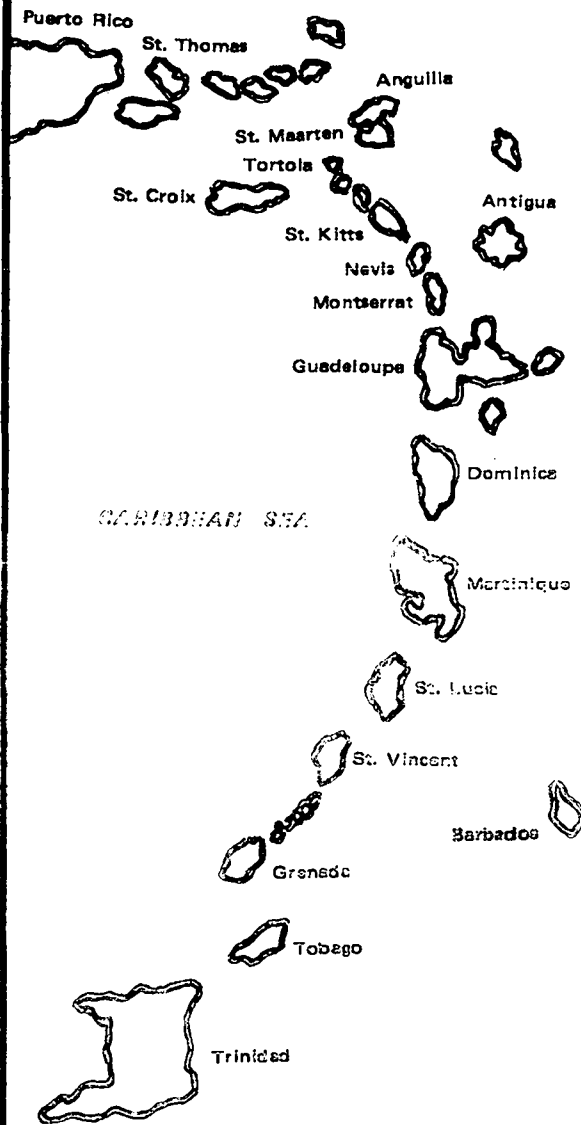
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A JOINT-VENTURE PROJECT OF THE GOVERNMENTS OF:

ANGUILLA, ANTIGUA, BRITISH VIRGIN ISLANDS, BARBADOS,
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AND

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CARIBBEAN BASIN WATER MANAGEMENT PROJECT
WATER TREATMENT PLANT OPERATION

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PREFACE

PURPOSE OF TRAINING/JOB MANUAL

MAINTAINING EFFECTIVE AND EFFICIENT ON-THE-JOB PERFORMANCE SHOULD BE THE AIM OF NOT ONLY EVERY SUPERVISOR AND FOREMAN BUT ALSO OF EVERY WORKER. FREQUENTLY SOME IMPROVEMENT IN PERFORMANCE IS NOTED AFTER TRAINING. OVER TIME, HOWEVER, PERFORMANCE OFTEN DECREASES TO, OR BELOW, THE ORIGINAL LEVEL. ONE WAY TO SET STANDARDS OF PERFORMANCE AND TO SUGGEST METHODS OF ATTAINING THE DESIRED PERFORMANCE SO THAT IT IS CLEAR TO THE WORKER, SUPERVISOR, OR FOREMAN AS WELL AS THE TRAINER, IS TO PROVIDE A TRAINING/JOB (T/J) MANUAL WHICH CLEARLY STATES THE DESIRED PERFORMANCE AND SUGGESTS PROCEDURES FOR THE WORKER TO ATTAIN THIS LEVEL OF PERFORMANCE. THE FOLLOWING T/J MANUAL DOES JUST THIS.

HOW TO USE THE TRAINING/JOB MANUAL

THE MATERIALS THAT FOLLOW CAN BE USED IN A NUMBER OF DELIVERY SYSTEMS, DEPENDING ON THE NATURE OF PERFORMANCE THAT NEEDS TO BE IMPROVED. IF THE TRAINEES ARE NEW TO THE SUBJECT MATTER, THE T/J MANUAL CAN BE USED IN A FORMAL TRAINING SYSTEM. THERE ARE SUFFICIENT DETAILED DESCRIPTIONS OF SUPPLIES AND MATERIALS AS WELL AS TRAINING ACTIVITIES TO GUIDE THE TRAINER.

A SUPERVISOR; FOREMAN, OR TRAINER REQUIRED TO DIAGNOSE PERFORMANCE DEFICIENCIES CAN USE THE OPERATION BREAKDOWN SHEET AS A REFERENCE TO IDENTIFY THE AREA OF PERFORMANCE DEFICIENCY. HE CAN THEN CONCENTRATE TRAINING ON THIS PARTICULAR AREA BY USING THE APPROPRIATE SECTIONS OF THE T/J MANUAL AS A GUIDE.

PREFACE (cont'd)

WORKERS WHO ARE EAGER TO MOVE AHEAD IN ACQUIRING NEW KNOWLEDGE AND SKILLS COULD USE THE T/J MANUAL, ALONG WITH ASSISTANCE FROM FELLOW WORKERS WHO ARE KNOWLEDGEABLE IN THE SUBJECT AREA, TO STUDY THE MATERIAL ON THEIR OWN.

THE T/J MANUAL IS DESIGNED TO BE USED ON THE JOB AS A READY REFERENCE AS NEEDED. IN MANY CASES, THE JOB-AIDS CAN BE LIFTED FROM THE MANUAL AND POSTED DIRECTLY AT THE SITE WHERE THE PERFORMANCE IS TO TAKE PLACE AS A CONSTANT REMINDER TO THE WORKER OF THE PROPER PROCEDURE FOR A TASK.

WHERE TO GET MORE INFORMATION

THIS T/J MANUAL IS ONE OF MANY BEING DEVELOPED BY THE CARIBBEAN BASIN WATER MANAGEMENT PROJECT TO IMPROVE THE PERFORMANCE OF PERSONNEL IN THE WATER UTILITIES OF THE EASTERN CARIBBEAN. MANUALS WILL BE DEVELOPED IN MANY ASPECTS OF WATER UTILITY OPERATION, MAINTENANCE, AND ADMINISTRATION. FOR MORE DETAILS ON MANUAL AVAILABILITY AND OTHER ASPECTS OF THIS PROJECT CONTACT:

ENGINEER NEIL F. CAREFOOT, MANAGER
CARIBBEAN BASIN WATER MANAGEMENT PROJECT
PAHO/WHO
BRIDGETOWN, BARBADOS

ACKNOWLEDGEMENTS

It would be extremely difficult for me to mention all the people who in some way helped to make this manual a reality. A large debt is owed to Winston Ramsay, Instrumentation and Laboratory Technician, whose advice and consultation were invaluable. I must also make mention of the people and organisations which were instrumental in the project. I wish to thank PAHO/WHO, the workers at Delaps Water Treatment Plant, graphic artist Miss Rosemary Deane, training coordinators and resource personnel, along with all the others who in some way helped.

Vere Williams



Laboratory Assistant
ANTIGUA PUBLIC UTILITIES AUTHORITY

INTRODUCTION

WHAT IS THIS MANUAL ALL ABOUT?

Upon completion, the treatment plant operator will be able to activate all the equipment and manipulate the various controls which are a necessary part of the daily routine operations of a water treatment plant.

The manual outlines only the operations which must be performed to take water from the dam and transfer it (having met both quantity and quality requirements) to the distribution system. It does not include any details of record keeping, preparation of chemical dosages, or other functions which are integral parts of a water treatment plant operation.

The water treatment operations as outlined in this manual are related to the experiences of the author at Delaps Water Treatment Plant, Antigua.

WHY DOES THE TRAINEE NEED TO LEARN THIS?

To meet the above requirements the operator must be capable of triggering and manipulating the plant's equipment in the correct sequence.

The operator's proficiency ensures not only an adequate quality product to the consumer but also the full life expectancy of the plant's equipment, thereby safeguarding the utility's investment and reducing the cost of water to the consumer.

WHAT DOES THE TRAINEE NEED TO KNOW BEFORE BEGINNING?

The trainee should be a skilled craftsman with basic knowledge of plumbing and pipe fittings.

WHAT EQUIPMENT AND SUPPLIES ARE NEEDED?

ITEM	LESSONS									
	1	2	3	4	5	6	7	8	9	10
in control panel	x									
andby/main power supply changeover control panel	x									
mpressor		x								
ectrical controls		x	x	x	x					
ant log		x	x			x				
oster pumps			x				x			
mps connected to outlet pipe				x						
lated valves (booster)			x	x			x	x		
ontrol panel for pumps				x						
um tank with connected outlet piping					x					
um solution					x					
justable spanner					x	x	x			
um pumps					x					
um pump controls					x					
ash mixer and controls					x	x				
ne mill with outlet piping					x	x				
ne solution						x				
xer attached to lime mill						x	x			
lorinators & connected delivery hose							x			
lorinator controls							x			
lorine cylinder containing chlorine							x			
monia							x			
tract fan							x			
w water flow meter								x		

WHAT EQUIPMENT AND SUPPLIES ARE NEEDED? (cont'd)

ITEM	LESSONS									
	1	2	3	4	5	6	7	8	9	10
Plant capacity								x		
Filter wash cycle record									x	
Valves to filter									x	
Filter control panel									x	
Float valve connected to filter outlet									x	
High-lift pump and controls										x
Gate valves										x

WHAT ARE THE OBJECTIVES?

The trainee will be able to:

1. Supply raw water to the plant.
2. Activate the equipment to treat raw water with alum.
3. Activate the equipment to treat raw water with lime.
4. Manipulate the equipment to treat water with chlorine.
5. Divert water to the sedimentation tanks.
6. Operate the equipment to filter the water leaving the sedimentation tanks.
7. Transfer treated water to the distribution lines.
8. Transfer the plant from standby power to the main power supply.
9. Trigger the appropriate controls to supply air and water to the plant.

LESSON 1



SUPPLYING RAW WATER TO THE PLANT

ESTIMATED TIME

30 minutes

PREREQUISITE

A basic knowledge of pumps and their use

PERFORMANCE OBJECTIVE:

- The trainee will be able to:
supply the raw water to the plant.
- Under the following condition:
given all necessary equipment and supplies.
- To this standard:
all procedures correctly performed.

TRAINING RESOURCES

Equipment and Supplies: Pumps connected to outlet pipe, related valves, control panel for pumps, plant log on pump use.

Information Sheets: L1:IS:01 through L1:IS:04.

TRAINER ACTIVITY	TRAINEE ACTIVITY
<ul style="list-style-type: none">. Read and discuss Information Sheets L4:IS:01 - 02. . Demonstrate and explain the operations. Refer to L1:IS:01 - 06. . Ask trainees to state the sequence and explain the details of the operations. . Ask trainees to perform the operations. Correct them when necessary.	<ol style="list-style-type: none">1. Read and discuss Information Sheets L1:IS:01 - 02. 2. Observe and discuss. Refer to L1:IS:01 - 06. 3. State as requested by the trainer. 4. Perform the operations.

OPERATION BREAKDOWN SHEET

L1:IS:01

POSITION W.T.P. Operator TASK Operating the plant
 OPERATION Supplying raw water to the plant

STEPS (Significant actions which advance the operation towards completion)	KEY POINTS (Keys to doing the steps efficiently and accurately)
1. Select raw water pumps.	1.1 Check record on pump use. 1.2 Choose appropriate number of pumps. See L1:IS:02. 1.3 Choose pumps with least hours use.
2. Isolate the pumps.	2.1 Close outlet valves to pumps not in use. 2.2 Turn anticlockwise. 2.3 Close all inlet valves to pumps not in use. 2.4 Open inlet valves to selected pumps. 2.5 Make sure outlet valves to selected pumps are closed.
3. Start high-lift pump.	3.1 Ensure that all necessary switches on the control panel are in the "on" position. 3.2 Put heater button to "on" position. 3.3 Push button labelled "start."
(cont'd next page)	

OPERATION BREAKDOWN SHEET
(continued)

L1:IS:01 (cont'd)

STEPS	KEY POINTS
4. Regulate the flow.	4.1 Open inlet valves before starting the pumps. 4.2 Open gate valve on outlet side. 4.3 Check pressure gauge. See L1:IS:02 4.4 Close outlet gate valve to decrease the pressure. 4.5 Open outlet gate valve to increase the pressure. 4.6 Check that water is passing over cascade aerator.

TREATMENT OF RAW WATER

Raw water is the term used to refer to water which needs treatment. The treatment required is not always the same. For example: Well water in most cases needs only disinfection because it is already clear. Surface water quite commonly needs coagulation,* sedimentation, filtration, and disinfection. River water, especially after a heavy rainfall, needs full-scale treatment: coagulation,* sedimentation, filtration, and disinfection (*Coagulation chemicals are used to assist in sedimentation. They bond particles together, making them heavier.)

Number of Pumps and Why

The number of pumps chosen depends on the quantity of water to be treated. A single pump can be used if the amount to be treated can be pumped by one pump without putting too much load on it. If the amount of water presents too large a load for one pump or if the pump cannot supply the volume of water within the specified time, then two pumps should be chosen and the load shared equally.

Pressure

The pressure at which the pump operates is determined by the volume of water needed.

Precautions

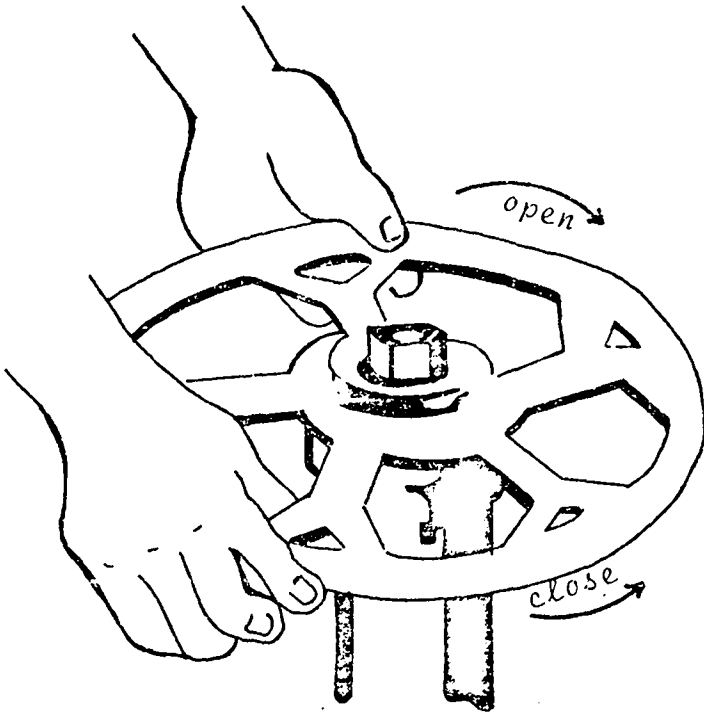
All outlet valves must be closed to ensure that no water flows back. If the water does flow back, it causes the pump to spin in the reverse direction. If the pump is started while

this is happening, it may be damaged. The valves should be opened slowly.

