

262.1

79WA

RAIN WATER MANAGEMENT PROJECT

WATER MAIN LAYING

A JOB-AID

BY

CYRIL COX

SUPERINTENDENT OF WORKS

BARBADOS WATERWORKS DEPARTMENT

A JOINT-VENTURE PROJECT OF THE GOVERNMENTS OF:

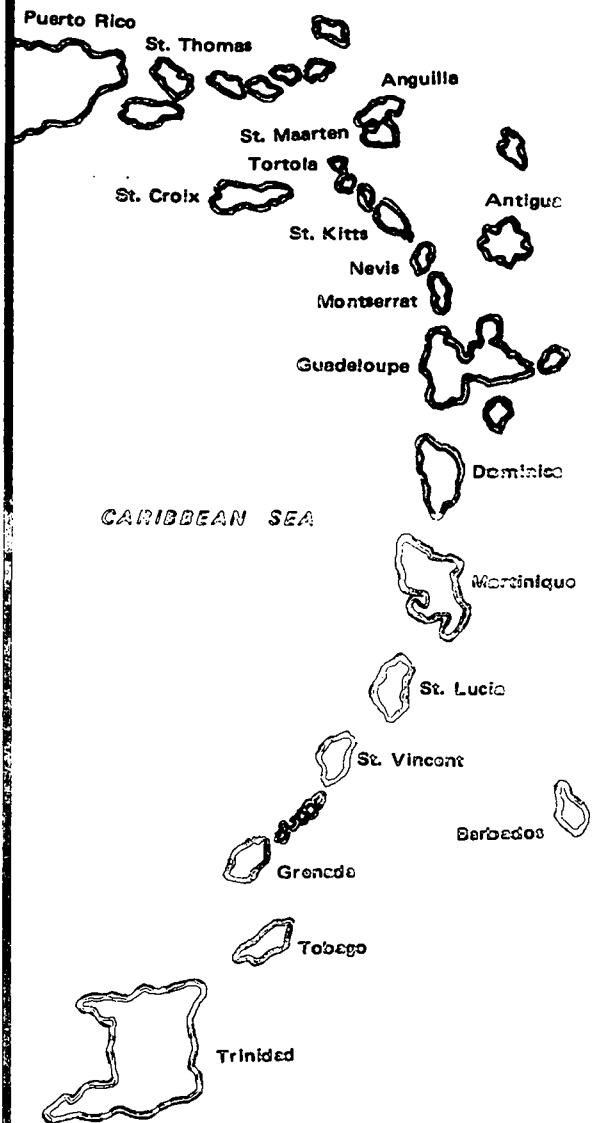
ANGUILLA, ANTIGUA, BRITISH VIRGIN ISLANDS, BARBADOS,
DOMINICA, GRENADA, MONTSERRAT, ST. KITTS/NEVIS,
ST. LUCIA, ST. VINCENT, CANADA, UNITED KINGDOM

AND

THE PAN AMERICAN HEALTH ORGANIZATION

300050

Approved by
Director of Health Services
Ministry of Health
Barbados



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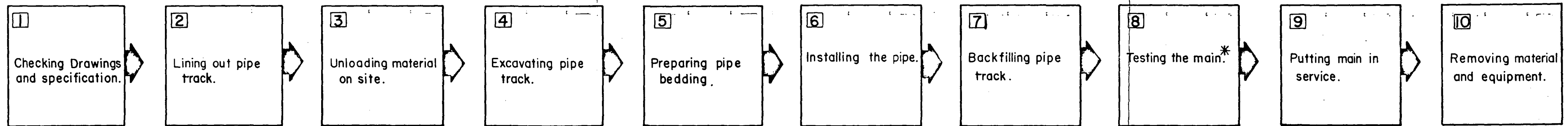
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for Community Water Supply

INTRODUCTION

This Job Aid is aimed at supervisory personnel who have had main laying experience. It is assumed that the supervisor has been handed a set of plans and specifications; the utilities have been contacted and the necessary easements have been secured.

The Job Aid only discusses laying of the main. Detailed discussions of excavating and backfilling techniques; installation techniques for fittings (valves, fire hydrants, air relief caps, branches, tees, thrust blocks); pipe cutting and jointing procedures are not included in this Job Aid.

It is intended for use as a memory aid, listing the critical points not to be forgotten in the laying of the main.



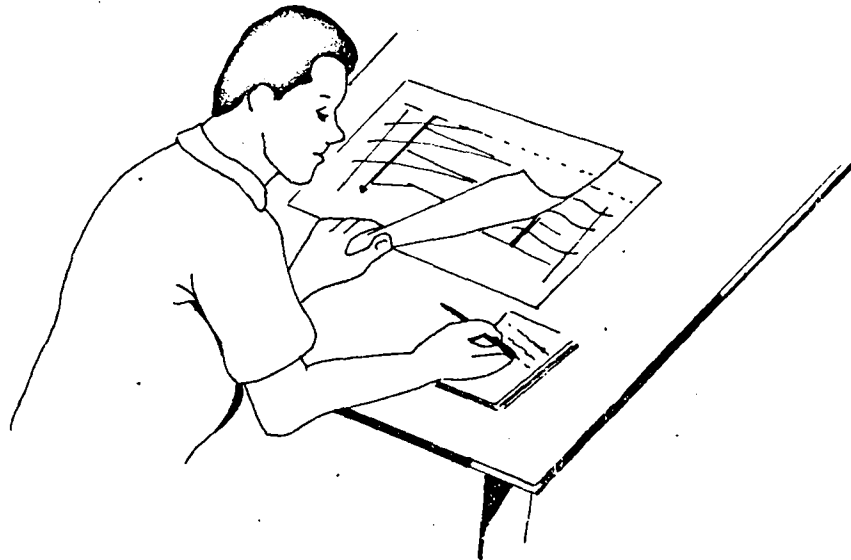
Water Main Laying Flow-Chart

* Includes mains' disinfection which is covered in Annex 14.

OPERATION

1

CHECKING DRAWINGS AND SPECIFICATIONS



STEP (HOW HE DOES IT)

KEY POINT (IN PERFORMING THE STEP)

1. Check scale and legend of the drawing.

1. Scale is generally located at right hand. Examine drawing legend for symbols on detail block of fittings, or on actual drawing for branches, bends, valves, etc.

2. Inspect profile.

2. Check elevations.

3. Order materials required for the job.

3.1 Pipes - Measure and calculate the length of each type and size of pipe required.

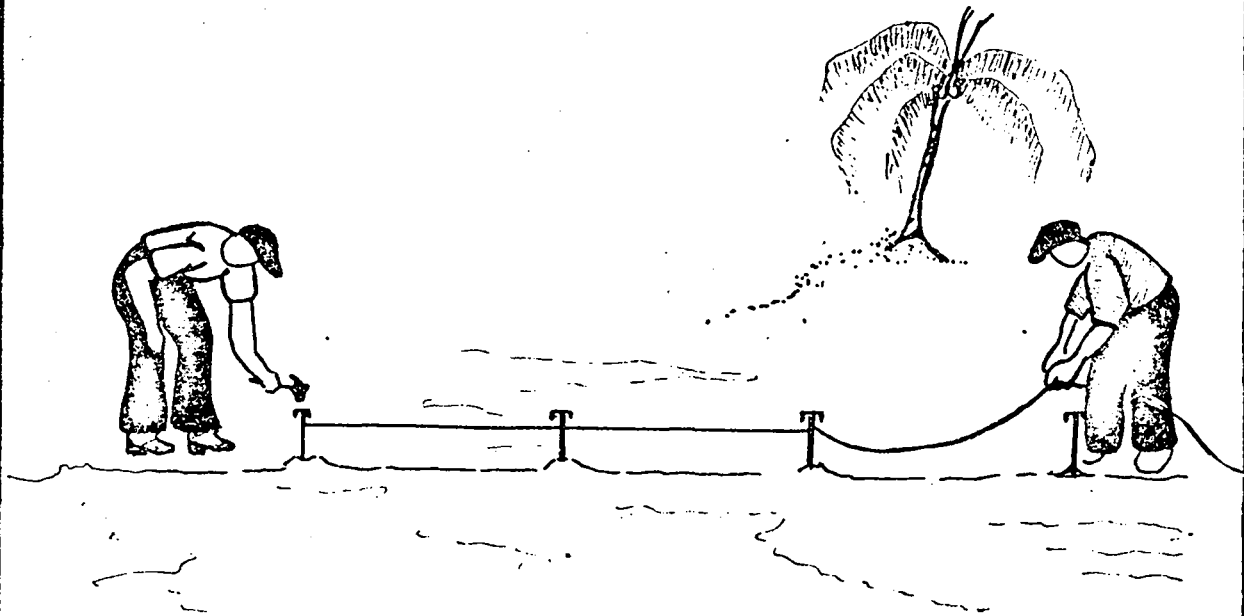
3.2 Fittings (valves, fire hydrants, caps, etc.) - determine the type, size and number of each type of fitting required for the job.

3.3 Branches, bends and thrust blocks - determine the type, size and number of each required for the job.

OPERATION

2

LINING OUT PIPE TRACK



STEP (HOW HE DOES IT)

1. Review drawing at the job site.
2. For pipelines along the roadway, the pipe track will be in the gutter and road reserve.
3. For pipeline through fields and agricultural areas, stake the left or right side of the track which ever is more convenient.

KEY POINTS (IN PERFORMING THE STEP)

1. Check location, elevations, directions.
2. The edge of the road will mark the track. Measure 18" from edge of road on the road reserve, then measure out width of track.
- 3.1 Measure and drive pins according to location of proposed track.
- 3.2 Try to maintain as straight a line as possible.
- 3.3 Tie a strong line between the stakes.

