Islamic Republic of Pakistan
Government of Azad Jammu & Kashmir

Local Government & Rural Development Department

Rural Water Supply & Sanitation Project

DESIGN MANUAL

(ENM1)

VOLUME - 2

MARCH 1995

BINNIE, HUNTING, TECHRED JOINT VENTURE
TECHNICAL ADVISORY UNIT

DESIGN MANUAL (ENM 1)

CONTENTS

VOLUME - 1

LIST OF ANNEXURES

DESIGN MANUAL (ENM 1)

CONTENTS

VOLUME - 2

LIST OF ANNEXURES

Chapter 10

OPTIMISED DESIGN OF PIPELINES UNDER GRAVITY

CHAPTER 10

OPTIMISED DESIGN OF PIPELINES UNDER GRAVITY

CONTENTS

CHAPTER 10

OPTIMISED DESIGN OF PIPELINES UNDER GRAVITY

1 INTRODUCTION

Purpose and Scope

1.1 The purpose of this chapter is to give the reader guidance in how to design the pipelines of water systems which flows under gravity. The theoretical principles are discussed as it is important to understand the philosophy of design. Practical instruction is set out in hydraulic design and the use of computer aided design (CAD) programmes, called BRANCH and LOOP to undertake such work.

Definition

1.2 The "transmission main" is the pipeline connecting the source and the first service reservoir on the distribution system. The "distribution system is the network of pipes transporting or reticulating the water safely from the transmission main or service reservoir to different places of storage and consumption, such as reservoirs and standposts.

2 BASIC HYDRAULIC PRINCIPLES FOR GRAVITY FLOW

Energy

2.1 Before going into the details of design for pipelines flowing under gravity within a transmission main or distribution system, it is important to review the basic hydraulic principles which govern the behaviour of flow under gravity systems. Thorough understanding on hydraulic concepts is required to enable the engineer to produce sound design for water systems.

2.2 To move water either uphill or downhill, energy is required. In a water system under gravity, the source of energy which is responsible to move water is the gravitational potential of the water itself.

2.3 The amount of gravitational potential energy can be determined by the relative elevations at any point in the system. At all locations on any pipeline in the ground, there is a specific quantity of gravitational potential energy available to move water.

2.4 As the water flows through pipes and fittings some of the energy is lost as it is converted into heat by friction. Due to the change in the topographic profile of a pipeline there may be some points with low energy (low pressure) at higher elevations or high energy (high pressures) at lower elevation.

2.5 A properly designed system should either conserve energy sufficiently enough to overcome all the frictional losses resulting from moving the desired flow through the system, or to dissipate excessive energy available in order to reduce unwanted higher pressure at the terminal points. Proper design is carried out by careful selection both of the pipe sizes and of the locations of reservoirs break pressure tanks (BPT) and tapstands.

Head

2.6 The term "Head" is the most convenient measure of the energy required to move water. Fresh water weighs 1 gm/cm^3. A water column with a cross sectional area of 1 cm^2 of 10 m high (=1000 cm) would weigh 1000 gms or 1 kg, where as the pressure exerted by this water at the base of this column will be:

$$\text{Pressure at base} = \frac{1}{1} \frac{Kg}{cm^2} = 1\ Kg/cm^2$$

2.7 Similarly the same water column at 20 m high would weigh 2 kg and exert the pressure of $2kg/cm^2$. In hydraulic work, rather than repeatedly calculating the water pressure, it is common practice to simply report the equivalent height of water column, known as the "HEAD", which represents the amount of gravitational potential energy.

Fluid Statics

2.8 In a pipeline system containing water which is not flowing, the system is termed as being in "static equilibrium". In such a system the level of the water surface in the tank above the pipeline is called the "static level". The pressure at points throughout the system is reported as "Static Head", which is the difference in elevation between the static level and any single point on the pipeline. Static pressure is exerted in the pipeline or at a tapstand when the system is in static equilibrium.

2.9 It is useful to visualise that if vertical small pipes/tubes were to be fixed in the main, the water level in each pipe would rise exactly to the same static water level in the tank. This is because no water is flowing, and thus there is no loss of energy due to friction. Hence the "static level" is perfectly horizontal (see attached Fig. 10.1)

2.10 It is particularly important for design engineers to understand the concept of static pressure in the design of water systems. As explained above any system under static equilibrium has static pressures exerted on fittings, on the inlets of reservoirs, BPT and on the bibcocks at tapstands.