If the valve is too wide open on starting the pump the water may move forward in the pipeline with a great force, causing water hammer, which can destroy the pipe lines.

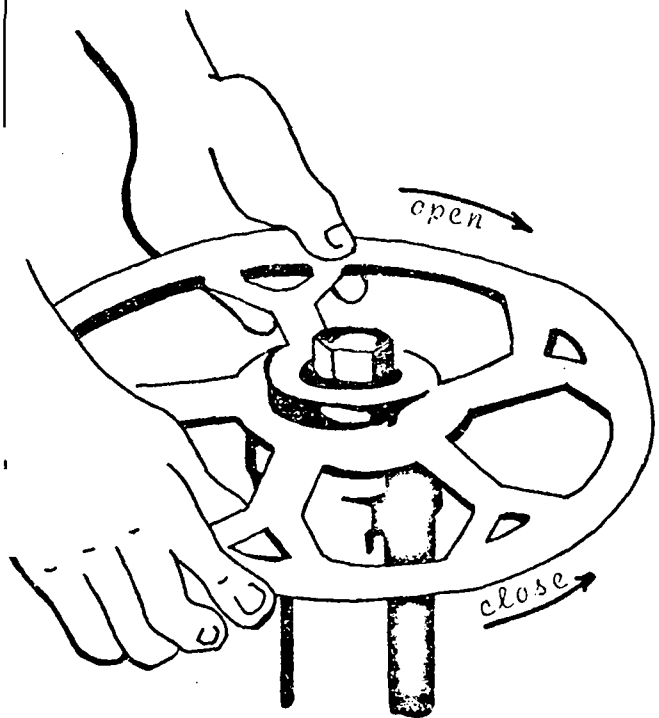
Inlet valves to the pumps in use should be opened before starting the pumps.

The raw water passes over a cascade aerator before entering the flash mixer tank.



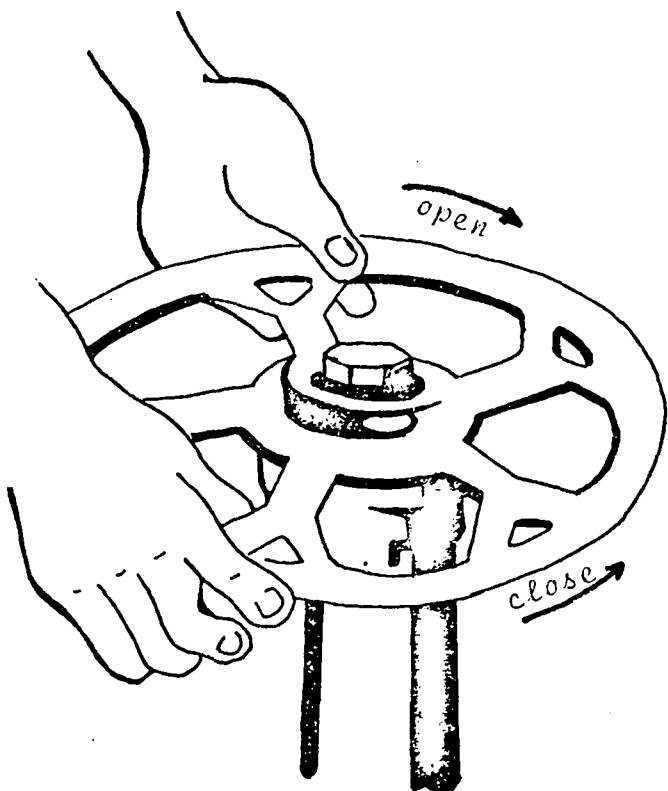
- (a) Close all outlet and inlet valves.
- (b) Open only those inlet valves to pumps selected.
- (c) Open outlet valves from pumps selected after starting the pump.

ISOLATING THE PUMP



To reduce the flow close the outlet valve slowly until the required pressure is obtained.

NB: Closing the valve increases the pressure on the pump.



To increase the flow open the outlet valve slowly until the required pressure is obtained.

NB: Opening the valve reduces the pressure on the pump.

REGULATING THE FLOW

LESSON 2



TREATING RAW WATER WITH ALUM

ESTIMATED TIME

1 hour

PREREQUISITE

Lesson 1

A basic knowledge of pump operation

PERFORMANCE OBJECTIVE:

- The trainee will be able to:
activate the equipment to treat raw water with alum.
- Under the following condition:
from recall, given the necessary equipment.
- To this standard:
all procedures correctly performed.

TRAINING RESOURCES

Equipment and Supplies: Alum tank with connected outlet piping, alum solution, adjustable spanner, water, information on pump use, alum pumps, pump controls, flash mixer, and controls.

Information Sheets: L2:IS:01 through L2:IS:06.

TRAINER ACTIVITY	TRAINEE ACTIVITY
<ul style="list-style-type: none">1. Read and discuss Information Sheets L2:IS:01 - 02. 2. Demonstrate and explain the operation. Refer to L2:IS:01 - 06. 3. Allow trainees to state the sequences and explain the details of the operations. 4. Ask trainees to practise the operations. Correct them when necessary.	<ul style="list-style-type: none">1. Read and discuss Information Sheets L2:IS:01 - 02. 2. Observe and discuss. Refer to L2:IS:01 - 06. 3. State and explain as requested by trainer. 4. Practise as requested by trainer.

OPERATION BREAKDOWN SHEET

L2:IS:01

POSITION W.T.P. Operator TASK Operating the plant

OPERATION Treating raw water with alum

<p style="text-align: center;">STEPS (Significant actions which advance the operation towards completion)</p>	<p style="text-align: center;">KEY POINTS (Keys to doing the steps efficiently and accurately)</p>
<p>1. Check alum tank.</p> <p>2. Check alum tank outlet piping.</p> <p>3. Select alum pump.</p> <p>4. Set alum pump.</p>	<p>1. Tank to be used should contain a prepared alum solution. See L2:IS:02.</p> <p>2.1 Remove plug located in the under side of piping. See L2:IS:04.</p> <p>2.2 Remove strainer.</p> <p>2.3 Wash strainer if clogged.</p> <p>2.4 Replace strainer.</p> <p>2.5 Replace plug.</p> <p>2.6 Open valves in piping to allow solution to go to pump inlet.</p> <p>3.1 Check plant log for pump use.</p> <p>3.2 Select pump with least hours of use.</p> <p>3.3 Turn selector switch to the pump chosen.</p> <p>4.1 Slacken lock-nut located below and behind setting knob.</p> <p>4.2 Turn knob to desired setting (predetermined from analytical results.)</p> <p>4.3 Tighten lock-nut.</p>

(cont'd next page)

OPERATION BREAKDOWN SHEET
(continued)

L2:IS:01 (cont'd)

STEPS	KEY POINTS
5. Start the flash mixer.	5.1 Locate the controls. 5.2 Turn control switch to "on" position. 5.3 Locate flash mixer. 5.4 Push flash mixer "start" button.
6. Start the alum pump.	6.1 Open valve to pump inlet. 6.2 Turn selected pump to "on" position. 6.3 Pull "stop" switch located over pump. 6.4 Open valve on outlet side of pump. 6.5 Check flash mixing tank to see that alum is flowing out of pipeline into raw water.

CHEMICAL DOSING

There are two major reasons for adding chemicals to water: (1) the water itself is unacceptable as it is, and (2) the distribution pipe line needs protecting.

The first reason is based on the fact that water in its natural form is not potable and must be treated with chemicals to become potable.

1. Well water may need only disinfection because it is low in turbidity.

2. Water obtained from some surface dams may need some minor treatment for clarification. In this case, the water may be filtered before disinfection. This depends largely on the area of run-off.

3. Water obtained from other surface dams may be fairly turbid and will need to be chemically treated with alum, a coagulant which bonds the particles together so that they settle fairly quickly.

The second reason for chemical dosing is to protect the pipe line. The water that travels through the line may be such that it could either corrode the pipe or cause scales to form. Thus in order to prevent destruction of the pipe line, the water is treated, and the treatment is controlled by the chemist.

ALUM DOSAGE

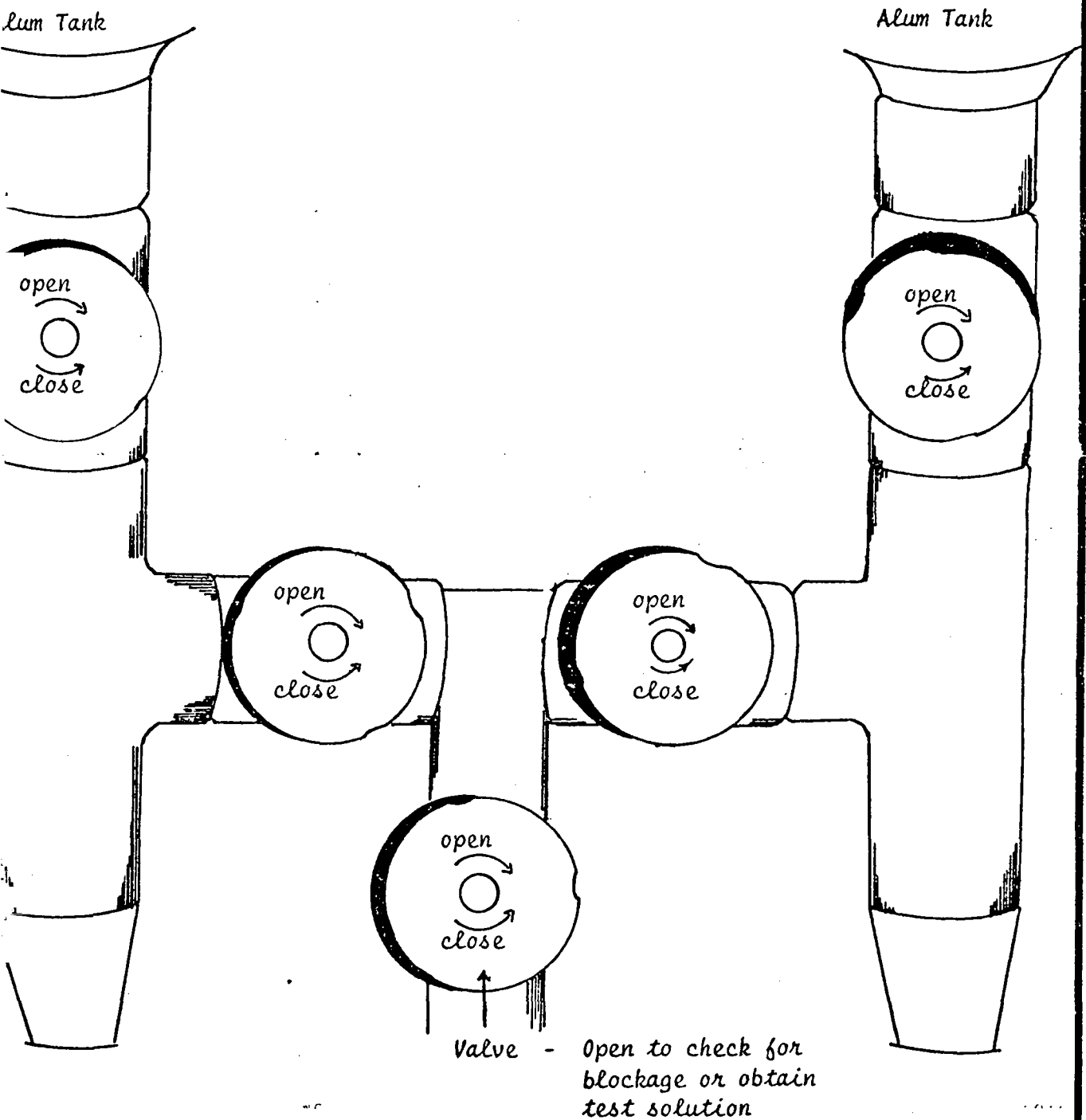
Alum dosage depends on the quality of water encountered. A dosage which is adequate for one type of water may prove

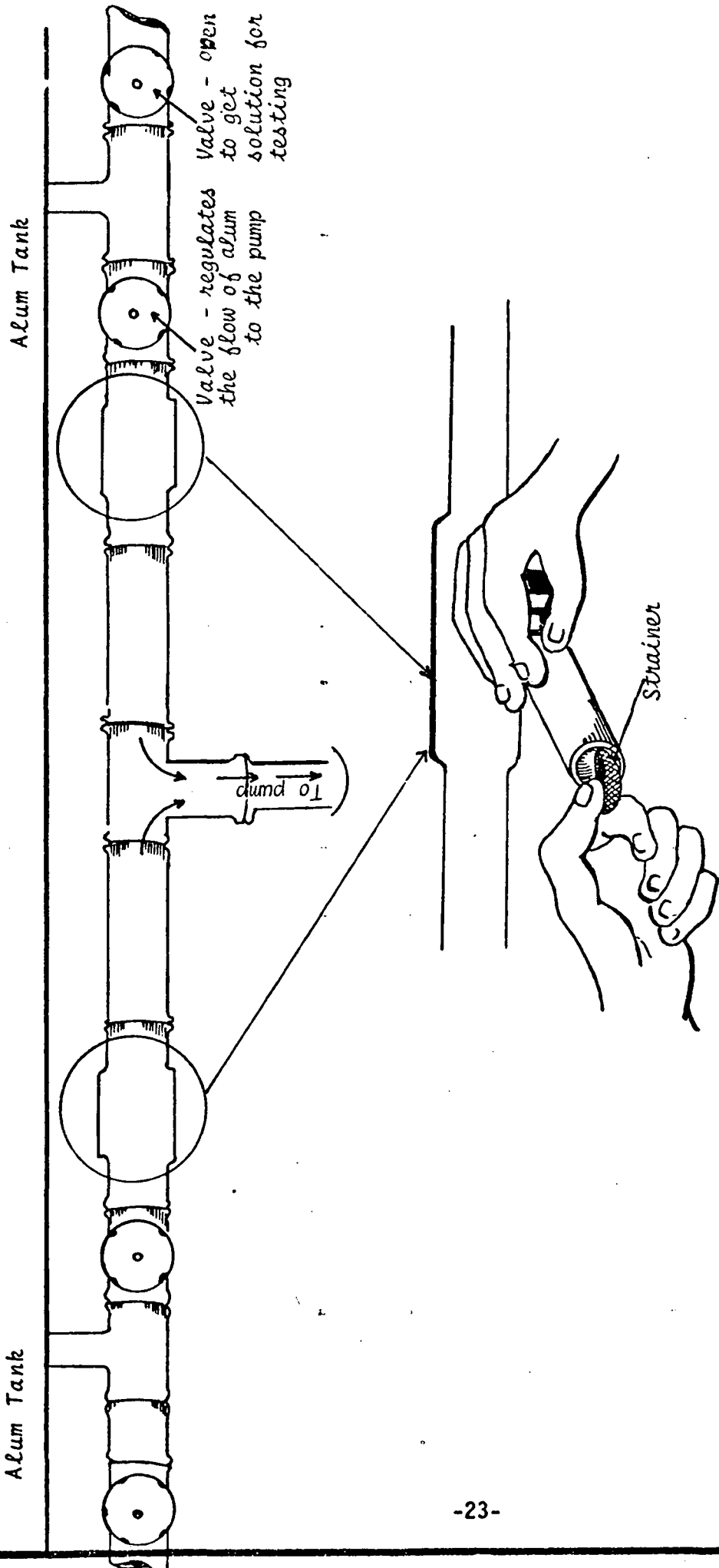
entirely inadequate for another.