OPERATION

1

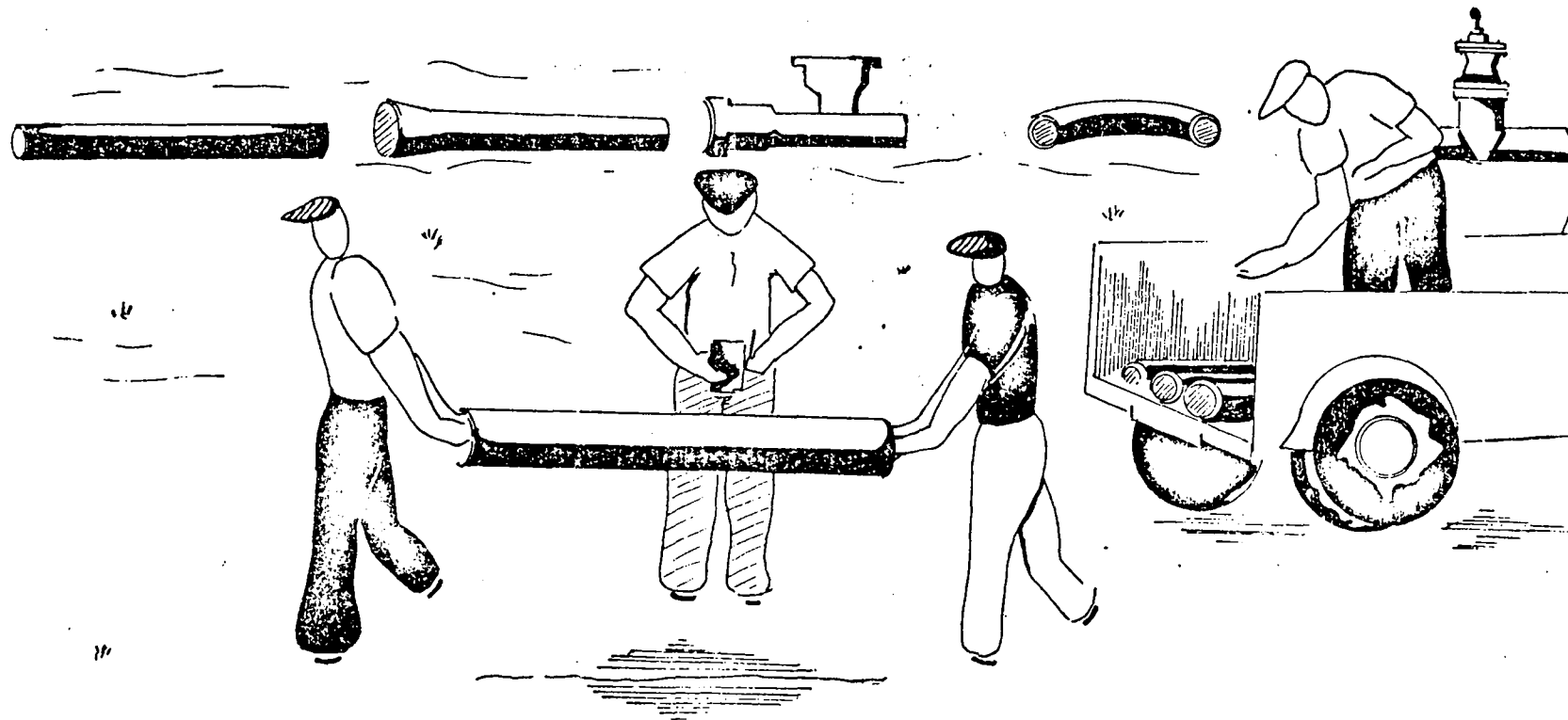
CHECKING DRAWINGS AND SPECIFICATIONS (cont'd)

STEP (HOW HE DOES IT)

KEY POINT (IN PERFORMING THE STEPS)

- 3.4 *Fill out stock sheet form and send to stores. See Annex 1 for sample stock sheet.*
- 3.5 *Detail transportation from stores to the job site.*
4. *Contact utilities, road authority and easement owners.*
 - 4.1 *Write letters to the utilities stating the route, depth, length and side of road for pipe track. See Annex 2 for typical letter.*
 - 4.2 *Secure permission from landowners to lay main on their property. See Annex 3 for typical letter.*

OPERATION 3 UNLOADING MATERIAL ON SITE



OPERATION

3

UNLOADING MATERIAL ON SITE (cont'd)

STEP (HOW HE DOES IT)

KEY POINT (IN PERFORMING THE STEPS)

1. Carefully unload and neatly stack material.
 - 1.1 Avoid dropping material off of truck.* (Dropping may cause cracks and other damage.)
 - 1.2 Carefully stack the material on the opposite side of roadway from the track.
2. Inspect pipes and fittings.
 - 2.1 Check for soundness, (cracks, rust, etc.)
 - 2.2 Make sure all material is accounted for and that the correct type, size and quantity have been delivered.

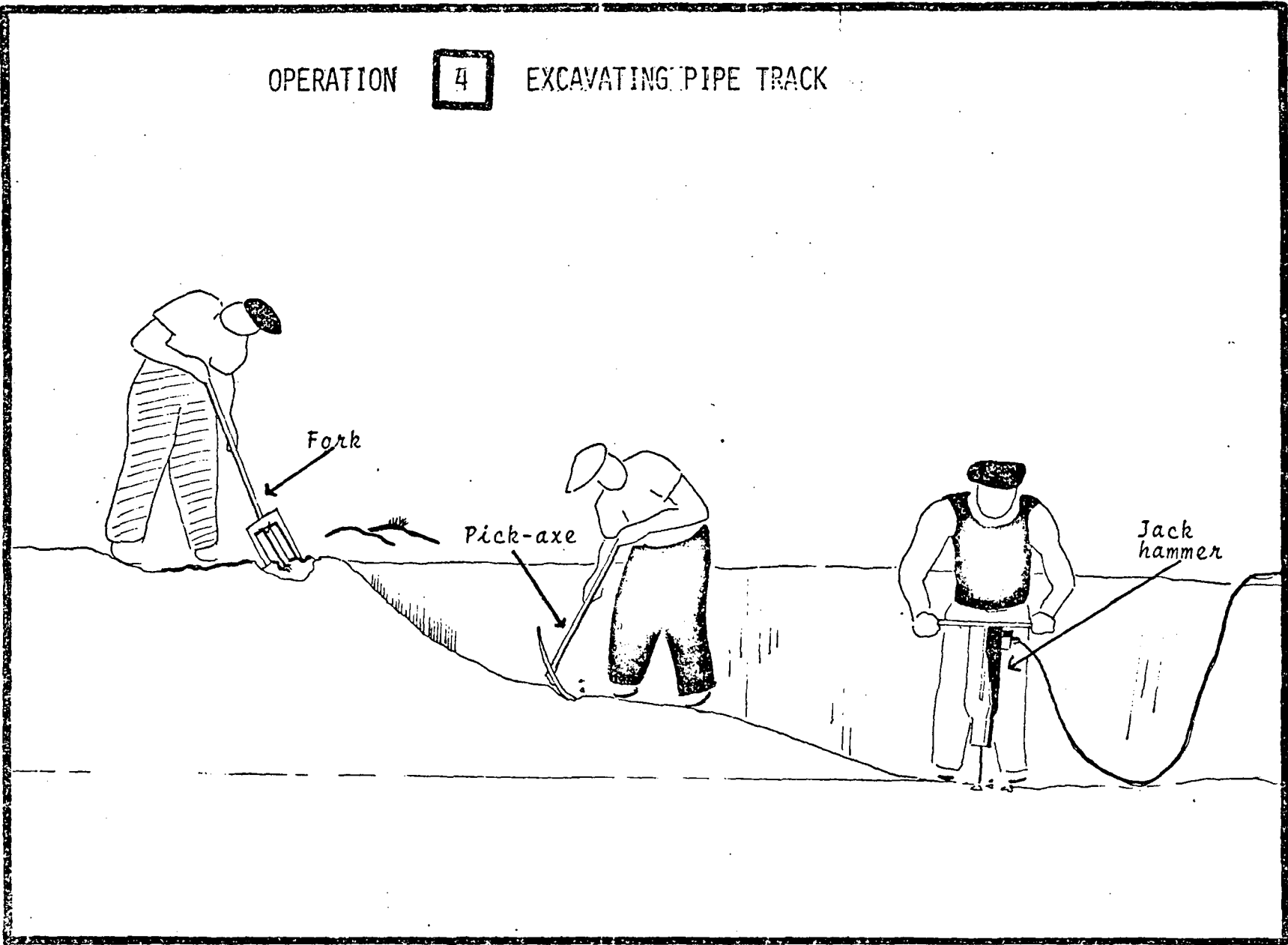
*If mechanical unloading equipment is not available, timber skids may be used to roll the pipes off the truck.

OPERATION

4

EXCAVATING PIPE TRACK

8



OPERATION

4

EXCAVATING PIPE TRACK (cont'd)

STEP (HOW HE DOES IT)

KEY POINT (IN PERFORMING THE STEPS)

NOTE: BEFORE EXCAVATING A TRACK ALONG A ROADWAY OR THROUGH THE ROAD, YOU MUST PLACE ROAD BARRIERS AND WARNING SIGNS FOR THE SAFETY AND PROTECTION OF THE WORKERS AND THE DRIVERS. SEE ANNEXES 4 - 6 FOR MORE INFORMATION

7. The proper method of excavation depends on the type of soil, the location of utilities, if you are crossing the roadway, how close people live and how close other buildings are to the pipe track.
- 1.1 For a pipe track near other utilities, arrange for representatives of the utilities to be present during the excavation to give directions. In some cases the other utilities may have to do the actual excavation.
 - 1.2 Always leave at least one lane open for traffic when laying a main across a roadway.
 - 1.3 When excavating through hard rock it may be necessary for cutting or blasting.
 - 1.4 Only blast when there is no chance of damaging surrounding buildings; utilities and endangering the safety of people - In these cases, the proper procedure would be to cut the rock. See Annex 7 for more information on blasting.
 - 1.5 The maximum length of track excavation is 280 ft.*
 - 1.6 The proper depth of the track is based on the minimum amount of cover, size of the pipe and topography.
 - 1.7 For roadways, the minimum cover is 2 ft.