2.11 The specials installed on the system for control and regulation of flow such as angular float valves at reservoirs and BPT, bibcocks at tapstands and air valves on pipelines must be capable of withholding the exerted static pressures on them, when the system is in static equilibrium, such as at night when there is no flow. The maximum pressure rating for an angular float valve which is installed on tank inlets, is typically 100 m (140 psi) and for regular bibcock is 40 m (60 psi) and for high rated pressure bibcock is 210 m (300 psi). Air valves are also typically 100 m and Pe pipe is commonly rated for 10 bar (100 m) working pressure.

2.12 In order to keep within the maximum working pressure rating of float valves and bibcocks, it is necessary to break the static pressure by providing a BPT or reservoir on a distribution system when exceeding 100 m static head. It is also necessary to provide proper rated pressure bibcocks which are exposed to higher static pressures. Any standpost which has a static pressure greater than 40 m must be fitted with a high rated bibcocks (to 300 psi).

Fluid Dynamics (Water in Motion)

2.13 Further to paragraph 2.9 above, if the water is now allowed to flow in the pipeline system which was at static equilibrium, the water level in each vertical tube will fall down and adjust to a new level. The new water levels will remain constant/steady for as long as the flow in the system is steady. These the system is said to be in "dynamic equilibrium" as shown in Fig 10.2. A line linking the water levels in each tube and the level in the tank(s), is called "HYDRAULIC GRADE LINE" (HGL)

Hydraulic Grade Line

2.14 The HGL represents the new energy levels at each point along the pipeline. The vertical distance between the pipeline and the hydraulic grade line is the pressure head. The static head divided by the length of the pipeline gives the available slope of the hydraulic grade line.

2.15 The difference between the HGL and static level is the amount of head (energy head) which is lost due to friction caused by the flow. Since frictional losses are never recovered the HGL always slopes down along the direction of the flow. The steepness of the slope represents the rate at which energy is lost due to friction. For further details refer to section titled "Residual Head" in this chapter.

Friction

2.16 As water flows through the pipeline energy is lost due to the friction of the flow against the pipe walls and through the fittings. Any obstruction to flow causes frictional losses.

2.17 The major factor influencing the loss of potential energy due to friction is a combination of roughness and velocity of the flow for a given volume. The roughness is expressed as a constant in hydraulic equations which is determined according to both experience and knowledge of the pipe or channel material. The value of the roughness coefficient "C" i.e (Hazen Williams constant) for good condition GI pipe is 120. This is lower than the "C" valve for polyethylene (Pe) pipe (typically 150), as Pe is smoother surfaces and therefore there is less friction than in GI pipe. Thus if a designer makes a change of pipe material to one of less roughness such as replacing GI by Pe, than losses will be reduced and residual head will increase.

2.18 For a given pipe diameter, material and head, it is the amount of flow through a pipe which determines the flow velocity. The greater the flow, the faster the velocity, and the higher will be the frictional losses. It is important to understand that frictional losses are not linear. If the flow is doubled then the losses will increase by more than double.

2.19 The method of reporting the head loss is by unit length of pipe. Typically this is expressed as m of head per m length of pipe (m/m), m/100 m length of pipe (ie as %) or as m/km length of pipe (m/km).

Residual Head

2.20 Residual head is the amount of energy remaining in the system when the desired flow has reached a particular discharge point. This remaining gravitational energy is defined as the vertical distance between the HGL and the level of the pipe/standpost (see attached Fig 10.3a).

2.21 If the HGL falls below the level of pipeline at any point or standpost, then the residual head is termed as "Negative Residual Head" (see attached Fig. 10.3b). This indicates that there is not sufficient gravitational energy to move the desired quantity of water in such section.

2.22 The HGL must not fall below the pipeline profile and it is always required to have a minimum of 5 m positive residual head throughout the pipeline. Negative pressure in the pipeline means that the air, water or other potential polluting fluids may be sucked into the pipeline. Polluted water may thus enter the pipeline via leaky joints. Negative pressures can also cause problems with dissolved air in the water. Such air may come out of solution and may form pockets of air at high points in the pipeline, which can obstruct flow.