The plant's alum dosage is determined in the laboratory by a carefully conducted jar test.

In the jar test, samples of the water to be treated are exposed to several concentrations and volumes of alum solution. The concentration and volume which produces the best analytical test result is the one used to treat the water on the plant.

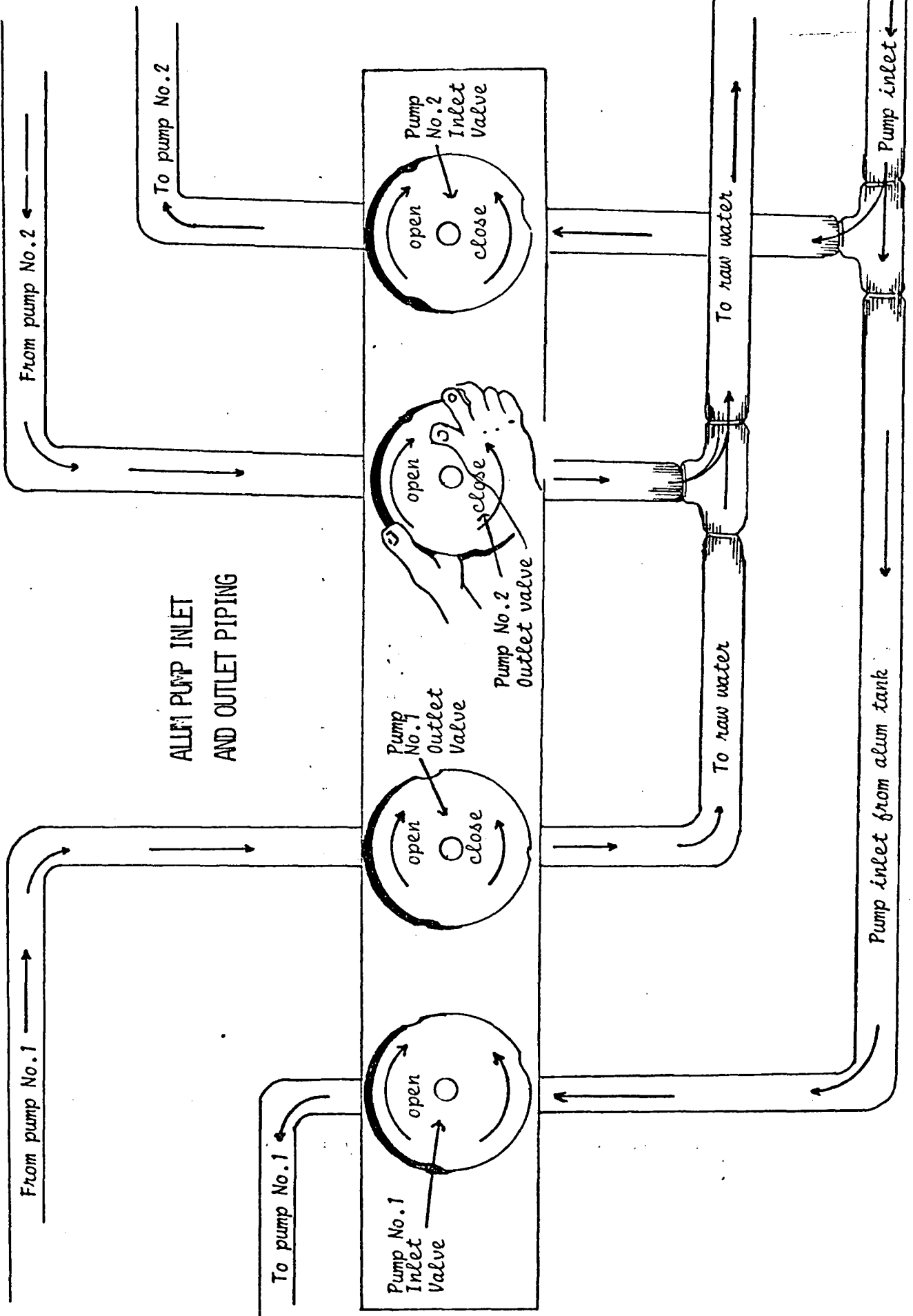
ALUM TANK WITH PIPING TO PUMP

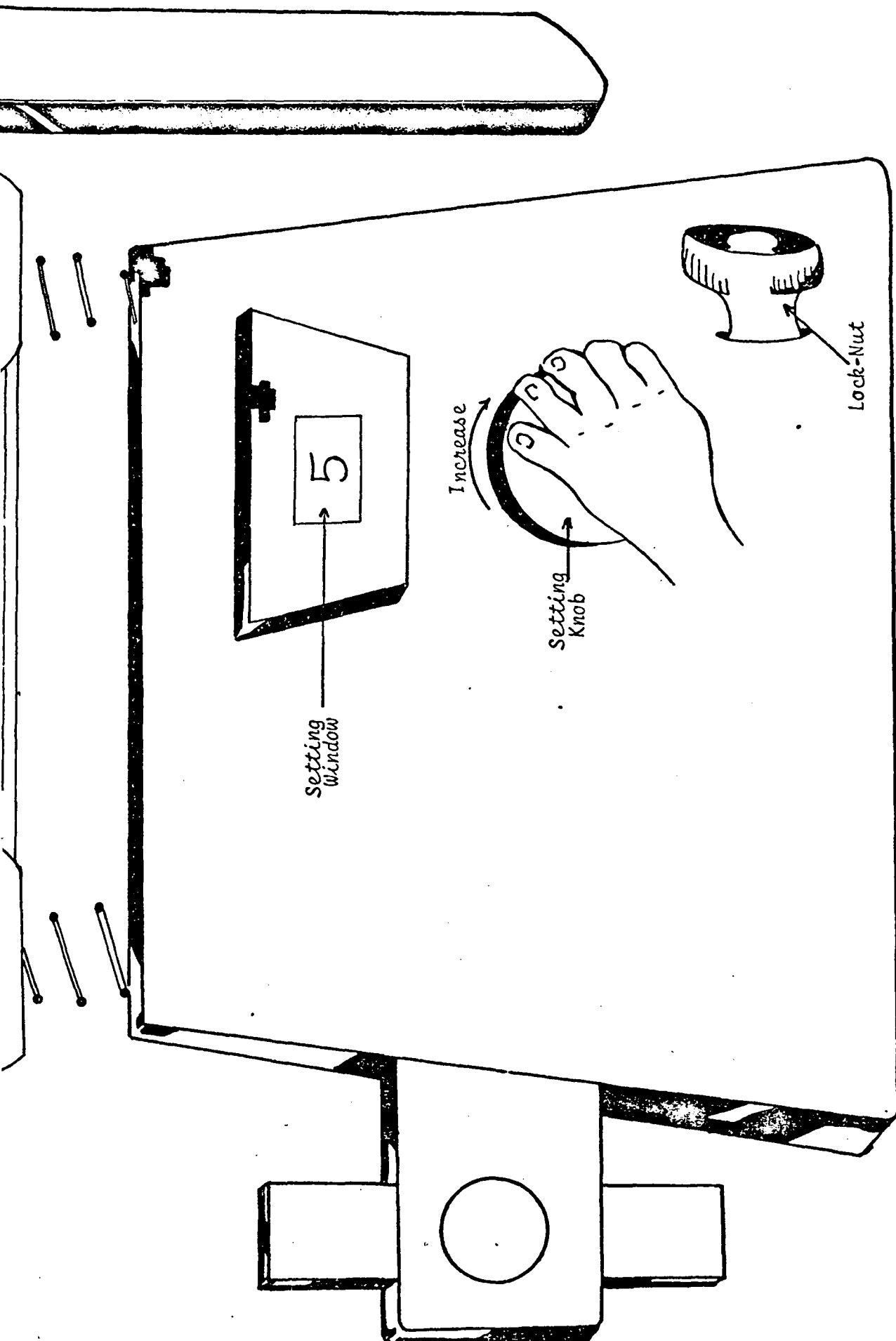




CHECKING ALUM PIPING

ALUM PUMP INLET AND OUTLET PIPING





ALUM PUMP CONTROLS

LESSON 3



TREATING RAW WATER WITH LIME

ESTIMATED TIME

1 hour

PREREQUISITES

Lesson 2
Basic knowledge of pump operation

PERFORMANCE OBJECTIVES:

- The trainee will be able to:
activate the equipment to treat raw water with lime.
- Under the following condition:
from recall given all necessary equipment.
- To this standard:
all procedures correctly performed.

TRAINING RESOURCES

EQUIPMENT AND SUPPLIES: Lime mill with outlet piping, adjustable spanner, water, lime solution, plant log, lime pumps and pump controls, mixer attached to lime mill, flash mixer, and controls.

Information Sheets: L3:IS:01 and L3:IS:02.

Refer also to L2:IS:03 - 06.

NOTE

The equipment used to add alum to the water is identical to that used to add lime. Therefore the drawings in Lesson 2 (L2:IS:03 - L2:IS:06) are applicable to the process described in this lesson on lime. Refer to them as needed.

TRAINER ACTIVITY	TRAINEE ACTIVITY
<ol style="list-style-type: none"> 1. Read and discuss Information Sheets L3:IS:01 -02. 2. Demonstrate and explain the operations. Refer to L3:IS:01 - 02 and L2:IS:03 - 06. 3. Ask trainees to state the sequences and explain the details of the operations. 4. Ask trainees to practise the operations. Correct them when necessary. 	<ol style="list-style-type: none"> 1. Read and discuss Information Sheets L3:IS:01 - 02. 2. Observe and discuss. Refer to L3:IS:01 - 02 and L2:IS 03 - 06. 3. State as requested by trainer. 4. Practise the operations.

OPERATION BREAKDOWN SHEET

L3:IS:01

POSITION W.T.P. Operator TASK Operating the plant
 OPERATION Treating raw water with lime

STEPS (Significant actions which advance the operation towards completion)	KEY POINTS (Keys to doing the steps efficiently and accurately)
1. Check lime mill.	1.1 Use tank with prepared lime solution. See L3:IS:02 and L2:IS:02.
2. Mix lime.	2.1 Select mixer attached to lime mill. 2.2 Turn switch to "on" position. 2.3 Check to see mixer is operating.
3. Check lime mill.	3.1 Open test valve. 3.2 Allow to flow for a few seconds. 3.3 Close test valve. 3.4 Open valve to pump tubing.
4. Select lime dosing pump.	4.1 Check plant log for pump use. 4.2 Select pump with least hours of use. 4.3 Turn selector switch to the number of the selected pump.
5. Set lime pump.	5.1 Slacken lock-nut located behind and below setting knob. 5.2 Turn setting knob until required setting is seen through hole above the setting knob.

(cont'd next page)

OPERATION BREAKDOWN SHEET
(continued)

L3:IS:01 (cont'd)

STEPS	KEY POINTS
<p>6. Start flash mixer.</p> <p>7. Start pump.</p>	<p>5.3 Tighten lock-nut.</p> <p>6.1 Locate the controls.</p> <p>6.2 Turn control switch to "on" position.</p> <p>6.3 Locate flash mixer.</p> <p>6.4 Push flash mixer "start" button.</p> <p>7.1 Open valve to pump inlet.</p> <p>7.2 Turn selected switch to "on" position.</p> <p>7.3 Pull "stop" switch located over pump.</p> <p>7.4 Open valve on outlet side of pump.</p> <p>7.5 Check to see if alum is flowing out of tube into raw water.</p>
<p>NOTE: Refer to L2:IS:03 through 06.</p>	

LIME DOSAGE

Hydrated lime—90% Ca(OH)_2 , calcium hydroxide—is mixed with water. The result is a 5% solution. The result is a "slurry"—a lime-water mixture. This must be stirred continuously. The stirrer must not be allowed to stop until the charge has been used up, otherwise the lime will settle to the bottom of the tank and solidify.

Adjust the stroke of the pump to obtain the required dose.

LESSON 4



TREATING WATER WITH CHLORINE

ESTIMATED TIME

1 hour

PREREQUISITE

Lesson 3

PERFORMANCE OBJECTIVE:

- The trainee will be able to:
manipulate the equipment to treat water with chlorine.
- Under the following condition:
from recall, given all necessary equipment and supplies.
- To this standard:
all procedures correctly performed.

TRAINING RESOURCES

Equipment and Supplies: Chlorinator and connected delivery hose, chlorinator controls, appropriate valves, operating booster pump, spanner, chlorine cylinder containing chlorine, ammonia, extract fan.

Information Sheets: L4:IS:01 through L4:IS:07.

NOTE

The water is treated twice with chlorine between the time it enters the plant and the time it is released for distribution. In both cases the chlorination procedure is the same, and so the exercise is described only once in this manual. See L4:IS:01 for further explanation.

TRAINER ACTIVITY	TRAINEE ACTIVITY
<ol style="list-style-type: none">1. Read and discuss L4:IS:01.2. Demonstrate and explain the operations. Refer to L4:IS:01 - 07.3. Ask trainees to state the sequence and explain the details of the operations.4. Ask trainees to practise the operations.	<ol style="list-style-type: none">1. Read and discuss L4:IS:01.2. Observe and discuss. Refer to L4:IS:01 - 07.3. State and explain as requested by trainer.4. Practise the operations.