* This is to avoid disrupting traffic and causing inconvenience to the public.

OPERATION

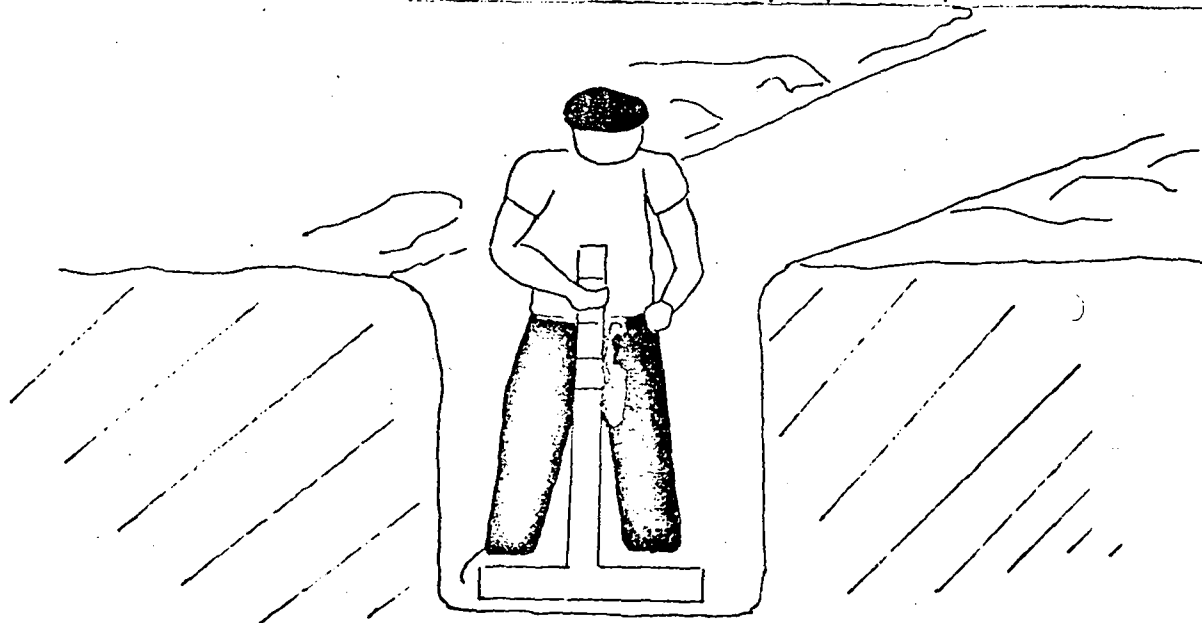
4

EXCAVATING PIPE TRACK (cont'd)

STEP (HOW HE DOES IT)

KEY POINT (IN PERFORMING THE STEPS)

- 1.8 For agricultural areas, the minimum cover is 3 ft.
- 1.9 For pipes larger than 10" the minimum track depth is 4 ft.
- 1.10 The width of the track is based on pipe size. For pipes less than 10", the track should be 18" wide.
- 1.11 For pipe 10" and larger, the track should be 24" wide.
2. Use a "T" templet to see that the pipe track is the proper width and depth.
 - 2.1 The head of the T should be the width of pipe track based on pipe size.
 - 2.2 The handle should be marked at one foot intervals so that you can see that track is proper depth.



OPERATION

5

PREPARING PIPE BEDDING



OPERATION

5

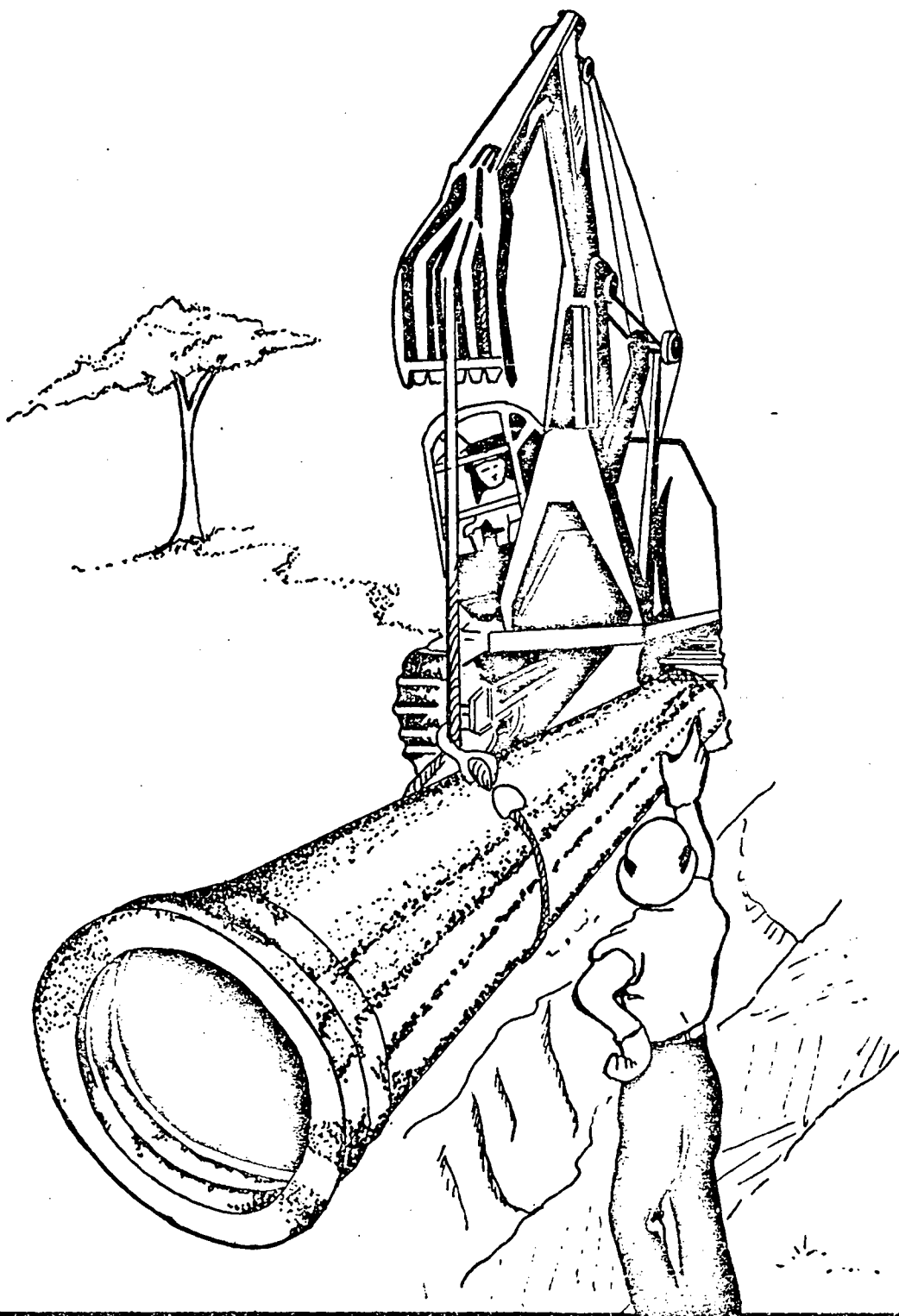
PREPARING PIPE BEDDING (cont'd)

STEP (HOW HE DOES IT)

KEY POINT (IN PERFORMING THE STEPS)

1. Spread bedding material along the bottom of the track.
 - 1.1 Best to use marl.
 - 1.2 If enough marl is not available, you may use a rock and marl mixture, providing the rock is less than $\frac{1}{2}$ inch.
2. Compact the bedding.
 2. Use a ram to tamp down the bedding.
3. Level the bedding with boneing rods.
 - 3.1 Use at least 3 rods.
 - 3.2 Sight across the top of the rods to check level.

OPERATION **6** INSTALLING THE PIPE



OPERATION

5

INSTALLING THE PIPE (cont'd)

STEP (HOW HE DOES IT)

KEY POINT (IN PERFORMING THE STEPS)

NOTE:

MAKE SURE THAT EVERYBODY IS CLEAR AND OUT OF THE WAY, BOTH IN THE TRACK AND OUTSIDE NEAR THE PIPE BEFORE THE CRANE LIFTS THE PIPE. KEEP ALL OF THE WORKERS OUT OF THE PATH AS THE CRANE MOVES THE PIPE INTO THE TRACK.

1. Carefully place the pipe in the track.

1.1 Do not drop or kick the pipe into the track. You may damage the pipe and disturb the bedding.

1.2 Make sure the crane operator avoids knocking excavated soil into the track.

1.3 Avoid getting dirt in the end of the pipes as you place them in the track.

1.4 You may have to cut the pipe to install fittings or finish laying a length of pipe. See Annex 8 for pipe cutting procedure.

1.5 See Annex 9 and 10 for pipe joining procedures.

2. Install fittings as required by the plans.

2.1 To install a fire hydrant, you must first attach a riser pipe from the main to the surface. The fire hydrant is usually attached to the riser by a flange.

2.2 Before installing a valve be sure it operates. Position the valve so that the stem is directed upwards.

/.....