Limits of Residual Head

2.23 With regard to the design criteria (see chapter 6) the residual pressure at discharge points is ranged from 5 m, which is the absolute minimum, to 30 m which is the absolute maximum. All standposts must be designed within these limits. Residual pressures at standposts can be adjusted by careful location of the spots at lower/higher elevations as required, or by providing a BPT when pressures are excessive. The maximum pressure limit of 30 m can only be relaxed up to 40 m, if there is unavoidably a single standpost in the system with a residual pressure between 30 and 40 m.

Velocity Limits

2.24 As explained above the flow velocity through a pipeline causes friction losses. Frictional losses are higher for higher velocity and lower for low velocity. At low velocity suspended particles present in the water may settle out of flow and collect at low points in the pipeline to clog it. Low velocities are also indicative of uneconomic diameters, hence the velocity limits should be checked carefully in the system designed.

2.25 Moreover low velocities indicate that the HGL is likely to be critically close to the ground surface. It is necessary that HGL and pipe profile for all pipelines with a velocity less than 0.75 m/sec should be examined following physical site survey/inspection, with particular care to guard against the existence of negative pressures. Check must be made to confirm that the HGL is always at least 5 m above the ground level.

2.26 With reference to the design criteria (see chapter 6), the range for the minimum and maximum velocity limits as set for any system, is 0.3 m/sec to 3 m/sec respectively. Any pipes in system which are outside these limits need the necessary attention of the designer for revision of the design.

2.27 A computer spread sheet is designed to facilitate the checking of velocities in the designed system (see annexure 10.1). The shaded portion of the sheet is the information input area only. Spread sheet is calculated by the computer itself under velocity status column with the remarks indicating the pipes with "Too High", "Ok" "Low" and "Too Low" velocity.

3 DESIGN METHOD FOR PIPELINES UNDER GRAVITY

General

3.1 The hydraulic design is made much easier with the aid of a computer. Suitable programmes have been developed which make repetitive calculations (iterations) of a set of diameters until the most economic diameters are determined to, fit given criteria. Thus the total cost of the transmission main and distribution network can be minimized (optimised) subject to meeting the design constraints imposed such as head loss and pressure limits.

3.2 The reminder of this chapter relates to the use of two CAD programmes, BRANCH and LOOP.

Design Method for Pipelines Under Gravity

a) Input Information

3.3 The information required as input into the computer, which is to be determined by the design engineer, is as follows:

(i) **Flow in l/sec:** Flow in l/sec is calculated for the design of transmission main according to the design criteria (see chapter 6). A calculation example showing how to assess the flow in l/sec for the design of transmission main is also attached as annexure 10.2. However in case of distribution mains the flow at each standpost is taken as 0.151 litre/sec.

(ii) **Pipe Nos and Node Nos:** Pipe and node numbers from the pipe layout plan must be noted down according to the design sequence on the data input sheet for computer input and subsequent calculations.

(iii) **Pipe Length in Meters:** Pipe lengths must be in m and noted down on the data input sheet for the computer input.

(iv) **Elevation in Meters:** Elevations of all node numbers in m should be taken carefully from the pipe layout plan on the data input sheet for computer input.

(v) **Hazen William Constant "C":** The constant for pipe friction depends upon the pipe material. The value of C is taken as 120 for good quality GI pipe and 150 for Pe pipe.

(vi) **Minimum and Maximum Head Loss Limits (m/km):** It is advised to start the analysis using values of 1 and 200 for the minimum and maximum head loss (m/km) respectively and subsequently follow the instruction given by the programme it self. The minimum & maximum values in the programmes are the given limits for the programme to design all the pipes in the system. The maximum/minimum limit can be increased/decreased further depending upon the instructions given by the computer, but this will require particularly careful check on velocities in the system. As bigger pipe diameter are selected, the velocities in the system will decrease.

Design Method for Pipelines Under Gravity

a) Input Information

3.3 The information required as input into the computer, which is to be determined by the design engineer, is as follows:

(i) **Flow in l/sec:** Flow in l/sec is calculated for the design of transmission main according to the design criteria (see chapter 6). A calculation example showing how to assess the flow in l/sec for the design of transmission main is also attached as annexure 10.2. However in case of distribution mains the flow at each standpost is taken as 0.151 litre/sec.

(ii) **Pipe Nos and Node Nos:** Pipe and node numbers from the pipe layout plan must be noted down according to the design sequence on the data input sheet for computer input and subsequent calculations.