OPERATION BREAKDOWN SHEET

L4:IS:01

POSITION W.T.P. Operator TASK Operating the plant

OPERATION Treating water with chlorine

STEPS (Significant actions which advance the operation towards completion)	KEY POINTS (Keys to doing the steps efficiently and accurately)
1. Select chlorinator.	1.1 Note which chlorinator is attached to hose leading to the raw water. 1.2 Pre-chlorinator is labelled "2".
2. Heat up chlorinator.	2.1 Check and identify the controls. 2.2 Turn on electricity to chlorinator. 2.3 Turn on heater to chlorinator. 2.4 Ensure heater is working.
3. Isolate chlorinator.	3.1 Close balancing valve. 3.2 Open valves to raw water.
4. Turn on water supply to chlorinator.	4.1 Ensure booster pumps are pumping. See Lesson 9. 4.2 Open valve leading to chlorinator. 4.3 Valve is located on wall behind chlorinator. 4.4 Open valves to delivery side.
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OPERATION BREAKDOWN SHEET
(continued)

L4:IS:01 (cont'd)

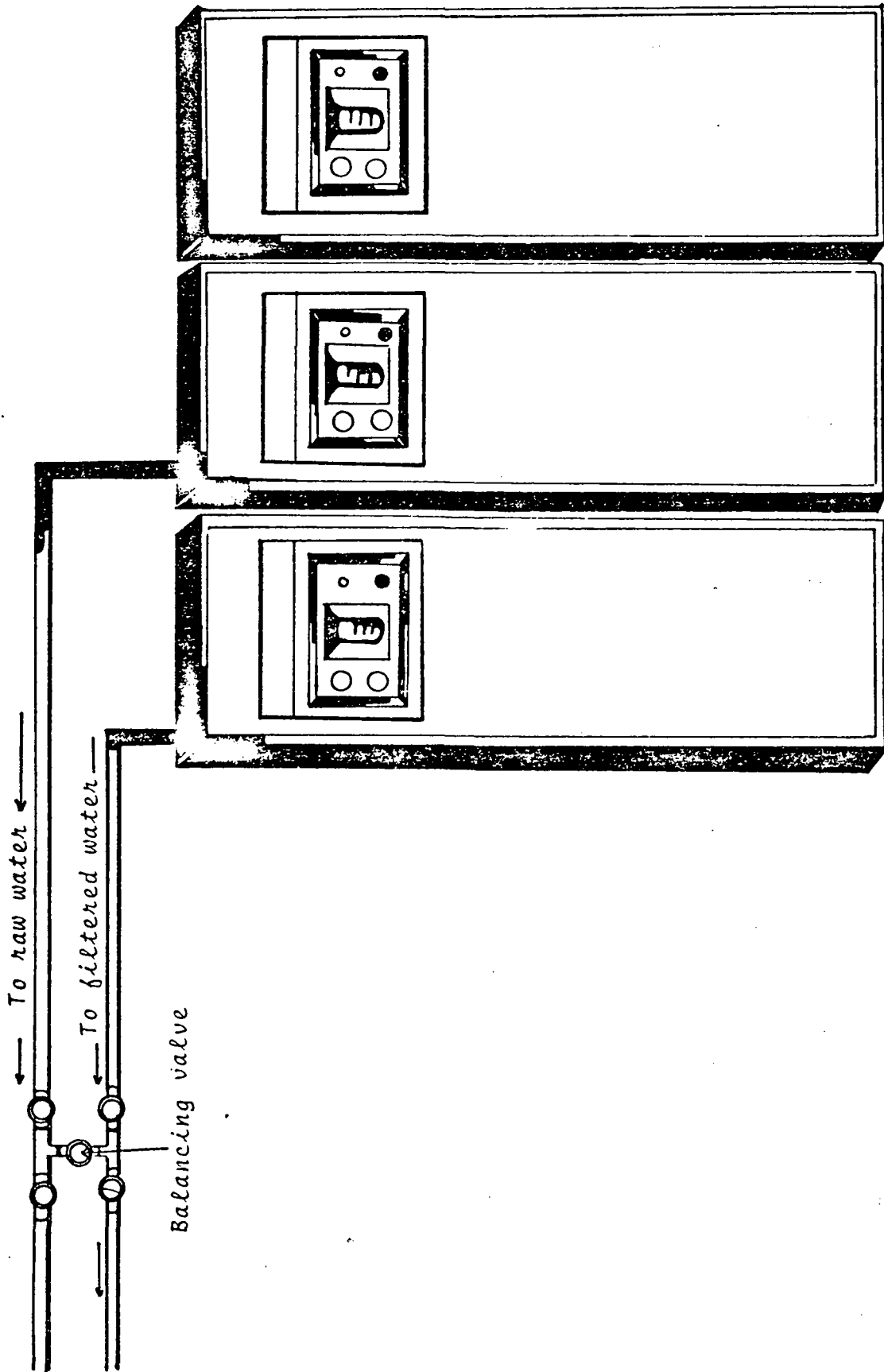
STEPS	KEY POINTS
<p>5. Turn on chlorine supply to chlorinator.</p> <p>6. Set chlorinator.</p>	<p>5.1 Make sure the extract fan is working.</p> <p>5.2 Open valve on cylinder connected to copper wire.</p> <p>5.3 Check for leak by holding a bottle containing ammonia close to the valve. If white smoke develops, there is a leak. Close and repair the valve.</p> <p>5.4 Open valve leading into evaporator.</p> <p>5.5 Repeat 5.3 (all valves must be closed in reverse order).</p> <p>5.6 Turn on manifold control. Open valve on outlet of manifold.</p> <p>5.7 Repeat 5.5.</p> <p>5.8 Open valve to chlorinator.</p> <p>5.9 Repeat 5.5.</p> <p>5.10 Open valve to selected chlorinator.</p> <p>5.11 Repeat 5.5</p> <p>6.1 Turn knob on chlorinator control clockwise.</p> <p>6.2 Read setting valve on meter scale.</p> <p>6.3 Stop turning knob when required value determined by the chemist is obtained.</p>
<p>NOTES: 1. As noted, chlorination occurs twice when preparing water for use. <u>Pre-chlorination</u> is done to raw water, and <u>post-chlorination</u> is done to the water that has already undergone sedimentation and filtering. The sequence of operations for <u>pre-chlorination</u> and <u>post-chlorination</u> are identical except for the following points:</p>	

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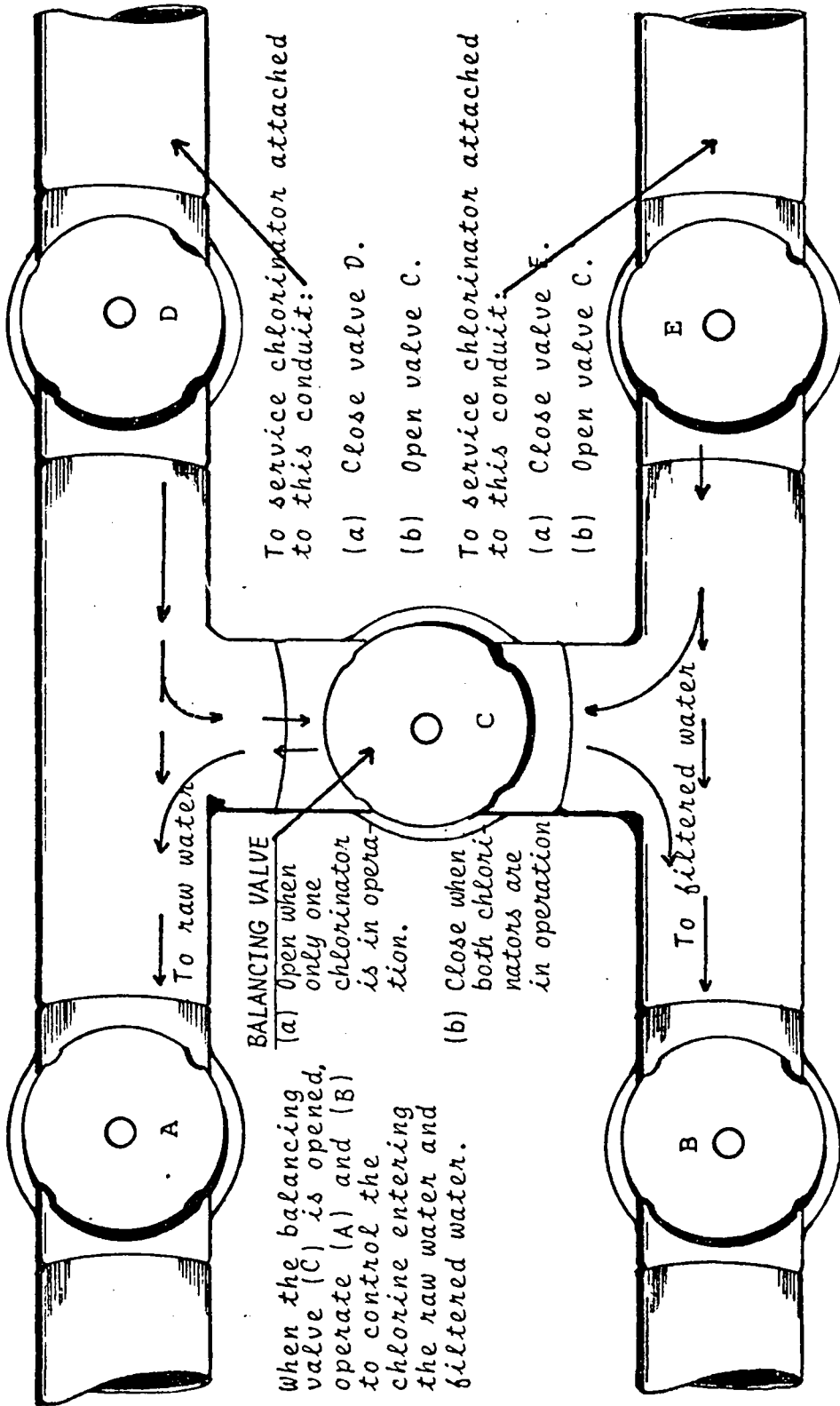
OPERATION BREAKDOWN SHEET
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L4:IS:01 (cont'd)

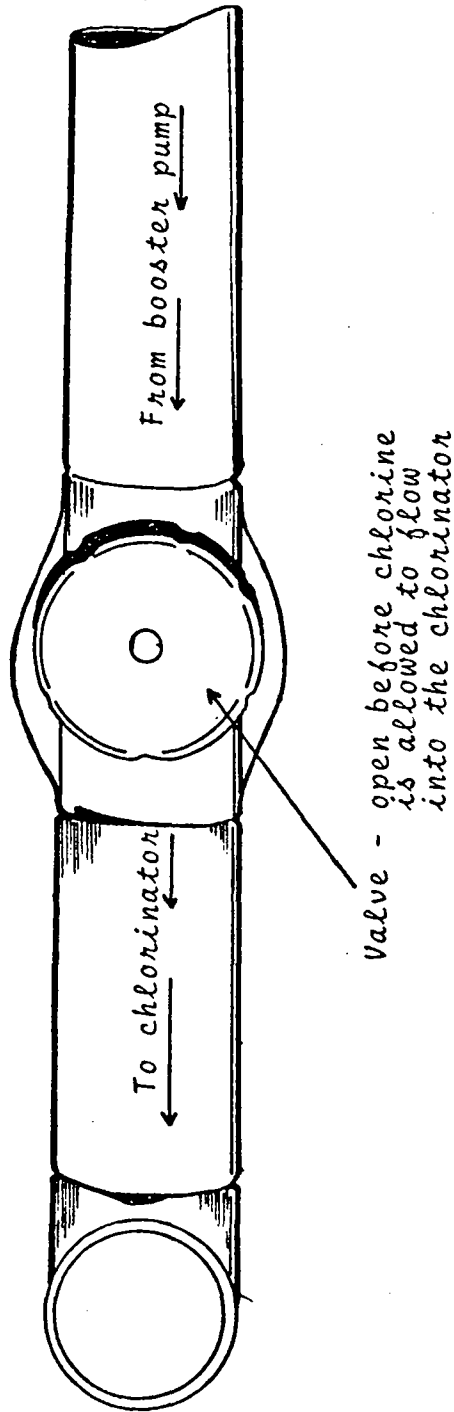
STEPS	KEY POINTS
<p>2. For post-chlorination, Key Points 1.1 and 3.2 should read:</p> <p>1.1 Note which chlorinator is attached to the hose leading to the filtered water.</p> <p>3.2 Open valve to filtered water.</p> <p>3. The balancing valve is opened when only one chlorinator is being used to chlorinate both raw water and filtered water.</p>	