OPERATION

6

INSTALLING THE PIPE (cont'd)

STEP (HOW HE DOES IT)

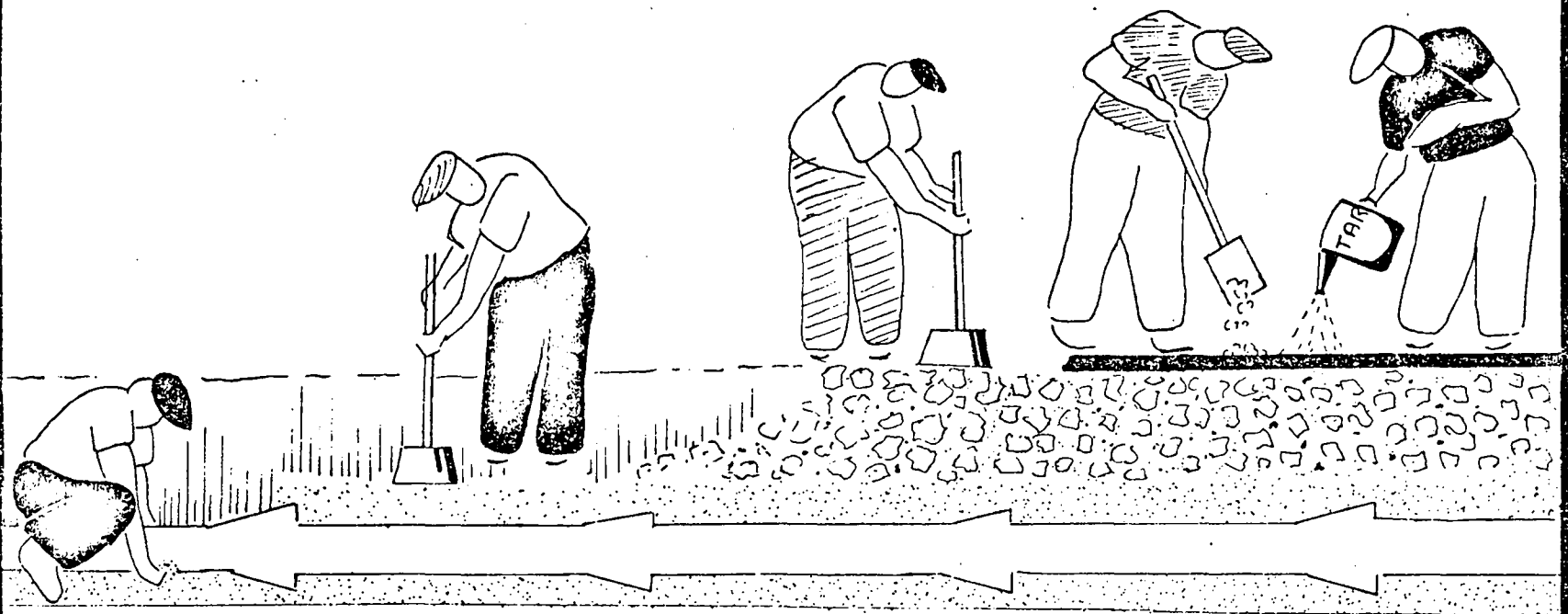
KEY POINT (IN PERFORMING THE STEPS)

- 2.3 *Open ends of the pipe must be fitted with a cap.*
- 2.4 *Pour thrust blocks at every change of direction in the line, bend, branch and "T". Be sure that flanges, bolts or moveable parts are not covered by the thrust blocks. The blocks should be of sufficient size to prevent movement. See Annex 12 for typical thrust block placements.*
- 2.5 *Wash outs should be installed at low places in the main. A 4" or 6" flanged branch should be used with a valve.*

OPERATION

7

BACKFILLING PIPE TRACK



OPERATION

7

BACKFILLING PIPE TRACK (cont'd)

STEP (HOW HE DOES IT)

KEY POINT (IN PERFORMING THE STEPS)

1. Carefully backfill around the pipe.
 - 1.1 This step is very important to keep the pipe from moving during the rest of backfilling.
 - 1.2 Select fine soil for this part of backfilling.
 - 1.3 Pack the fine soil around the pipe and for the first foot above the pipe.

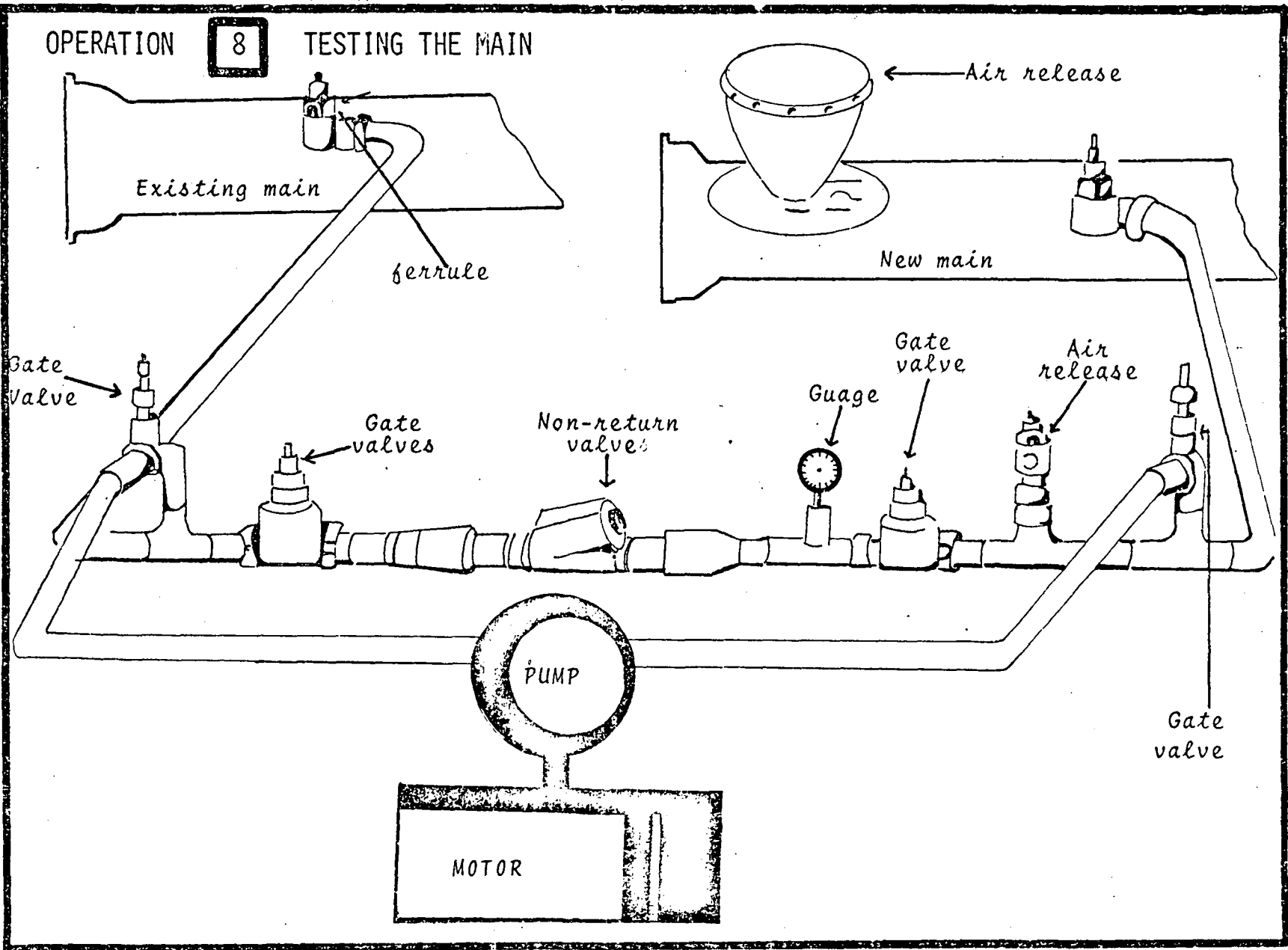
2. Backfill rest of the track.
 - 2.1 The remaining soil does not need to be selected.
 - 2.2 Be sure to compact as you fill to reduce the amount of settling.
 - 2.3 Any remaining soil should be carted away, leaving the site tidy.

3. The surface should be restored to its original condition and elevation.
 - 3.1 Reinstatement of roadways should be arranged.