(iii) **Pipe Length in Meters:** Pipe lengths must be in m and noted down on the data input sheet for the computer input.

(iv) **Elevation in Meters:** Elevations of all node numbers in m should be taken carefully from the pipe layout plan on the data input sheet for computer input.

(v) **Hazen William Constant "C":** The constant for pipe friction depends upon the pipe material. The value of C is taken as 120 for good quality GI pipe and 150 for Pe pipe.

(vi) **Minimum and Maximum Head Loss Limits (m/km):** It is advised to start the analysis using values of 1 and 200 for the minimum and maximum head loss (m/km) respectively and subsequently follow the instruction given by the programme it self. The minimum & maximum values in the programmes are the given limits for the programme to design all the pipes in the system. The maximum/minimum limit can be increased/decreased further depending upon the instructions given by the computer, but this will require particularly careful check on velocities in the system. As bigger pipe diameter are selected, the velocities in the system will decrease.

(vii) **Residual Head:** In keeping with the design criteria (see chapter 6), the minimum desirable limit for residual head is 10 m with the absolute minimum of 5 m. It is advised to start the design with a residual head of 10 m until and unless it is unavoidable to in put for 5 m.

(viii) **Reference Grade:** This is the elevation of the reference node from where the HGL is to start.

(ix) **Peak Factor:** For standpost systems in AJK where flows are set at 2 gm (0.151 l/see) which is an adequate rate to fill portable containers, there is no peak factor , which is thus set at 1.

(x) **Set of Actual Internal Pipe Diameters:** A set of actual pipe diameter is required as input to the computer with their cost rate / m for trial and generation of the cost optimized design. Tables 10.1 and 10.2 below represent selected specifications for nominal and actual internal pipe diameters and weights for medium duty GI and Pe pipes respectively. It is important that cost rate for the pipes must be current and valid for the scheme under design.

SELECTED SPECIFICATIONS FOR MEDIUM DUTY GI PIPE		
Nominal Dia (mm)	**Actual Min. Internal Dia (mm)**	**Weight (Kg/m)**
15	15.80	1.22
20	21.30	1.58
25	26.90	2.44
32	35.60	3.14
40	41.50	3.61
50	52.50	5.10
65	68.10	6.51
80	80.10	8.47
100	104.30	12.10

Table 10.1:Selected Specification for M.D G.I Pipe (Adapted from BSS 1387)

SELECTED SPECIFICATIONS FOR Pe PIPE		
Nominal Dia (mm)	**Average Internal Dia (mm)**	**Weight (Kg/m) (10 bar pipe)**
20	15.9	0.12
25	20.2	0.17
32	25.7	0.27
40	32.6	0.43
63	50.9	1.04
90	72.9	2.10
110	90.0	3.00
125	101.2	4.04

Table 10.2:Selected Specification for Pe Pipe (Adapted from Dadex Catalogue)

b) Calculation Procedure

3.4 In order to calculate the friction losses, the BRANCH programme will take one pipe diameter from the set of diameters given to the computer and calculate the head loss in the system by using Hazen Williams equation as under:

$$S = H/L = 10.667 \times C^{-1.85} \times D^{-4.87} \times Q^{1.85} \quad \ldots. \quad 10.1$$

Where H = Head Loss in m/m
L = Length of pipe in m
C = Hazen William constant
D = Diameter pipe in m
Q = Flow in m^3 /s

3.5 The calculated head loss for the pipe will be checked automatically against the limits of maximum and minimum head loss criteria, along with the minimum residual pressure criteria.

c) Calculation of HGL and Pressure

3.6 After calculating the head loss in a pipe length, the HGL and relative pressures along the pipeline can be determined by using equation no 10.2 and 10.3 as under and shown in attached Fig. 10.4.

$$HGL = Elevation_{at\ A} - Head\ Loss_{pipe\ 0B} \quad \ldots \quad 10.2$$

$$Pressure_{at\ B} = HGL - Elevation_{at\ B} \quad \ldots \quad 10.3$$

3.7 The method to calculate the head loss, HGL and the static and residual pressures in a pipeline is thus explained. The computer repeats the calculation for different lengths and diameters of pipes with several combinations to arrive at the optimized or lowest cost subject to the given design parameters.

3.8 Sample designs using "BRANCH" of a transmission main and of a distribution system along with input data sheets are attached as Annexure 10.3 & 10.4 respectively.