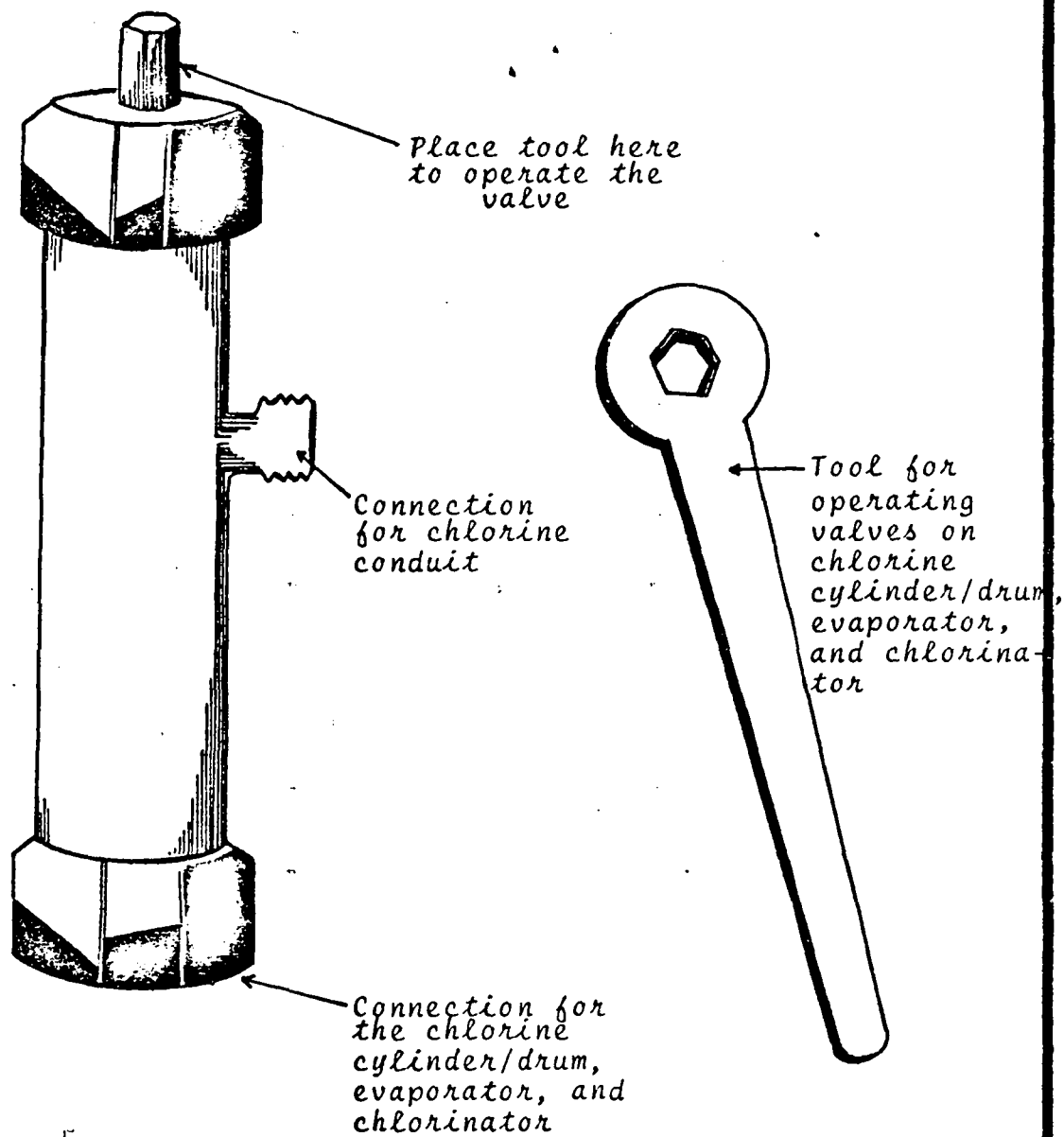
CHLORINATORS WITH DELIVERY HOSE



VALVES ON THE CHLORINATOR DELIVERY HOSE



CONDUIT SUPPLYING WATER FROM BOOSTER PUMPS TO CHLORINATORS



TYPICAL VALVE ON CHLORINE CYLINDER/DRUM, EVAPORATOR, AND CHLORINATOR

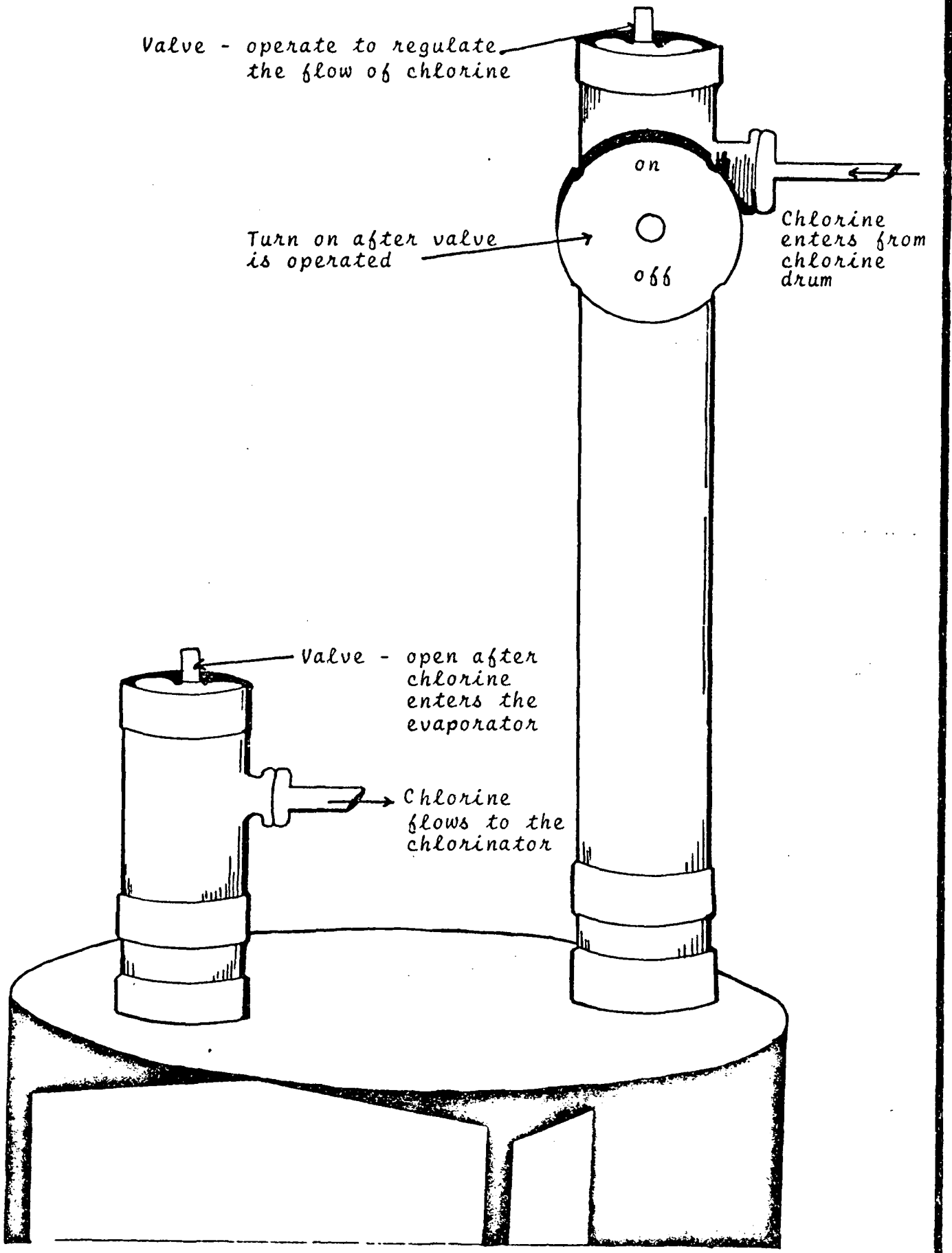
Valve - operate to regulate the flow of chlorine

Turn on after valve is operated

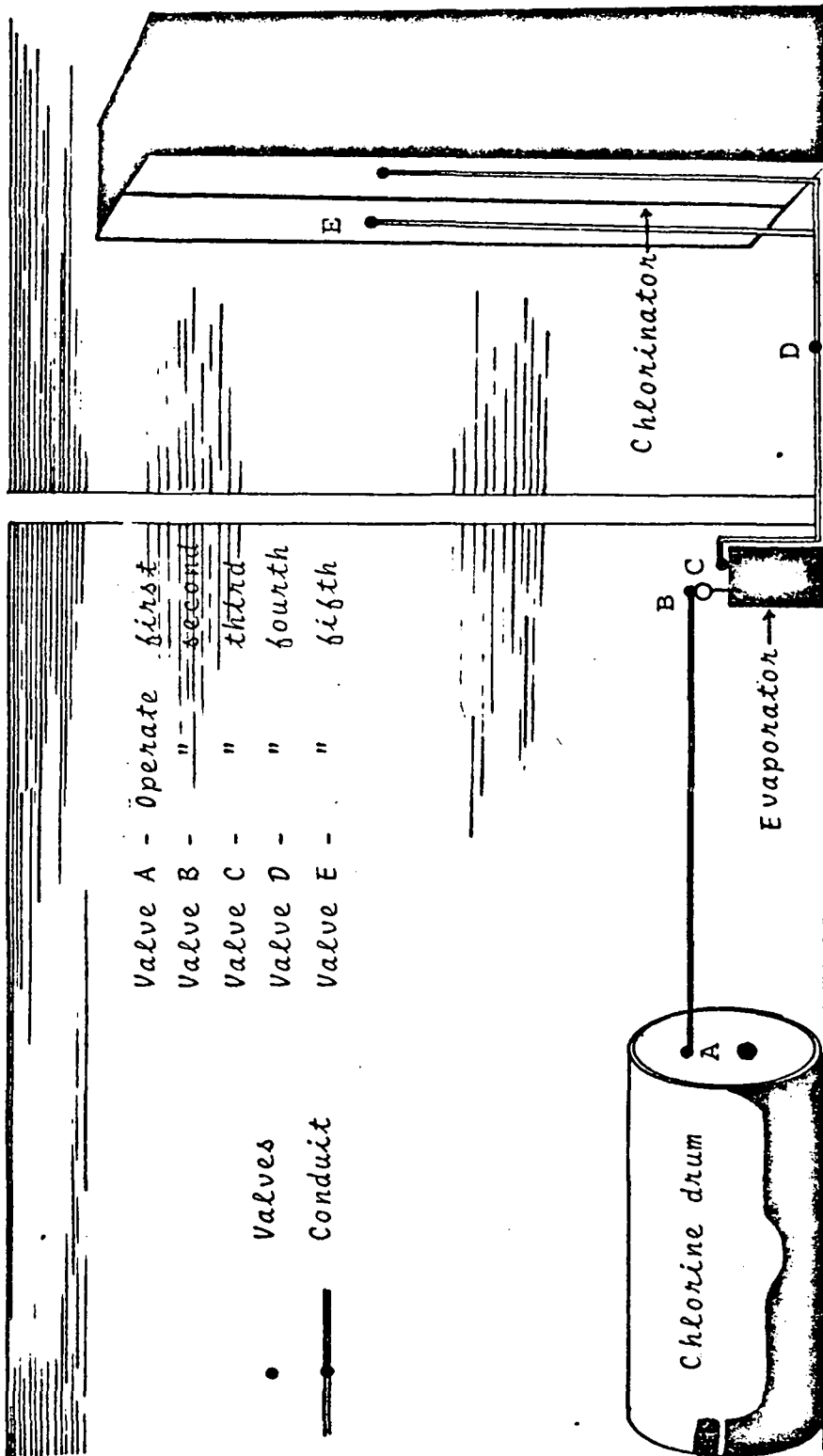
Chlorine enters from chlorine drum

Valve - open after chlorine enters the evaporator

Chlorine flows to the chlorinator



CHLORINE EVAPORATOR



OPERATING SEQUENCE FOR VALVES

LESSON 5

SEDIMENTATION OF CHEMICALLY
TREATED WATER

ESTIMATED TIME

20 minutes

PREREQUISITE

Lesson 4

PERFORMANCE OBJECTIVE:

- The trainee will be able to:
divert water to the sedimentation tank.
- Under the following condition:
from recall, given all the necessary equipment and supplies.
- To this standard:
all procedures correctly performed.

TRAINING RESOURCES

Equipment and Supplies: Raw water flow meter, plant capacity, valves.

Information Sheets: L5:IS:01 and L5:IS:02.

TRAINER ACTIVITY	TRAINEE ACTIVITY
1. Read and discuss Information Sheet L5:IS:01.	1. Read and discuss Information Sheet L5:IS:01.
2. Demonstrate and explain the operations.	2. Observe and discuss.
3. Ask trainees to state and explain the procedure.	3. State and explain as requested by the trainer.
4. Ask trainees to practise the procedure. Correct them when necessary.	4. Practise the procedure.

OPERATION BREAKDOWN SHEET

L5:IS:01

POSITION W.T.P. Operator TASK Operating the plant

OPERATION Sedimentation of chemically treated water

STEPS (Significant actions which advance the operation towards completion)	KEY POINTS (Keys to doing the steps efficiently and accurately)
1. Select sedimentation tanks.	1.1 Cleanest tanks should be used. 1.2 If flow is not at near-maximum capacity, three tanks (instead of four) may be used.
2. Open valves to the selected sedimentation tanks.	2.1 Valve is located in front of tank along walk between tanks. 2.2 Open the valve slowly. 2.3 Turn the wheel clockwise. 2.4 Approximately 16 turns open the valve fully. 2.5 Valve must be opened without disturbing the floc blanket that has formed toward the bottom of the tank.
<p>N.B. <u>Given:</u> Plant capacity = $4000 \text{ m}^3/\text{day}$ No. of tanks = 5 Capacity of each tank = $\frac{4000 \text{ m}^3/\text{day}}{5} = 800 \text{ m}^3/\text{day}$</p> <p>On any given day, plant is treating 2700 m^3 water</p> <p>No. of tanks required $\frac{2700}{800} = 3\frac{3}{8}$</p> <p>Therefore:</p> <p>3 tanks would be inadequate. 4 tanks must be selected.</p>	
<p><u>NOTE:</u> Refer to L5:IS:02.</p>	

SEDIMENTATION TANKS

The sedimentation (or settling) tanks are the next step in the process after chemical dosing. The chemically treated water enters the base of the sedimentation tank where it rises at reducing velocity, a rate predetermined by the flow of the incoming water. The floc, or coagulant material (referred to commonly as "suspended matter" or "sludge") reaches a level in the tank where it is in balance with the upward velocity of the water. This level is referred to as the "sludge level." This sludge is drawn off by operating valves on the sedimentation tank, thereby preventing solids from rising to a level where there could be a danger of carry-over with the settled water.

The amount of sludge withdrawn varies according to the condition of the raw water which is being treated.

LESSON 6



FILTERING THE WATER

ESTIMATED TIME 30 minutes

PREREQUISITE Lesson 5

PERFORMANCE OBJECTIVE:

- The trainee will be able to:
operate the equipment to filter the water leaving the sedimentation tanks.
- Under the following condition:
from recall, given all the necessary equipment.
- To this standard:
*all procedures correctly done;
float valve operation correct.*

TRAINING RESOURCES

Equipment and Supplies: Filter wash-cycle record, valves to filter, filter control panel, float valve connected to filter outlet.

Information Sheets: L6:IS:01 through L6:IS:06.

TRAINER ACTIVITY	TRAINEE ACTIVITY
<ul style="list-style-type: none">. Read and discuss Operation Breakdown Sheet L6:IS:01.. Demonstrate and explain the operations. Refer to L6:IS:01 - 05.. Ask trainees to state the sequence and explain the details of the operations.. Ask trainees to practise the operations. Correct them when necessary.	<ol style="list-style-type: none">1. Read and discuss Operation Breakdown Sheet L6:IS:01.2. Observe and discuss. Refer to L6:IS:01 - 05.3. State and explain as requested by the trainer.4. Practise the operations.