OPERATION

8

TESTING THE MAIN



OPERATION

8

TESTING THE MAIN (cont'd)

STEP (HOW HE DOES IT)

KEY POINT (IN PERFORMING THE STEPS)

1. Flush the main before you test.

1. Be sure to wash the dirt and debris to prevent damaging the air relief valve during the pressure test.

2. Pressure test the main.

2.1 Arrange for the plumber to pressure test the main.

2.2 The main is considered to be tight after it holds pressure for 24 hours without change.

2.3 See Annex 13 for more information.

3. Disinfect the main.

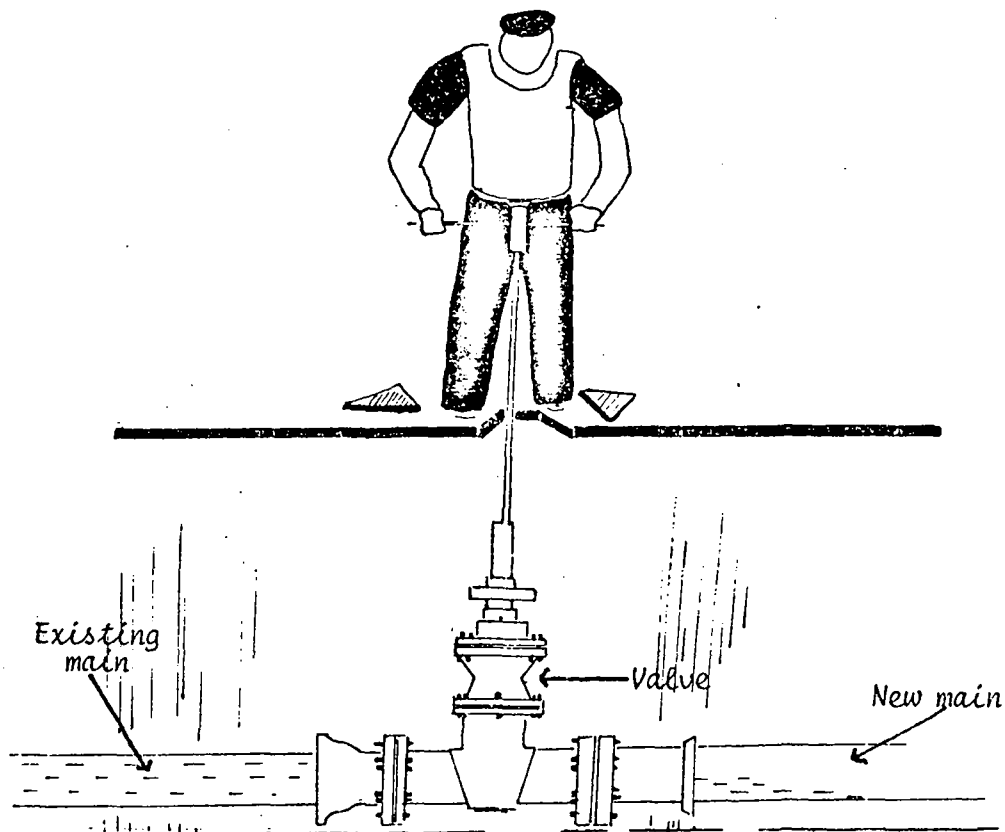
3.1 Arrange for the laboratory technician to disinfect the main.

3.2 See Annex 14 for more information.

OPERATION

9

PUTTING THE MAIN IN SERVICE



STEP (HOW HE DOES IT)

1. After the main has been disinfected, it will be flushed and refilled.
2. Make sure that water is potable.
3. Contact the district superintendent and tell him the main is ready to be put into supply.

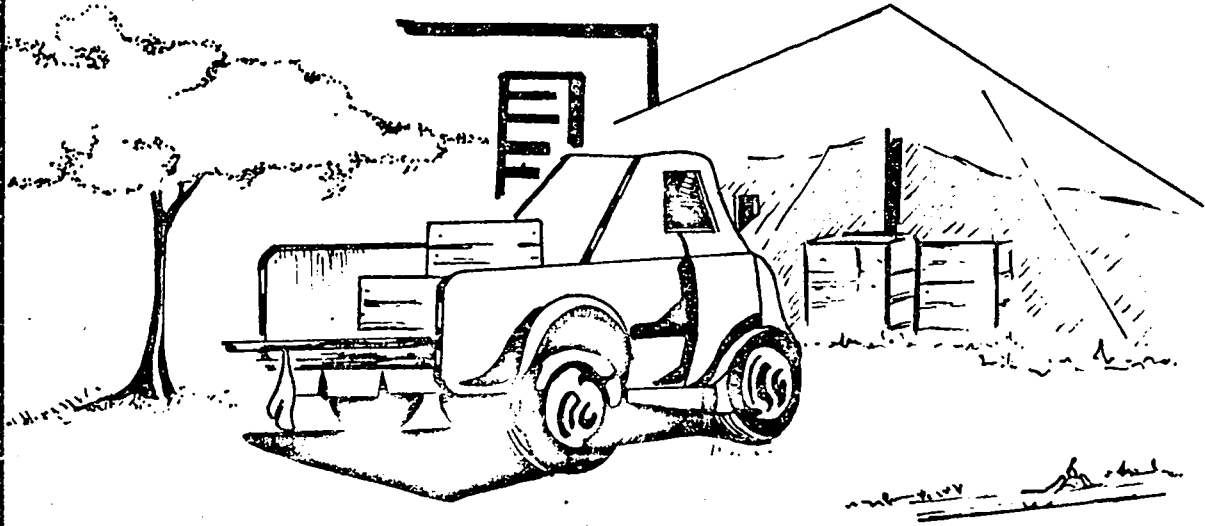
KEY POINT (IN PERFORMING THE STEPS)

1. The disinfected water should be washed out and not allowed in the system.
2. Test for chlorine residual.
- 3.1 Do not turn on the main yourself.
- 3.2 Tell district Superintendent the main is ready for use.

OPERATION

10

REMOVING MATERIAL AND EQUIPMENT



STEP (HOW HE DOES IT)

1. Remove all excess materials.
2. Remove all equipment.

KEY POINT (IN PERFORMING THE STEP)

1. Make a list of all unused pipe and fittings. Carefully load them on trucks and return them to stores.
2. Move equipment to new site or back to the headquarters.

ANNEXES

SAMPLE

A71:004

Plb. or other allocations

0001

WATERWORKS DEPARTMENT

.....5/10.....1979....

To Storekeeper

Please deliver for Foreman Jones at Jackmans Terrace, St. Michael

the following material 24 - 4" tyton pipes and joints

..... 2 - 3" off 4" Sop branches (etc)

.....
.....
.....
.....
.....
.....
.....
.....

Signature

Foreman.....

SAMPLE

WATERWORKS DEPARTMENT

STOCK SHEET

WEEK ENDING

RECEIPTS

DATE	LEAD	YARN	K.OIL	GELATINE	CAPS	FUSE	REMARKS
B/FWD							
TOTAL							

USED

DATE	LEAD	YARN	K.OIL	GELATINE	CAPS	FUSE	REMARKS
TOTAL USED							
BALANCE							

Replied

M.1/231/79

SAMPLE

1979-02-14

The Manager,
General Crude Oil Co.,
Woodbourne,
ST. PHILIP.

Dear Sir:

Proposed Route for 16" ϕ Water Main from
Hampton Pumping Station to Rising Sun Reservoir

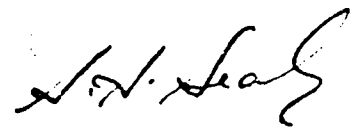
This Department will within the next two weeks or so
be commencing work on the laying of/abovementioned main. /the

In an attempt to avoid traffic congestion along
Highway 6 (especially during the crop season), we propose
to route part of this main through certain cart roads of
Woodbourne Plantation. (See attached sketch)

I would be grateful if you would indicate on the
sketch any existing mains, cables or any proposals which
you have for the area.

I await an early reply and look forward to your
co-operation.

Yours faithfully,



Chief Engineer,
Waterworks Department.

SL:gh

WATERWORKS DEPARTMENT,
Pine,
St. Michael.
1979-04-12.

SAMPLE

Dear Sir/Madam:

Proposed Route for 16" Ø Water Main from
Hampton Pumping Station to Rising Sun Reservoir

This Department will within the next few weeks, be commencing work on the laying of the abovementioned water main.

We have chosen a route for this main and part of it falls on lands believed to be owned by you.

We are requesting your permission to lay part of this main along your property, at a distance of approximately 6ft. (1.8m) from the edge of the main road.

Your co-operation would be appreciated and I shall be grateful if you would sign your name at the bottom of this letter, indicating your approval or disapproval, and return it to this Department as soon as possible.

Yours faithfully,
H.A. Sealy
H.A. SEALY
Chief Engineer,
Waterworks Department.

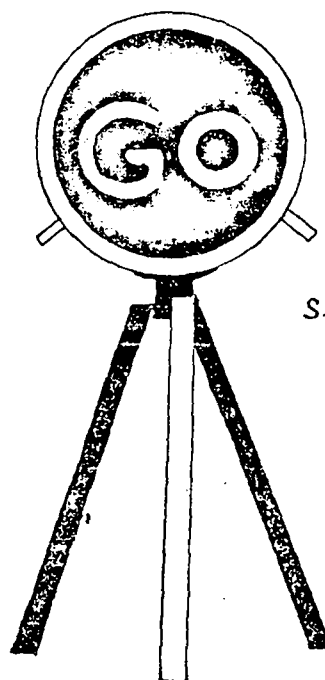
I.....will/will not
allow the Waterworks Department to lay a water main along
my property.

Signature:.....