Distribution Network

3.9 The same procedure is adopted for the hydraulic design of the whole distribution network. The computer can deal with all the pipes in a network from a tank simultaneously to determine the most economic network.

Loop

3.10 Loop programm simulates the hydraulic characteristics of a looped (closed circuit) water distribution network which are common in urban areas. Loop can also be used when designing the rehabilitation and extension of an existing system.

3.11 The method for calculation of head loss, HGL and pressures are the same as applied in the BRANCH programm, but Loop has an additional quality of calculating the velocity of flow of in the pipe.

3.12 The merit of this process is that it is capable of <u>hydraulic</u> optimisation of the network but with a demerit that the network is not necessarily <u>cost</u> optimised.

ANNEXURES

ANNEXURE 10.1

Calculation for Velocity Check In Each Pipe

Scheme Name: Sample Nespak No: 123 Dated: 17-2-95
Village Name: Sample Village No: 4567 Cal. By: A.E
District: Markaz:

Pipe No	Flow lps	Diam mm	Velocity m/sec	Velocity ft/sec	Velocity Status
1	0.600	15	3.40	11.14	TOO HIGH
2	0.500	15	2.83	9.28	OK
3	0.450	32	0.56	1.84	LOW
4	0.151	32	0.19	0.62	TOO LOW

ANNEXURE 10.2

Design for Transmission Main Flowing Under Gravity

The following is abstracted from design criteria:

1 If minimum measured yield of source is less than 30% of the total daily design demand then the scheme is unviable, ie:
Min yield < 0.3 x Demand = unviable scheme

2 If twice the total daily design demand is greater than maximum measured yield of source, then design the transmission main (TM) on maximum yield, ie:
2 x Demand > Max. yield = design TM on max. yield

3 If twice the total daily design demand is less than the maximum measured yield of source, then design the transmission main on twice the daily demand, ie:
2 x Demand < Max. yield = design TM on 2 x Demand

EXAMPLE: Assume the following Spring Flow Measurements:

25 April	8,000 gpd	
5 June	6,000 gpd	
5 August	10,000 gpd	(maximum available yield)
5 September	8,000 god	
6 November	5,000 gpd	
4 December	**4,000 gpd**	**(minimum available yield)**

How to design the Transmission Main:

SNo.	Demand	Decision	Design of Tr.Main
1.	1000 gpd	Criteria 3 applies.	2000 gpd
2.	2000 gpd	Criteria 3 applies	4000 gpd
3.	3000 gpd	Criteria 3 applies	6000 gpd
3.	4000 gpd	Criteria 3 applies	8000 gpd
4.	6000 gpd	Criteria 2 applies	10000 gpd
5.	8000 gpd	Criteria 2 applies	10000 gpd
6.	10000 gpd	Criteria 2 applies	10000 gpd
7.	12000 gpd	Criteria 2 applies	10000 gpd
8.	13333 gpd	Criteria 1 applies	Unviable

Note that in the case of an unviable scheme, the community must be consulted and alternative/additional sources must be sought or the demand/coverage of the scheme must be reduced.

ANNEXURE 10-3

(DATA SHEET)

T I T L E	:	Sample Design of Transmission Main
NO. OF PIPES	:	1
NO. OF NODES	:	2
PEAK FACTOR	:	1
MIN HL/KM	:	.01
MAX HL/KM	:	200
RESIDUAL HEAD	:	10

PIPE NO.	NODE FROM	NODE TO	LENGTH	DIA	HWC
1	1	2	915.00	0	0

NODE #	FIX	F L O W	ELEVATION
1	0.0	0.000	1723.00
2	0.0	-2.660	1680.00

REFERENCE NODE	GRADE LINE
1	1723.00

DIAMETER SIZE	HWC	COST per METER
15.8	120.00	49.00
21.3	120.00	55.00
26.9	120.00	85.00
35.6	120.00	105.00
41.5	120.00	131.00
52.5	120.00	174.00
68.1	120.00	220.00
80.1	120.00	318.00
104.3	120.00	406.00

(RESULT SHEET)

```
T I T L E      :  Sample Design of Transmission Main
NO. OF LINKS   :  1
NO. OF NODES   :  2
PEAK FACTOR    :  1
MIN  HL/KM     :  .01
MAX  HL/KM     :  200
RESIDUAL HEAD  :  10
```