OPERATION BREAKDOWN SHEET

L6:IS:01

POSITION W.T.P. Operator TASK Operating the plant

OPERATION Filtering the water

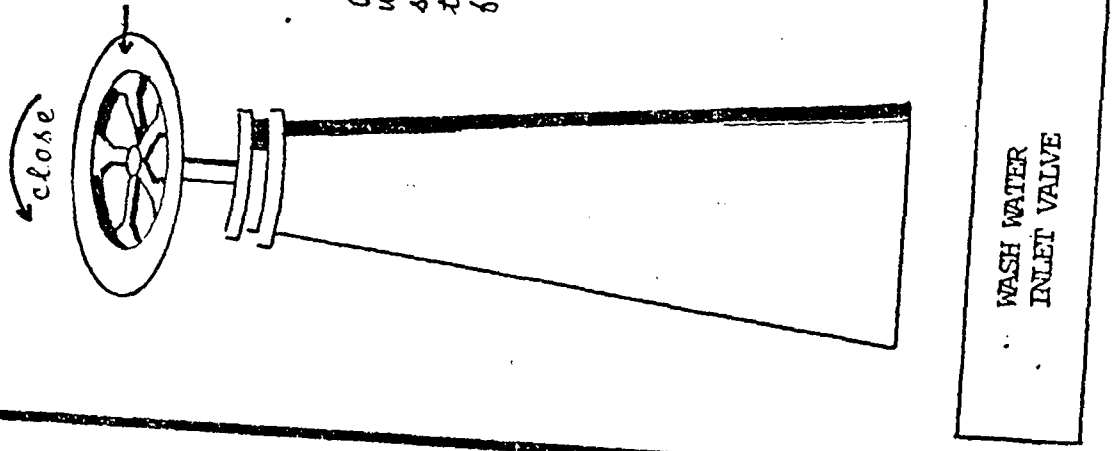
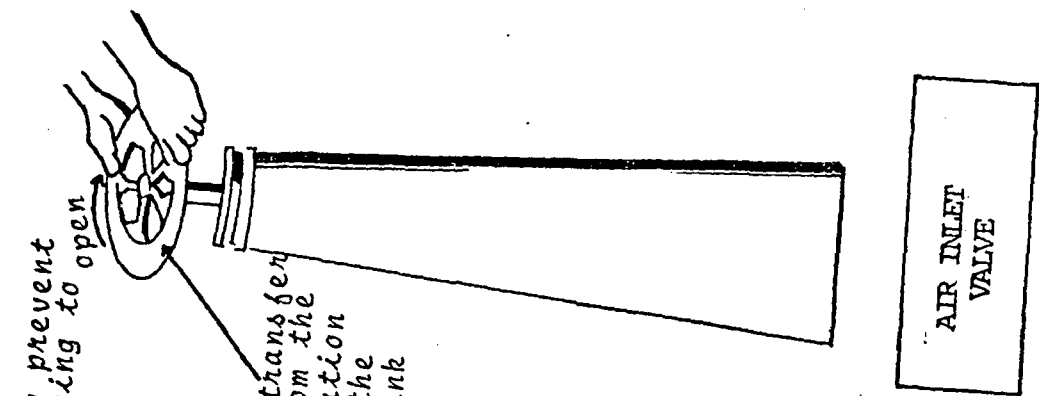
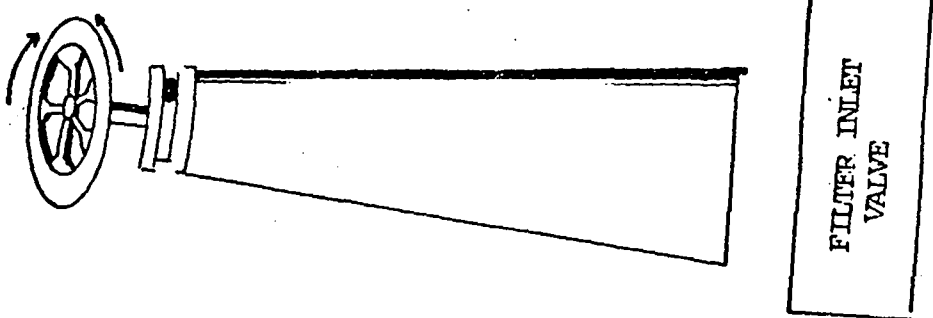
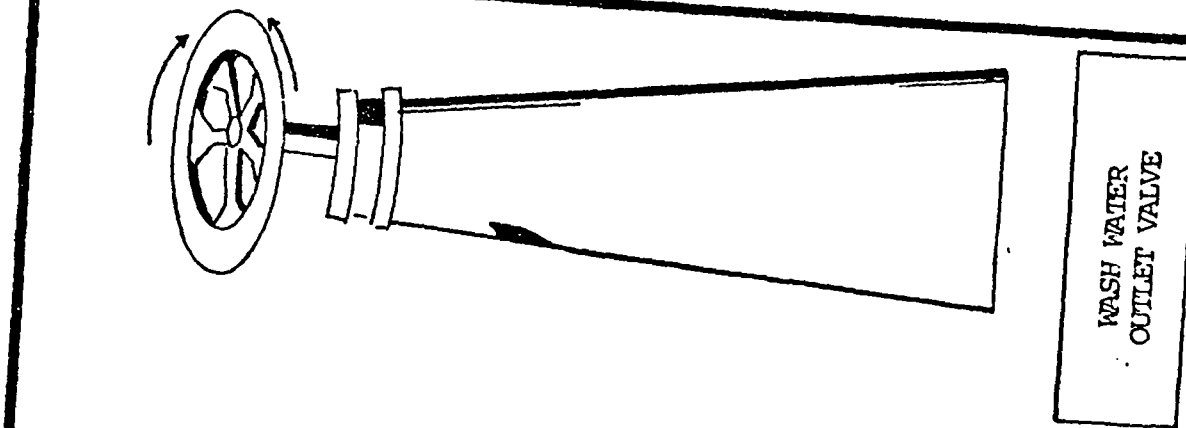
STEPS (Significant actions which advance the operation towards completion)	KEY POINTS (Keys to doing the steps efficiently and accurately)
1. Select filter.	1.1 Check record sheets to determine which filter was "washed" most recently. 1.2 Filter most recently washed should be used. Refer to L6:IS:06.
2. Open inlet valve to filter.	2.1 Filter inlet valve is located in front of the filter. See L6:IS:02. 2.2 Valve is labelled "filter inlet valve." 2.3 Valve is colour-coded. See L6:IS:06. 2.4 Valve opens clockwise.
3. Select control pump.	3.1 Control panels for filter are located below operation gallery. 3.2 Each filter has an individual control situated in front of the filter as well.
4. Activate control panel.	4.1 Turn knob on filter control (below operation gallery) to either "open" or "auto" position. See L6:IS:03.
5. Check float valve operation.	5.1 Open manhole in front of filter. 5.2 Pull down connection to float. See L6:IS:04.

(cont'd next page)

OPERATION BREAKDOWN SHEET
(continued)

L6:IS:01 (cont'd)

STEPS	KEY POINTS
	<p>5.3 Note flow of water out of filter:</p> <p>If flow does not increase when connection is pulled down, filter should be isolated.</p>

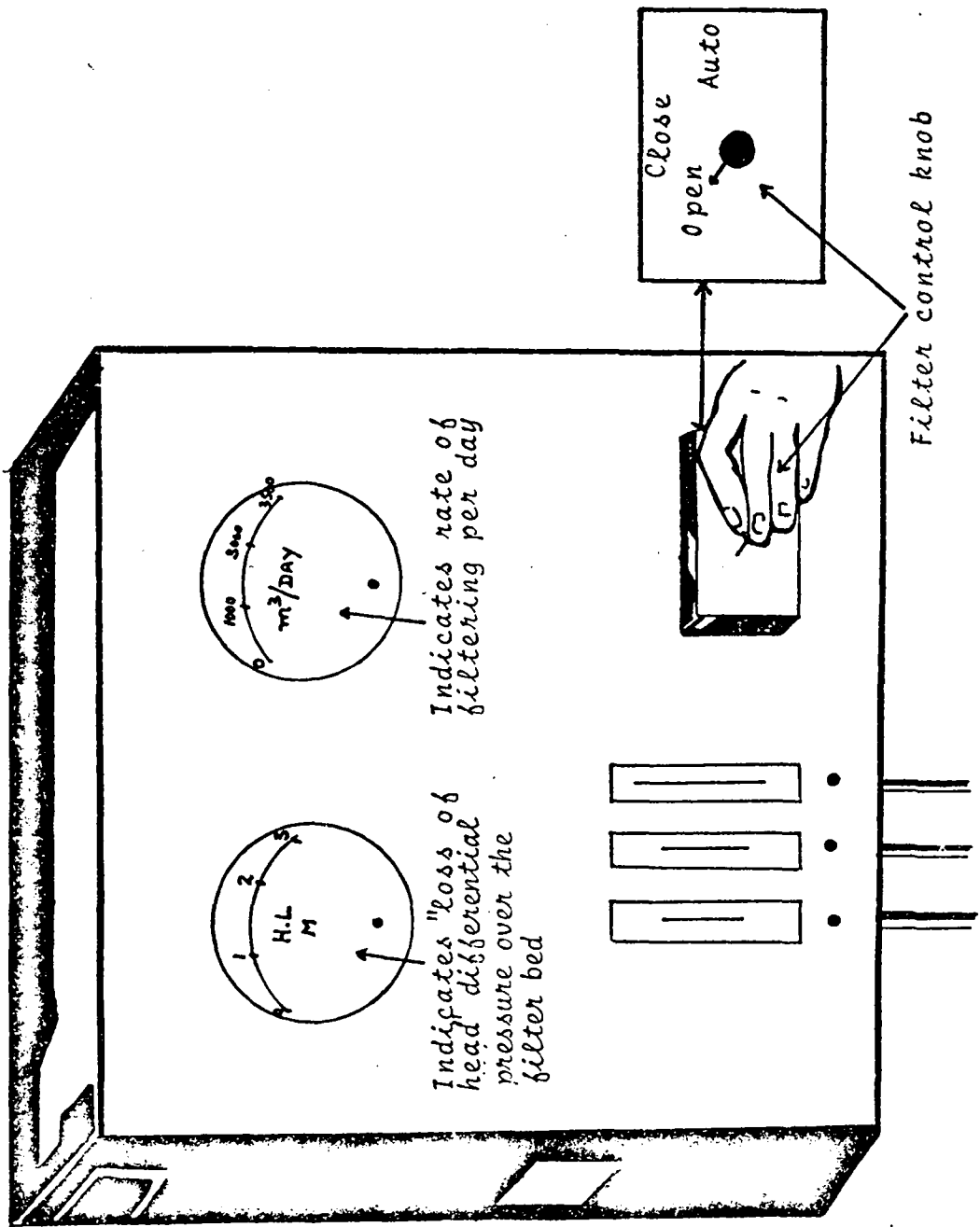


Close to prevent
water going to open
waste

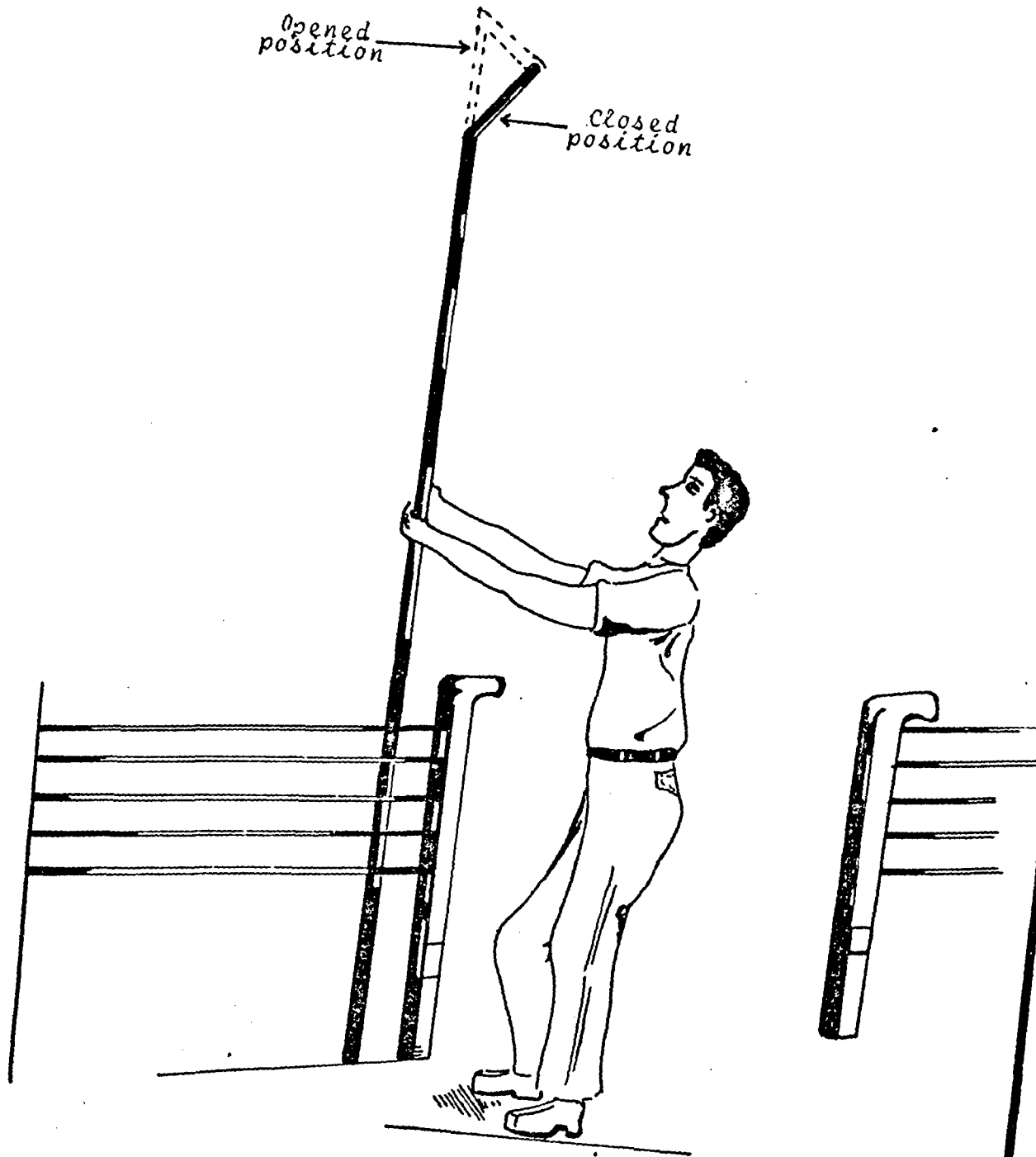
Open to transfer
water from the
sedimentation
tank to the
filter tank

close

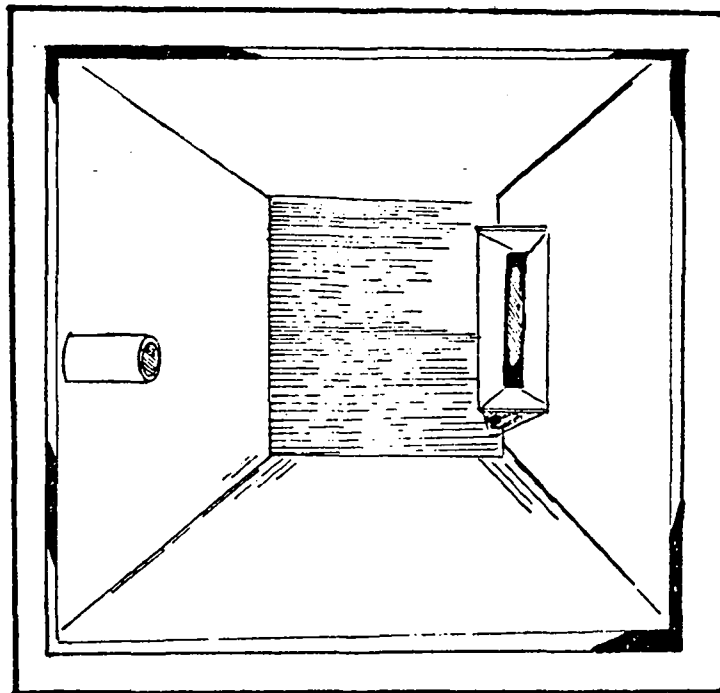
FILTER VALVES



FILTER CONTROLS



CHECKING OPERATION OF FLOAT VALVE



WEIR

FILTERS

The treated water leaves the sedimentation tanks and enters the rapid sand filters.