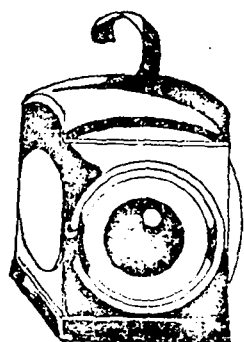
TYPICAL ROAD SIGNS, LAMP & BARRIER



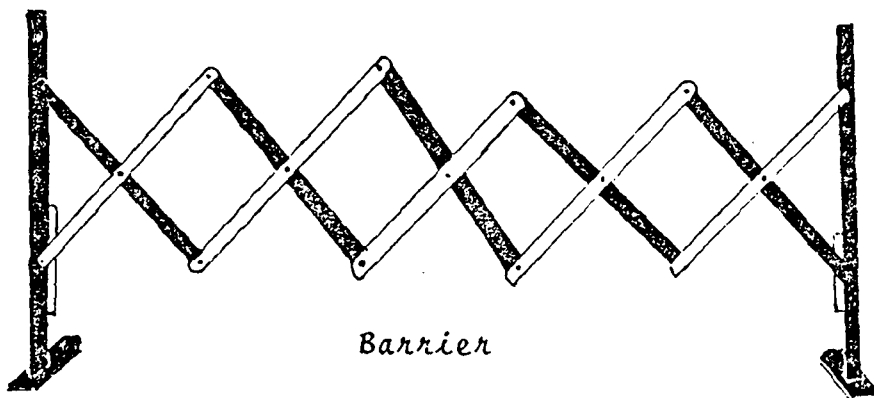
Warning
sign



Signal

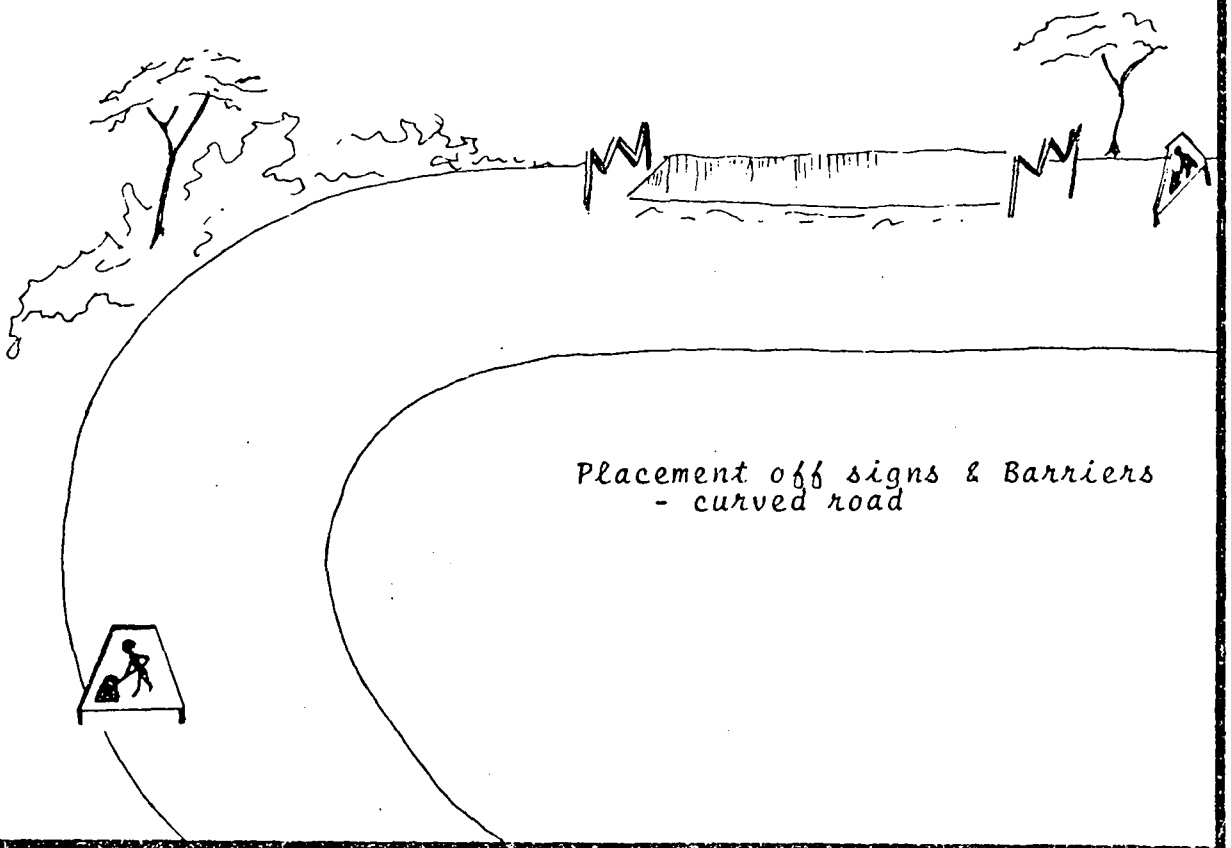
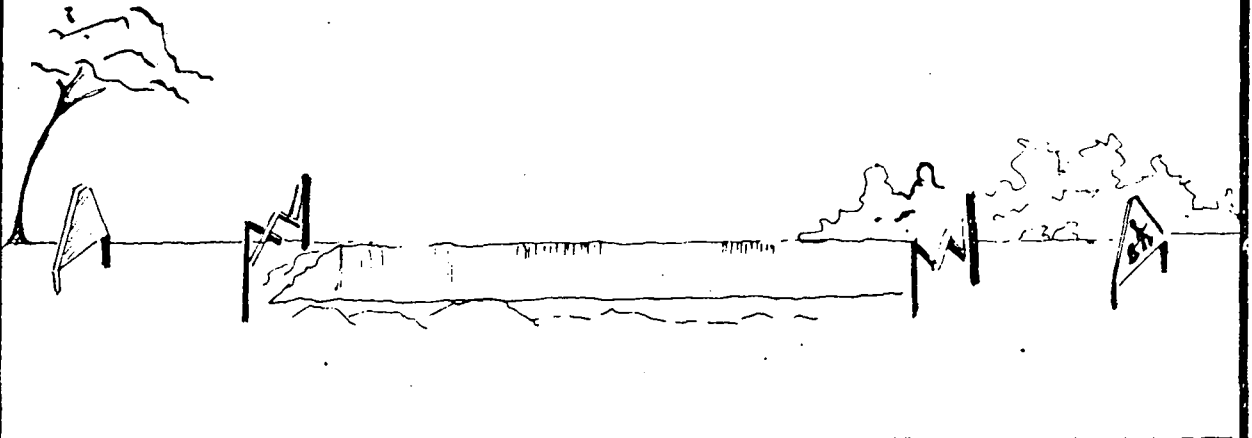


Lamp



Barrier

PLACEMENT OF SIGNS & BARRIERS - STRAIGHT ROAD



Placement of Road Barriers and Warning Signs

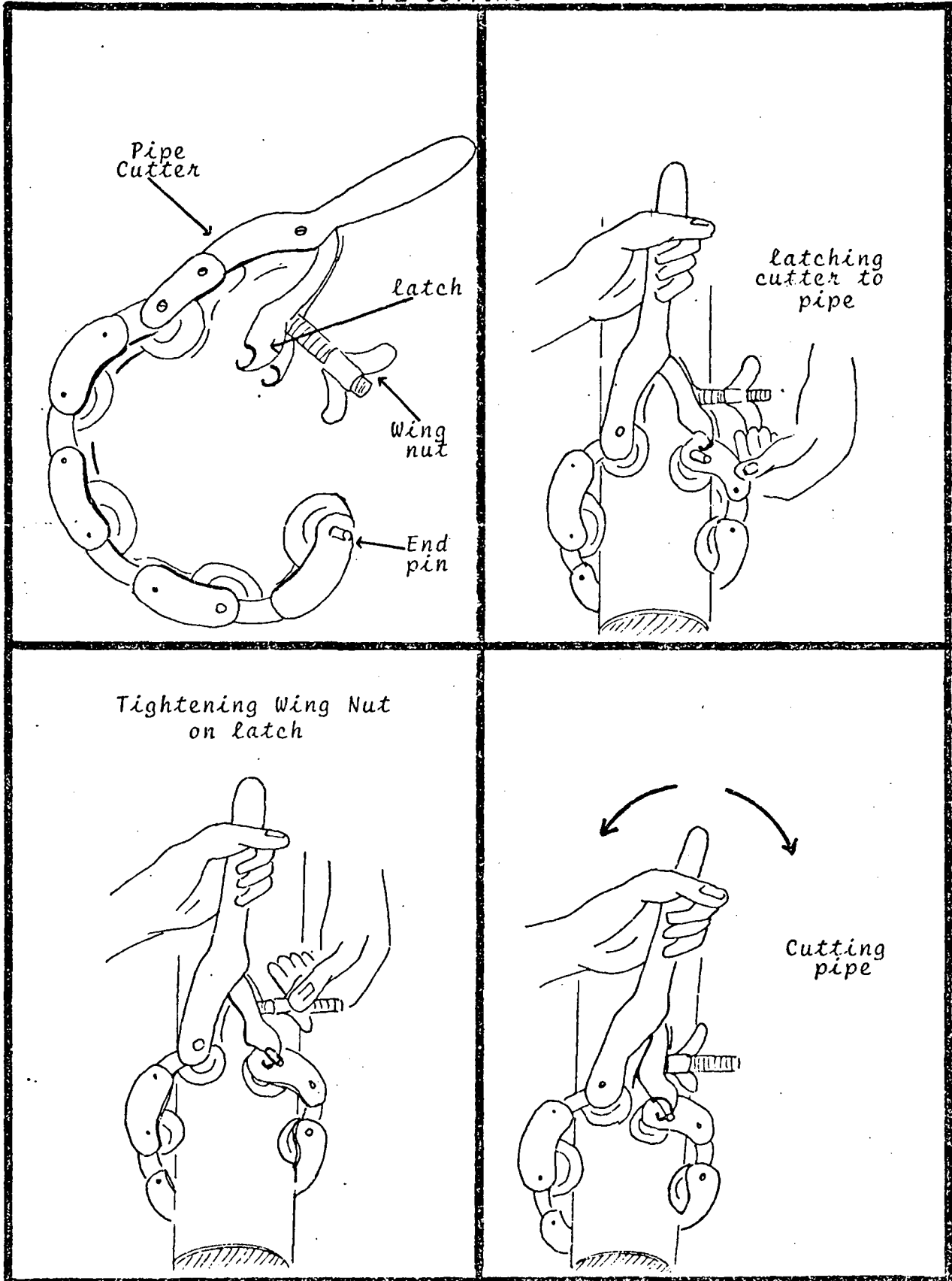
1. Road barriers should be placed at both ends of the open track.
2. Warning signs should be posted at each barricade. They should also be placed at least 25 ft before each barricade.
3. If an open track is hidden by a curve, a warning sign should be placed before the curve.
4. On heavily travelled roads, it may be advisable to use flag men.
5. Lighted red lanterns or wickers should be used during the night time. They should be placed on the warning signs. They should remain lighted until daylight.
6. A watchman should be assigned to the job site each night to watch the equipment and materials, and make sure the lanterns or wickers are lighted and remain lighted until daylight. Other duties of the watchman include checking washed out pipe tracks; setting up barriers to these washed out tracks; noting the time of accidents and the vehicles numbers and immediately reporting information to the Department.