Each rapid sand filter consists of a 1 foot depth of gravel stone, on top of which lies another 1 foot of fine gravel stone, 2 feet of coarse sand, and 3 feet of fine sand. (N.B. All of the sand is from a fresh water source. Beach sand cannot be used.)

The water enters the filter, which has a float-operated valve to control the outflow. This valve is operated on the filter control panel. The water filters downward and over the outlet weirs to the final post-chlorination tank for distribution.

The differential pressure gauge on the filter panel will indicate when the loss of head across each filter bed is increased. When this occurs, it means that the filter is filtering slowly, and that the filter should be cleaned.

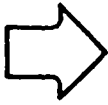
The filters are washed by reverse flow of treated water from a distribution storage tank following air agitation of the filter bed.

The "rate of flow" indicator on the filter control panel indicates the rate of filtering per day, which is also an indication of the efficiency of the filter bed.

The filter valves—which consist of a wash water inlet valve, an air inlet valve, a filter inlet valve, and a wash water outlet valve—are used for cleansing the filters. They are painted different colours for easy differentiation.

The filters should be cleaned every 24 hours.

LESSON 7



DISTRIBUTING TREATED WATER

ESTIMATED TIME 30 minutes

PREREQUISITE Lesson 6

PERFORMANCE OBJECTIVE:

- The trainee will be able to:
transfer treated water to the distribution line.
- Under the following condition:
from recall, given the necessary equipment.
- To this standard:
all procedures correctly performed.

TRAINING RESOURCES

Equipment and Supplies: High-lift pump and controls,
gate valves, incorporated in
outlet lines.

Information Sheets: L7 :IS:01 through L7:IS:05.

RAINING ACTIVITIES

TRAINER ACTIVITY	TRAINEE ACTIVITY
1. Read and discuss Operation Breakdown Sheet L7:IS:01.	1. Read and discuss Operation Breakdown Sheet L7:IS:01.
2. Demonstrate and explain the operations. Refer to L7:IS:01 - 06.	2. Observe and discuss. Refer to L7:IS:01 - 06.
3. Ask trainees to state the sequence and explain the details of the operations.	3. State the sequence and explain as requested by the trainer.
4. Ask trainees to practise the operations. Correct them when necessary.	4. Practise the operations.

OPERATION BREAKDOWN SHEET

L7:IS:01

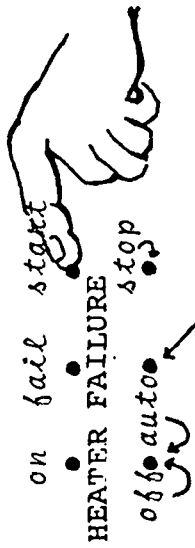
POSITION W.T.P. Operator TASK Operating the plant

OPERATION Distributing treated water

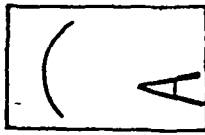
STEPS (Significant actions which advance the operation towards completion)	KEY POINTS (Keys to doing the steps efficiently and accurately)
1. Select high-lift pump.	1.1 Check meters on pumps for hours of usage. 1.2 There are three pumps. 1.3 Choose pump with least hours of use.
2. Isolate the pump.	2.1 Close outlet valves for other pumps. 2.2 Close outlet valves for selected pump temporarily.
3. Start high-lift pump.	3.1 Ensure that all knobs on control panel are in the "on" position. 3.2 Ensure that the amber light, which indicates heater is on, is lit. 3.3 Push the green button labelled "start."
4. Regulate flow.	4. Open and/or close valves until a predetermined desired pressure is obtained.

PUMP NO. 2

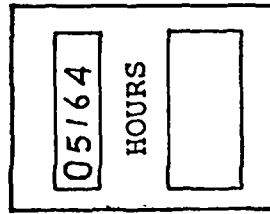
MOTOR HEATER



failure
reset



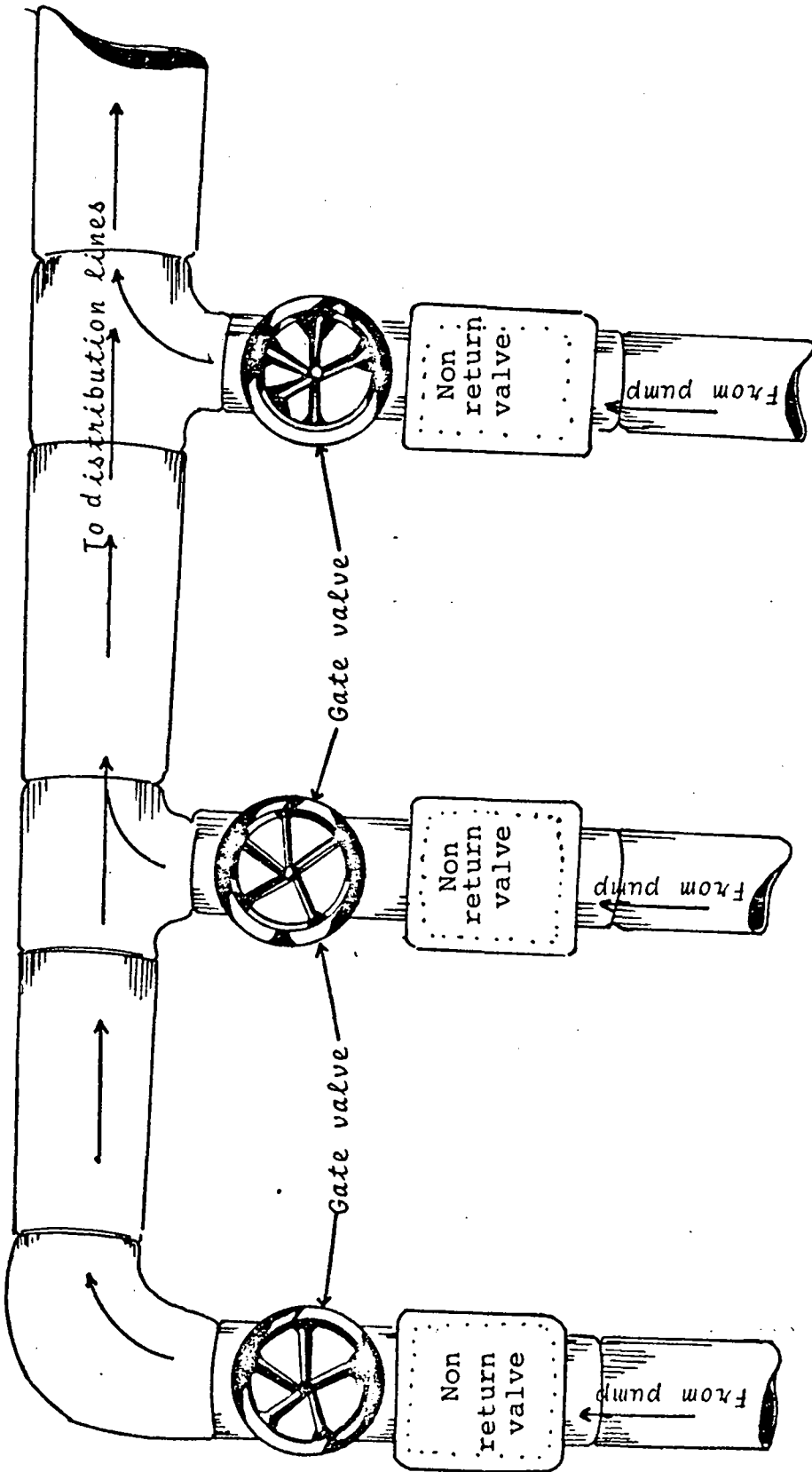
Ammeter



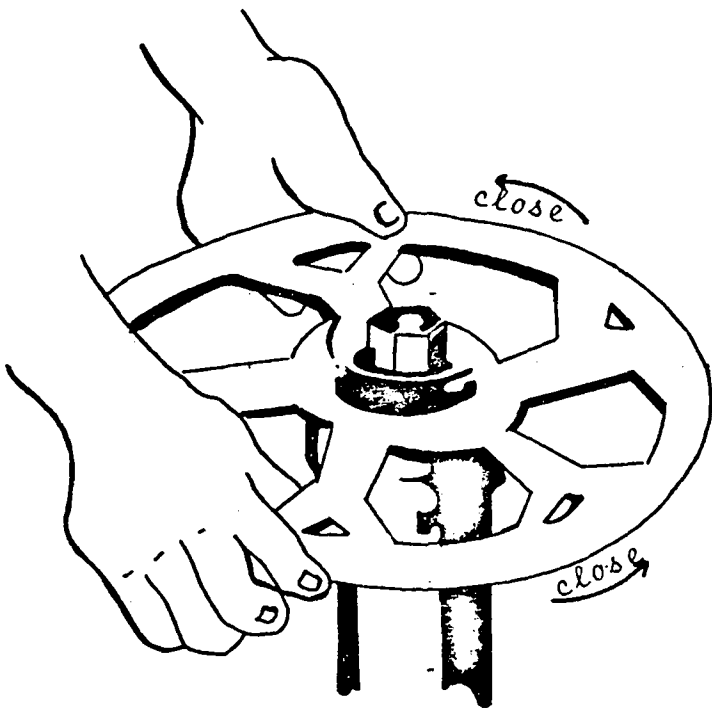
HIGH-LIFT PUMP CONTROL

N.B. Before pressing the start button the heater is on and switch is in the "on" position.

The upper and lower buttons at the far left control the motor heater (necessary to dry up collected moisture). The other four buttons are controls for the pump itself - to be used when the pumps fail to operate for some reason.

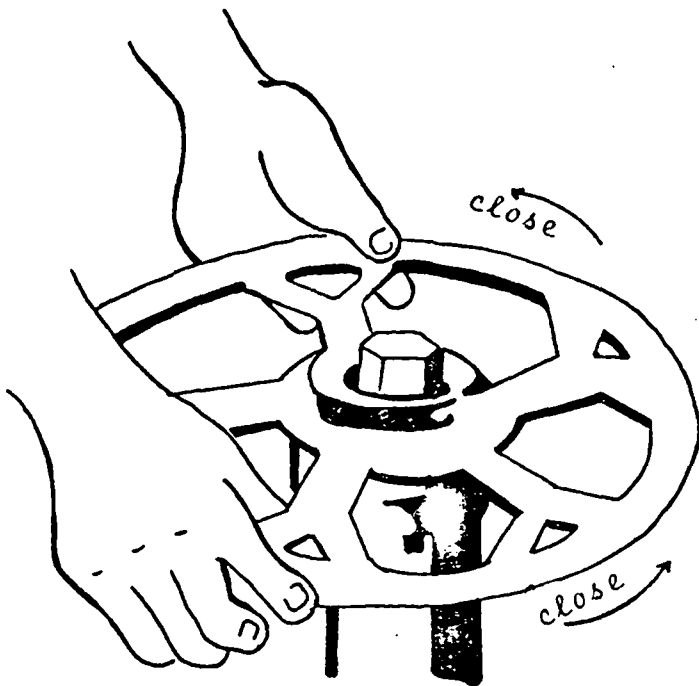


PUMP OUTLET FROM PUMP TO DISTRIBUTION LINE

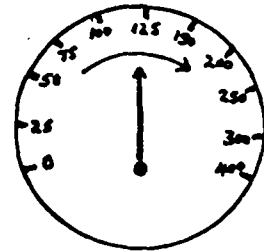


All gate valves must be closed to prevent back-flow and/or water hammer when the pump is started.

ISOLATING THE PUMP

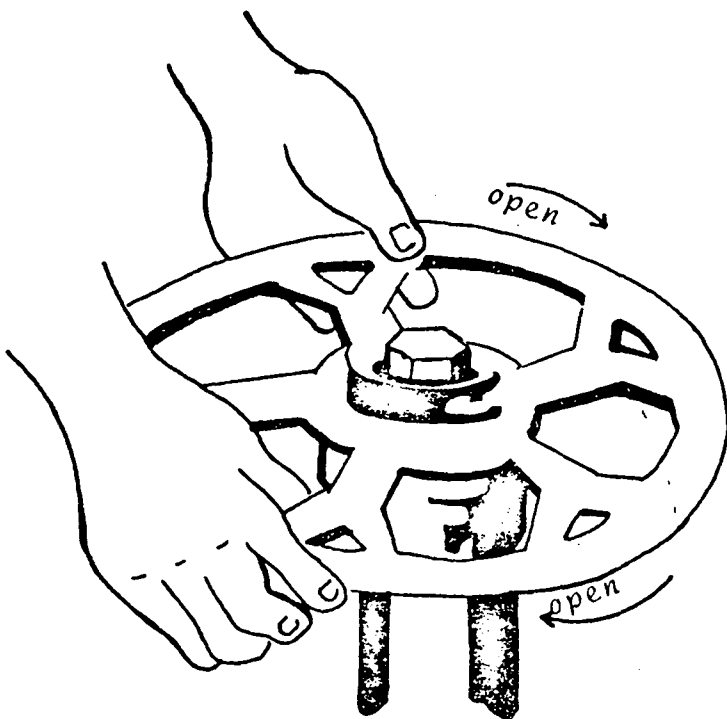


Close to reduce the flow and increase the pressure.

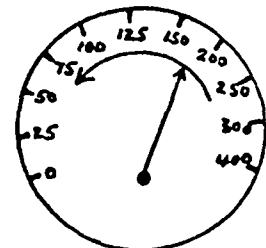


PRESSURE GAUGE

The pressure increases as the valve is closed.



Open to increase the flow and reduce the pressure.



PRESSURE GAUGE

The pressure decreases as the valve is opened.

REGULATING THE DISTRIBUTION PRESSURE

LESSON 8

TRANSFERRING THE PLANT FROM STANDBY
POWER TO THE MAIN POWER SUPPLY

ESTIMATED TIME

20 minutes

PREREQUISITE

Basic knowledge of electrical principles

PERFORMANCE OBJECTIVE:

- The trainee will be able to:
transfer the plant from standby power to the main power supply.
- Under the following condition:
from recall, given a plant on standby power.
- To this standard:
all procedures correctly performed.

TRAINING RESOURCES

Equipment and Supplies: Main control panel, standby/main
change-over control panel.

Information Sheets: L8:IS:01 through L8:IS:03.

NOTE

This procedure is done only in case of a power failure. When there is such a failure, switch from the failed power supply to the plant generator. To do this, follow the same steps outlined here, substituting standby (alternator) switches for the main switches.

TRAINER ACTIVITY	TRAINEE ACTIVITY
1. Distribute and discuss Operation Breakdown Sheet L8:IS:01.	1. Read and discuss Operation Breakdown Sheet L8:IS:01.
2. Demonstrate and explain the procedure. Refer to L8:IS:01 - 03.	2. Observe and discuss. Refer to L8:IS:01 - 03.
3. Ask trainees to state the steps of the procedure in correct sequence.	3. State and explain the steps of the procedure from recall.
4. Ask trainees to demonstrate the procedure. Correct them when necessary.	4. Demonstrate the procedure as instructed by the trainer.

OPERATION BREAKDOWN SHEET

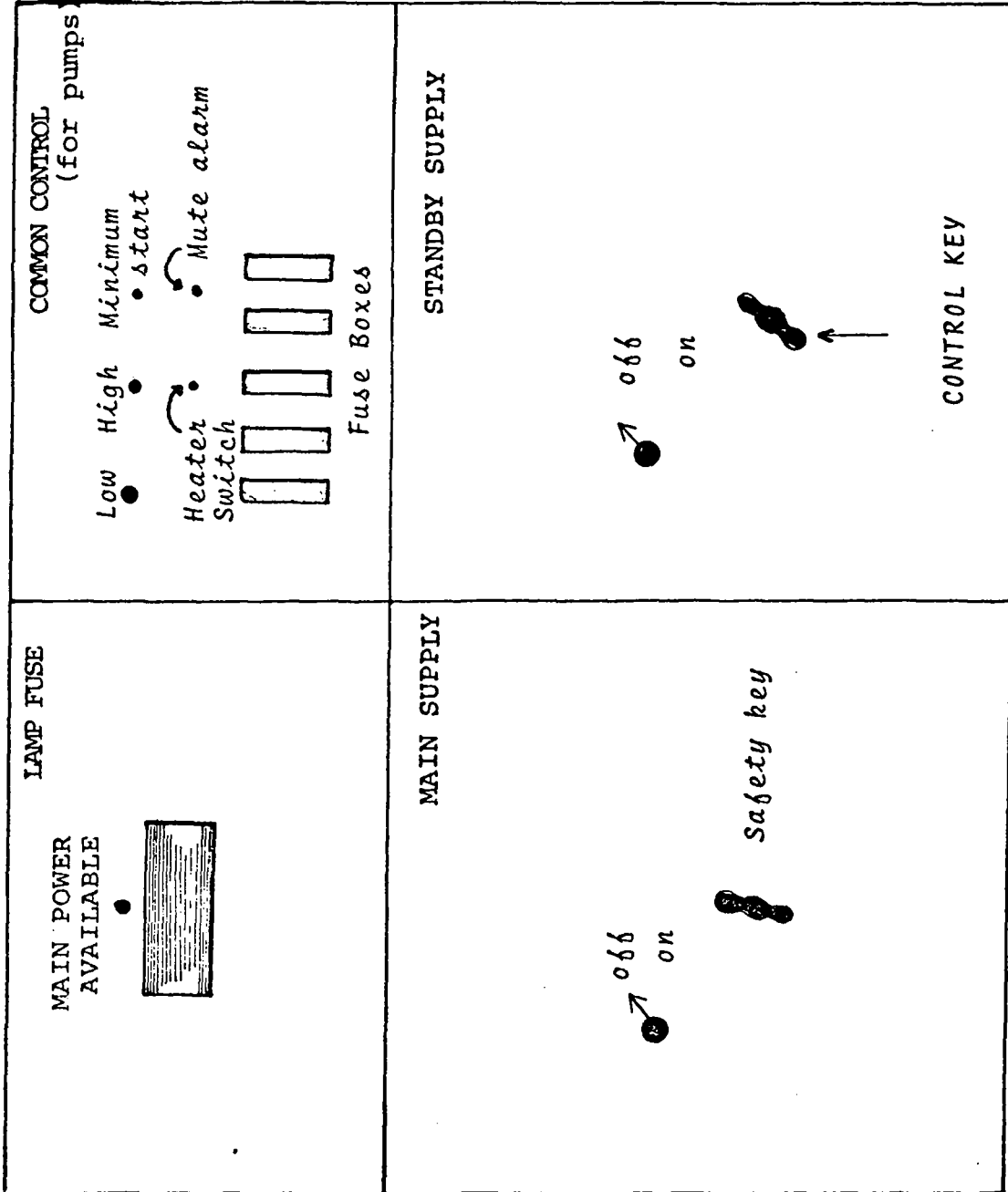
L8:IS:01

POSITION W.T.P. Operator TASK Operating the plant

OPERATION Transferring plant from standby power to main power supply

STEPS (Significant actions which advance the operation towards completion)	KEY POINTS (Keys to doing the steps efficiently and accurately)
1. Turn control on panel from standby power (labelled "alternator ") to the main power supply (labelled "mains ").	1.1 Remove safety key from standby control. 1.2 Insert "key" into area provided on main supply panel. See L8:IS:02). 1.3 Turn safety key clockwise until it stops. 1.4 Turn knob to "on" position. 1.5 Locate standby/main power supply change-over control in the standby room. 1.6 Turn pointer to "mains."
<p>NOTE: The plant is built for 24-hour-a-day operation and uses power primarily from the island's main power supply. There is also a standby generator to supply power to the plant in the event of a power failure. The operation described in this lesson is performed at the end of a power failure, when the main power supply is repaired and ready for use—and the standby unit is no longer needed.</p>	

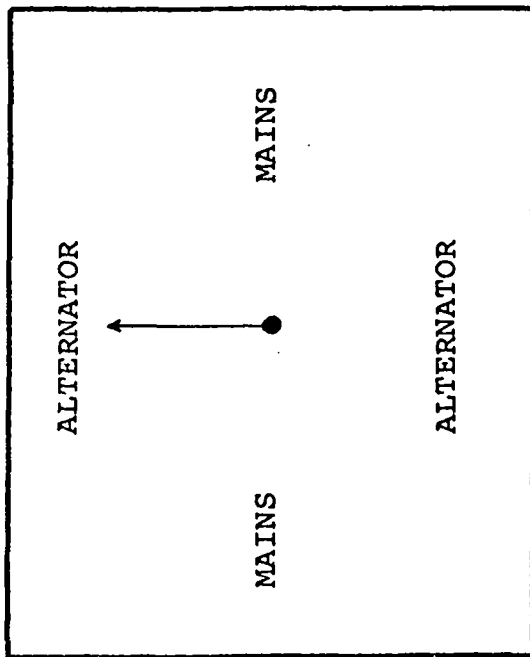
The top three buttons are indicators of the amount of water in the tank.



SECTION OF MAIN CONTROL PANEL

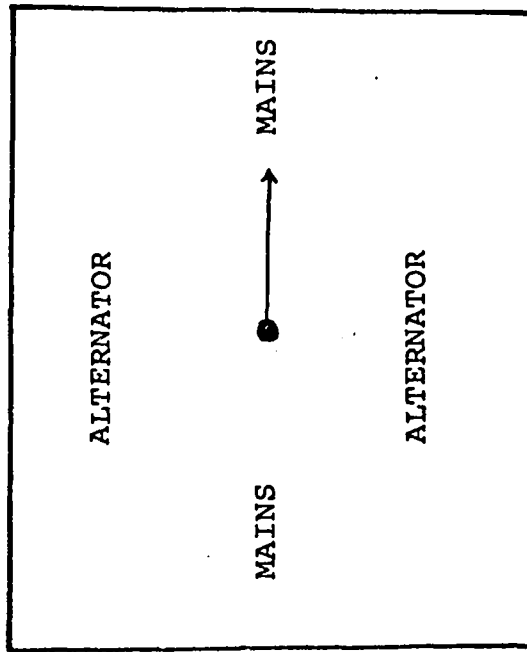
Alternator = standby generator

Mains = main power supply



MAIN/STANDBY

(STANDBY GENERATOR IS IN OPERATION)



CHANGE-OVER CONTROL

IS IN OPERATION

LESSON 9



SUPPLYING AIR AND WATER TO THE PLANT

ESTIMATED TIME

1 hour

PREREQUISITES

Knowledge of pumps and electrical principles

PERFORMANCE OBJECTIVE:

- The trainee will be able to:
trigger the appropriate controls to supply air and water to the plant.
- Under the following condition:
from recall, given necessary equipment and controls.
- To this standard:
all procedures correctly performed.

TRAINING RESOURCES

Equipment and Supplies: Compressor, electrical controls, plant log, booster pumps.

Information Sheets: L2:IS:01, L2:IS:02.

TRAINER ACTIVITY	TRAINEE ACTIVITY
<ol style="list-style-type: none">1. Read and discuss Operation Breakdown Sheet L9:IS:01.2. Demonstrate and explain the operations of the procedure. Refer to L9:IS:01.3. Ask trainees to state the sequence of the operations and explain the details of specific operations.4. Allow the trainees to practise the procedure. Correct them when necessary.	<ol style="list-style-type: none">1. Read and discuss Operation Breakdown Sheet L9:IS:01.2. Observe and discuss the operation. Refer to L9:IS:01.3. State and explain as requested by the trainer.4. Practise the procedure.

OPERATION BREAKDOWN SHEET

L9:IS:01

POSITION W.T.P. Operator TASK Operating the plant

OPERATION Supplying air and water to the plant

STEPS (Significant actions which advance the operation towards completion)	KEY POINTS (Keys to doing the steps efficiently and accurately)
1. Select the compressor. 2. Turn on power to the compressor. 3. Start the compressor.	1.1 Check plant log for hours of use of compressors. 1.2 Select compressor with least hours of use. 2.1 Turn isolating switch to "on" position. 3.1 Turn selected compressor switch to "on" position. 3.2 Pull "stop" button located beside the compressor.
NOTE: Some of the equipment in the plant uses pneumatic instruments (e.g., sand filters) which require a supply of air to function properly.	
4. Select booster pumps. 5. Start pumps.	4.1 Check log for pump use. 4.2 Choose pumps with least hours use. 4.3 Choose two pumps to work together. 5.1 Identify the booster controls. 5.2 Turn controls to selected pumps to "on" position. 5.3 Slowly open inlet valve to pump.

(cont'd next page)

OPERATION BREAKDOWN SHEET
(continued)

L9;IS;01 (cont'd)

STEPS	KEY POINTS
	<p>5.4 Pull pump "stop" button.</p> <p>5.5 Slowly open the pump's outlet valves.</p>

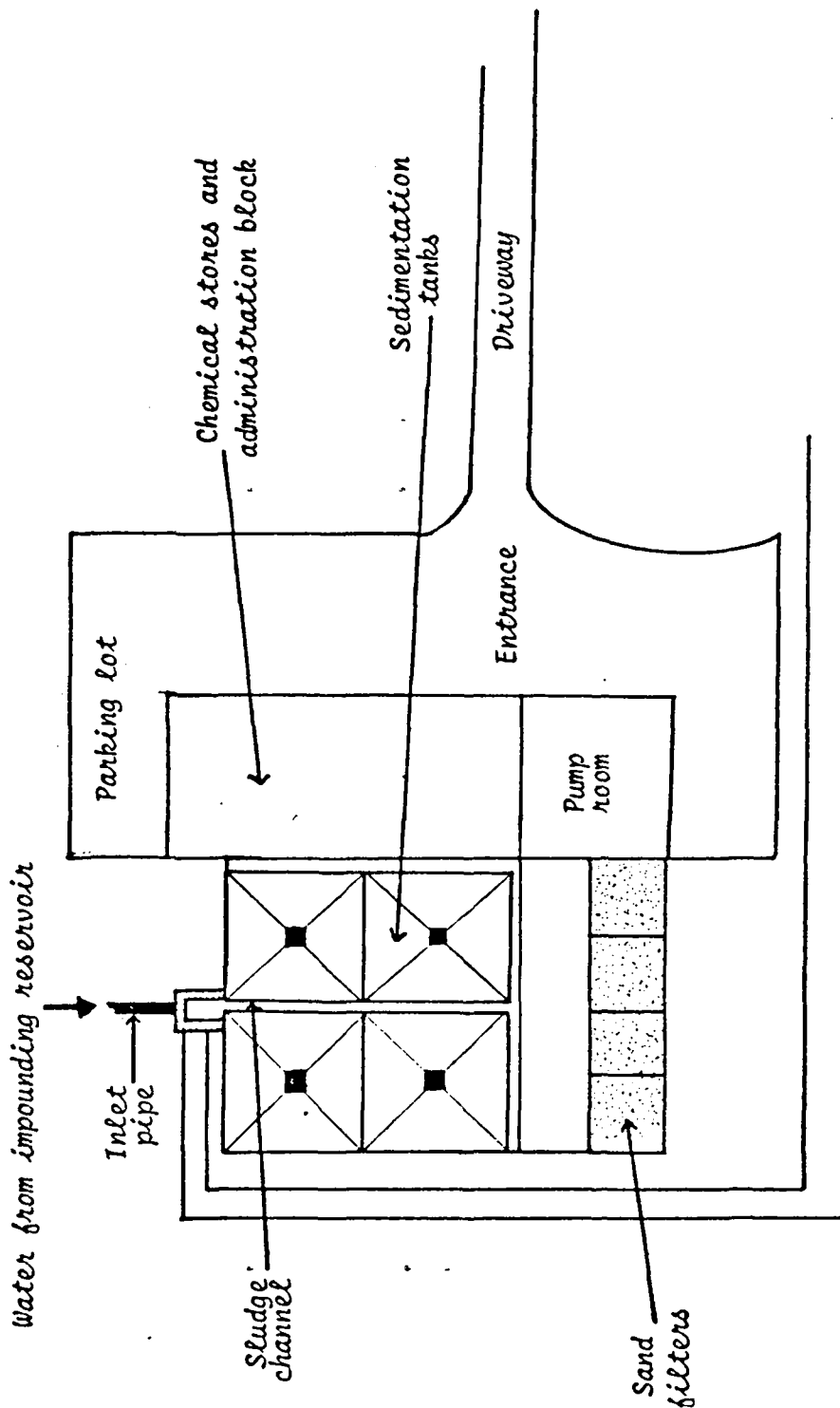
BOOSTER PUMPS

Booster pumps supply water to the chlorinator. It is essential that the chlorine be added to the water in the form of a solution. If the chlorine is added in its liquid form, it would be very easy to super-chlorinate* the water: if it is added in a gaseous form, the chlorine could easily escape into the atmosphere. Hence it is of utmost importance to mix the chlorine with the water before adding it to the water to be treated. As a result, the chlorinators need a constant supply of water, which is supplied by the booster pumps.

(*Super-chlorination is a term used to refer to a process where more chlorine is used than needed.)

Why Two Pumps?

As noted above, it is absolutely essential that when the chlorinator is in use it has a continuous supply of water. If one pump is used, there is a possibility that this could break down and cut off the supply of water to the chlorinators. With the use of two pumps, the odds against both pumps breaking down increases. Hence the odds against the supply of water to the chlorinator being cut off also increases.



LAYOUT OF DELAPS WATER TREATMENT PLANT
(AERIAL VIEW)