BLASTING

WARNING: BLASTING SHOULD ONLY BE PERFORMED BY AUTHORIZED PERSONNEL. A SUMMARY OF THE MAJOR STEPS IS LISTED BELOW. THIS ANNEX IS NOT INTENDED TO TRAIN PERSONNEL ON HOW TO USE EXPLOSIVES.

1. Use a rotary drill to drill holes. You need to know the proper depth, placement and size of holes.
2. Prepare the dynamite. Sound preliminary warning with whistle.
3. Insert prepared dynamite into holes.
4. Before exploding dynamite, sound warning whistle and stop traffic at least 100 feet from the area.
5. If you are setting off more than one charge, count the number of explosions.
6. After all explosions, whistle "all clear."
7. Inspect blasted area to see if the rock has been satisfactorily cracked or blown away.

PIPE CUTTING

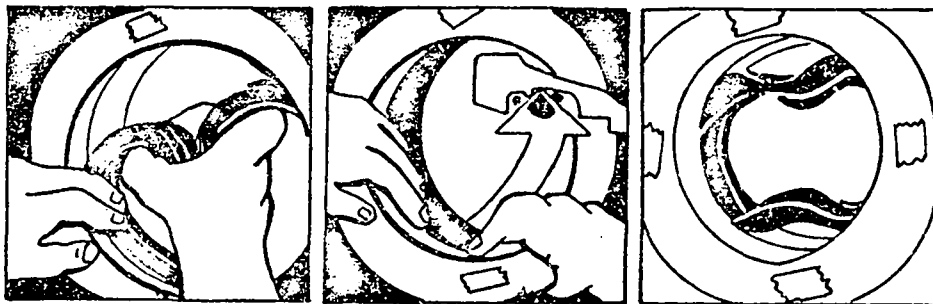


Pipe Cutting

1. Measure pipe and use chalk or crayon to mark the desired length.
2. Clamp pipe and attach pipe cutter.
Fasten the cutter by latching end link over the end of the latch. Tighten the wing nut at the top of the latch.
3. Rock cutter to and fro making sure that each knife meets or passes over groove of other knife. Continue to tighten the wing nut as the cutter becomes slack.
Continue until pipe is completely cut.
4. Slacken wing nut, unlatch and lift off cutter.
5. Use a file to taper the ends of the cut.
Taper off to an angle of 60° .

TYTON JOINING PROCEDURES

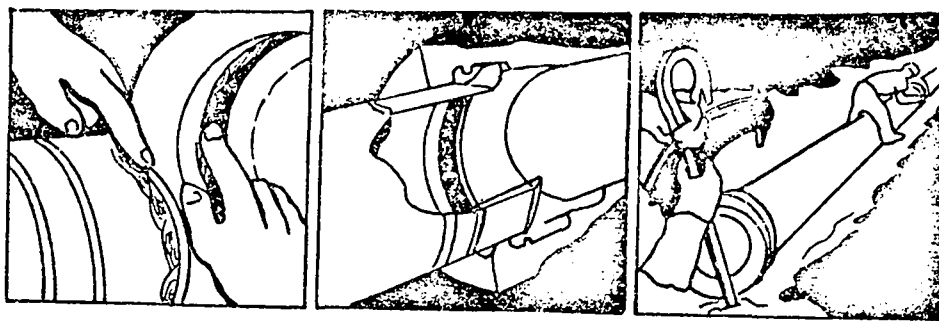
Inspect both ends of pipe (socket and spigot) to make sure there are no obstructions, debris, dents or splits. Be sure there is nothing which will damage the rubber gasket. Clean ends if necessary.



Bend rubber gasket into "U" shape.

Insert lip of gasket into groove in socket.

Press it in securely, making sure there are no buckles.

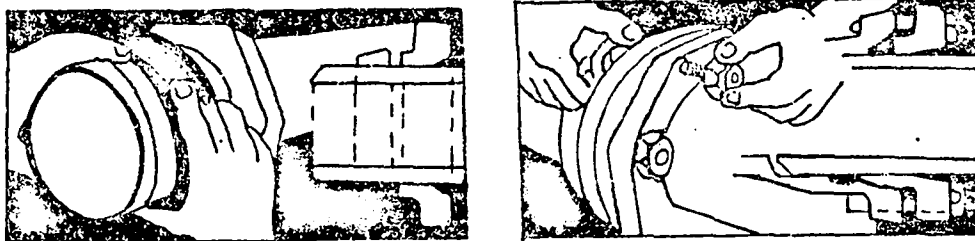


Lubricate the gasket after it is in the groove. Lubricate the gasket after it is in the groove. Also lubricate about 1" of the spigot end of the pipe.

Enter spigot end into socket of pipe.

Place tip of crowbar firmly in the earth at the socket end of the inserted pipe. Push pipe until spigot comes in contact with "inside back" of the socket.

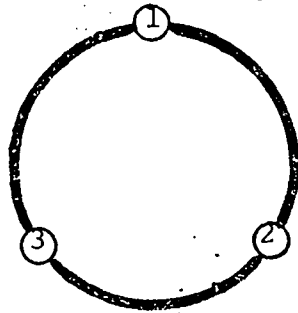
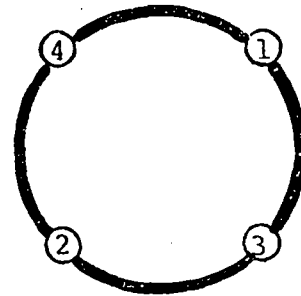
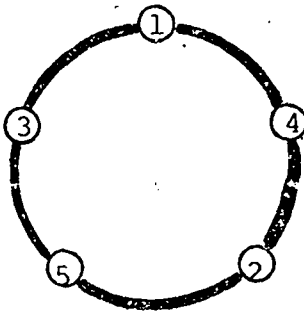
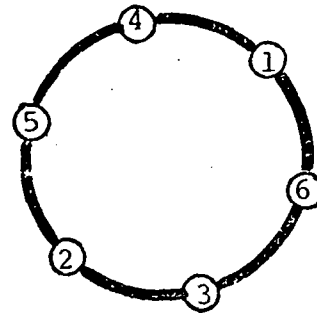
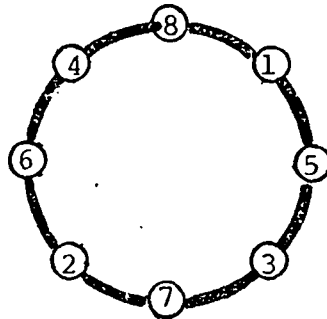
MECHANICAL JOINTING PROCEDURE



Mechanical Joining Procedure

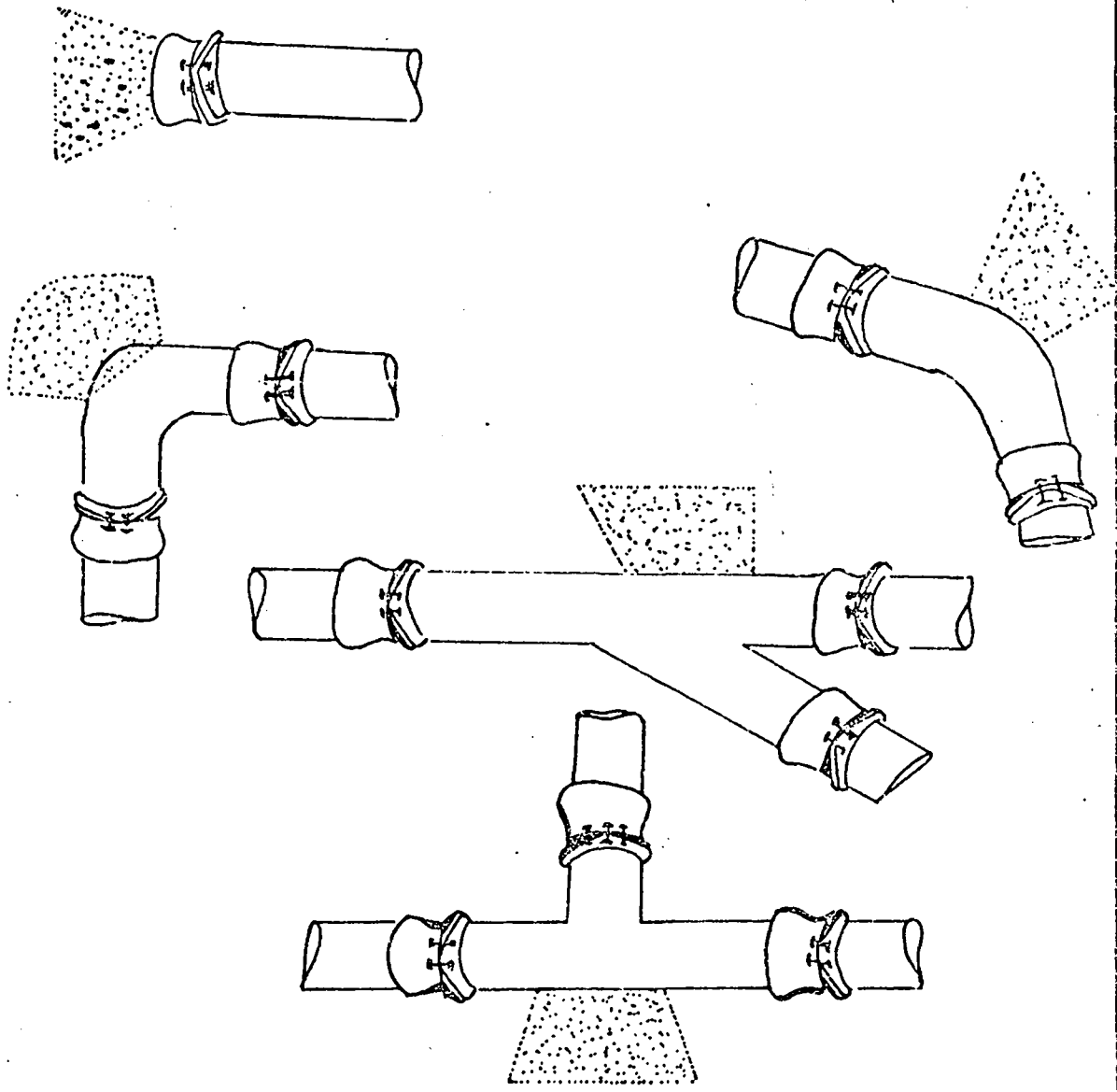
1. Inspect both ends of pipe to make sure there are no obstructions, debris, dents or splits. Be sure there is nothing which will damage the rubber gasket. Clean ends if necessary.
2. Place gasket over spigot end. The tapered end should face the spigot end of the pipe.
3. Put ends of pipe together. Bring flanges together and insert "T" shaped bolts.
4. Tighten each nut one half turn starting on the top sides and bottom until tight. See bolt tightening sequence - Annex 11.

BOLT TIGHTENING SEQUENCE

3 BOLTS4 BOLTS5 BOLTS6 BOLTS8 BOLTS

IT IS IMPERATIVE THAT SUCH SEQUENCES ARE ADHERED TO SO AS TO MINIMIZE, IF NOT STOP, CRACKING OR BREAKING OF GLANDS BY UNEVEN PRESSURES APPLIED TO THE GASKETS AND GLANDS.

TYPICAL THRUST BLOCK DETAILS



Pressure Testing

1. After the dirt and debris has been washed out, the main should be sealed off. All air relief valves must be left open.
2. Slowly fill the main. All air in the main will be expelled through the air relief valve.
3. Watch the pressure build on the pressure gauge.
4. Turn off pump after the pressure reaches 50 - 100 ft above the working pressure of the particular area.
5. By watching the pressure gauge you can determine if there are leaks.
6. The main is considered to have no leaks if it holds same pressure for 24 hours.

Disinfection of Mains

The following material is copied from the World Health Organisation "Guide to Sanitation in Natural Disasters" by M. Assar 1971, pages 121 - 124.

When a section of a water main is laid or repaired it is impossible to avoid contaminating the inner surface with the dirt, mud or water in the trench while the pipes are being fixed into place. Contamination may also occur by accident, negligence or malice; adequate surveillance during non-working hours and the plugging of open ends after the day's work will reduce these risks. It should be assumed, however, that the pipe is contaminated despite all the precautions taken to prevent the entry of foreign matter. Consequently, the main must be disinfected before it is put into service.

To obtain good results from disinfection and to avoid the hazards of subsequent obstructions and damage to valves, all foreign objects should be removed beforehand by swabbing and flushing clean the pipeline. Packing and jointing materials should also be cleaned and disinfected immediately before use by immersion in a 50-ppm chlorine solution for at least 30 minutes.

Flushing of the section of the water can be combined with the hydrostatic pressure test for detecting faulty joints and leaks. Once this test is completed the pipeline should be flushed at a water velocity of at least 0.75 m per second. The presence of hydrants air valves, gate valves and other openings in or near the section to be disinfected facilitates the injection and extraction of water for flushing and disinfection.

Recently developed plastic foam swabs are useful in the disinfection of mains. As they are displaced by the water pressure, these swabs wipe clean the inner surface of the pipe; they can also isolate the section to be disinfected from the rest of the main and prevent the loss of the disinfecting solution.

1....

Chlorine compounds such as those described on pages 40 and 46 are the most commonly used for disinfecting water mains. The strength of the disinfecting solution should be much higher than that normally used for water chlorination. Under normal conditions, a strength of 10 ppm is recommended when the chlorine remains in the main for a period of 12-24 hours; application for 24 hours is necessary when the chlorine has to penetrate through organic matter coating the inner surface. In emergencies, when it is not possible to leave a section of the main out of service for a long time, the period of contact can be shortened by proportionately increasing the strength of the solution; thus, for a contact period of 1 hour the strength of the solution should vary between 120 and 240 ppm.

When strong solutions are used, particular attention should be paid to their thorough removal from the main after completion of disinfection; illness and discomfort may result from using highly chlorinated water, and the corrosive action of the chlorine may damage pipes, valves, hydrants and household plumbing and fixtures.

Procedures for application

Chlorine gas may be injected directly into the section of the main by a dry-feed chlorinator supplied with a special gas diffuser or silver tube and attached to a hydrant or other opening by means of a special plug valve. After the section has been thoroughly flushed, the intake valve is partly shut to bring the water pressure below 1.7 kg/cm^2 (25 lb/in^2). At the hydrant or opening where the water is discharged the flow rate is measured to determine the rate at which chlorine gas needs to be delivered. To obtain a concentration of 10 ppm in the section to be disinfected, the chlorine gas input rate should be 0.9 kg/24 h for every litre per second of flow (0.12 lb/24 h for every US gal/min or 0.14 lb/24 h for every UK gal/min). The valve of the chlorine cylinder is opened and adjusted so that the dial shows the required rate of chlorine flow.

As soon as the odour of chlorine is detected in the water discharged from the main, water samples are taken to determine the chlorine content. The drop-dilution method is suitable for high concentrations of residual chlorine; if the orthotolidine method is used, a deep red colour should be produced in the sample when the reagent is added.

When the desired chlorine content is reached, the discharge hydrant is shut and the appropriate valves are turned to stop the flow of water and chlorine gas. The water so treated is allowed to stand in the main for 12-24 hours, after which the main should be thoroughly flushed until the water is clear and has no odour of chlorine.

A similar procedure is used for feeding a mixture of chlorine gas and water by means of a solution-feed chlorinator; a special rubber hose should be added to the plug valve and the silver-tube diffuser. A booster pump may be required to provide a pressure at least three times higher than that in the main, in order to ensure satisfactory injection of the solution.

When calcium hypochlorite or chlorinated lime is used for disinfecting a section of a main, the easiest method of application is to inject a strong chlorine solution by means of a portable chlorinator. If the intake valve is kept partly open, a small flow of water can enter the pipe to assist in the dispersion of the chemical. The discharge or valve is shut off when the odour of chlorine is detected in the water flowing out, and the section of the main is allowed to fill. The intake valve is regulated so that the required amount of disinfecting solution is injected before the pipe is completely full.

When there is no chlorinator or pump to inject the disinfecting solution, the intake valve is shut off after the flushing operation, and the section is allowed to drain dry; then the discharge hydrant or valve is shut off, thus leaving the section to be disinfected isolated from the rest of the main. The disinfecting solution is slowly poured through a funnel or hose into an intermediate hydrant, valve or opening made for this purpose, until the section is completely filled. Precautions should be taken to allow air trapped in the pipe to escape; where there is no air valve or other orifice by which the air can be released, one or more connexions could be detached or a hole could be drilled in the top of the pipe.

If the section to be disinfected is short, weighed quantities of calcium hypochlorite or chlorinated lime in powder form may be placed at regular intervals inside the pipes while they are fixed into place; when water is introduced later, the powder will mix with it and produce strong concentrations of chlorine.

The disadvantage is that the powder will be flushed to the far end of the section even when the water is admitted slowly, and no uniform distribution of the disinfectant is possible.

While the disinfecting solution remains in the pipes, the valves and hydrants in that section of the main should be operated to ensure that all surfaces come into contact with the disinfectant. The valves at either end of the treated section should remain shut during the whole period of contact to prevent the loss of disinfecting solution.

At the end of the contact period, samples of the disinfecting solution should be taken to check that the chlorine content has remained at the prescribed strength. The section should then be thoroughly flushed to remove the disinfecting solution. Samples for bacteriological tests should be taken every day during the 3 days following disinfection to ascertain that the operation was successful.

To ensure that the chlorine concentration remains at 10 ppm throughout the period of contact, the original strength of the solution should be at least twice as high (20 ppm). The following table shows the amount of disinfectants required for pipes of various diameters in order to provide a chlorine concentration of about 20 ppm.

The volume in litres of the disinfecting solution required for 100 m of pipe can be expressed by $V_1 = 5.07 d^2$, where d is the diameter of the pipe in inches.

The volume in US gallons of the disinfecting solution required for 100 yd of pipe can be expressed by $V_2 = 1.22 d^2$, where d is the diameter of the pipe in inches.

SANITATION IN NATURAL DISASTERS

QUANTITY OF DISINFECTANTS REQUIRED TO PROVIDE
A CONCENTRATION OF 20 ppm

Diameter of pipe		Chlorinated lime (25 % available chlorine)		Calcium hypochlorite (70 % available chlorine)		Sodium hypochlorite (5 % available chlorine)	
mm	in	g per 100 m	oz per 100 yd	g per 100 m	oz per 100 yd	litres per 100 m	US gal per 100 yd
75	3	37	1.2	13	0.4	0.18	0.05
100	4	65	2.1	23	0.7	0.33	0.08
150	6	146	4.8	53	1.7	0.73	0.18
200	8	260	8.4	92	3.0	1.30	0.31
250	10	405	13.4	145	4.7	2.03	0.49
300	12	584	19.2	210	6.8	2.92	0.66
400	16	1040	33.6	368	11.8	5.20	1.27