AVAILABLE PIPES :

DIAM (MM)	HWC	UNIT COST
16	120	49.00
21	120	55.00
27	120	85.00
36	120	105.00
42	120	131.00
53	120	174.00
68	120	220.00
80	120	318.00
104	120	406.00

PIPE no.	N O D E from	to	FLOW (lps)	DIAM (mm)	HWC	HLOSS (m)	HL/KM (m)	LENGTH (m)	C O S T
1	1	2	2.660	53	120	29.93	44.62	670.88	116,733.50
				68	120	3.07	12.57	244.12	53,705.91
								T O T A L =	170,439.41

NODE NO.	FLOW (LPS)	ELEV (M)	H G L (M)	PRESSURE (M)	
1S	2.660	1723.0	1723.0	0.0	**
2	-2.660	1680.0	1690.0	10.0	

S U M M A R Y

DIAM (MM)	LENGTH (M)	C O S T
53	670.9	116,733.50
68	244.1	53,705.91
	T O T A L =	170,439.41

INTERIOR NODES WITH (**) DO NOT MEET THE MINIMUM PRESSURE REQUIREMENT

TO RESOLVE THIS PROBLEM ASSIGN THEIR NODE NUMBERS GREATER THAN 500

ANNEXURE 10-4

(DATA SHEET)

T I T L E	:	Sample Design of Distribution System
NO. OF PIPES	:	4
NO. OF NODES	:	5
PEAK FACTOR	:	1
MIN HL/KM	:	.01
MAX HL/KM	:	200
RESIDUAL HEAD	:	10

PIPE NO.	N O D E FROM	TO	LENGTH	DIA	HWC
35	30	7	150.00	0	0
6	7	8	213.00	0	0
7	8	9	122.00	0	0
8	9	10	92.00	0	0

NODE #	FIX	F L O W	ELEVATION
30	0.0	0.000	1600.00
7	0.0	-0.151	1575.00
8	0.0	-0.151	1530.00
9	0.0	-0.151	1525.00
10	0.0	-0.151	1518.00

REFERENCE NODE	GRADE LINE
30	1600.00

DIAMETER SIZE	HWC	COST per METER
15.8	120.00	49.00
21.3	120.00	55.00
26.9	120.00	85.00
35.6	120.00	105.00
41.5	120.00	131.00
52.5	120.00	174.00
68.1	120.00	220.00
80.1	120.00	318.00
104.3	120.00	406.00

(RESULT SHEET)

T I T L E	:	Sample Design of Distribution System
NO. OF LINKS	:	4
NO. OF NODES	:	5
PEAK FACTOR	:	1
MIN HL/KM	:	.01
MAX HL/KM	:	200
RESIDUAL HEAD	:	10

AVAILABLE PIPES :

DIAM (MM)	HWC	UNIT COST
16	120	49.00
21	120	55.00
27	120	85.00
36	120	105.00
42	120	131.00
53	120	174.00
68	120	220.00
80	120	318.00
104	120	406.00

PIPE no.	N O D E from	to	FLOW (lps)	DIAM (mm)	HWC	HLOSS (m)	HL/KM (m)	LENGTH (m)	C O S T
35	30	7	0.604	27	120	11.19	74.59	150.00	12,750.00
6	7	8	0.453	21	120	29.08	136.52	213.00	11,715.00
7	8	9	0.302	21	120	7.87	64.48	122.00	6,710.00
8	9	10	0.151	16	120	7.05	76.61	92.00	4,508.00
								T O T A L =	35,683.00

NODE NO.	FLOW (LPS)	ELEV (M)	H G L (M)	PRESSURE (M)	
30S	0.604	1600.0	1600.0	0.0	**
7	-0.151	1575.0	1588.8	13.8	
8	-0.151	1530.0	1559.7	29.7	
9	-0.151	1525.0	1551.9	26.9	
10	-0.151	1518.0	1544.8	26.8	

S U M M A R Y

DIAM (MM)	LENGTH (M)	C O S T
16	92.0	4,508.00
21	335.0	18,425.00
27	150.0	12,750.00
T O T A L =		35,683.00

INTERIOR NODES WITH (**) DO NOT MEET THE MINIMUM PRESSURE REQUIREMENT

TO RESOLVE THIS PROBLEM ASSIGN THEIR NODE NUMBERS GREATER THAN 500

FIGURES

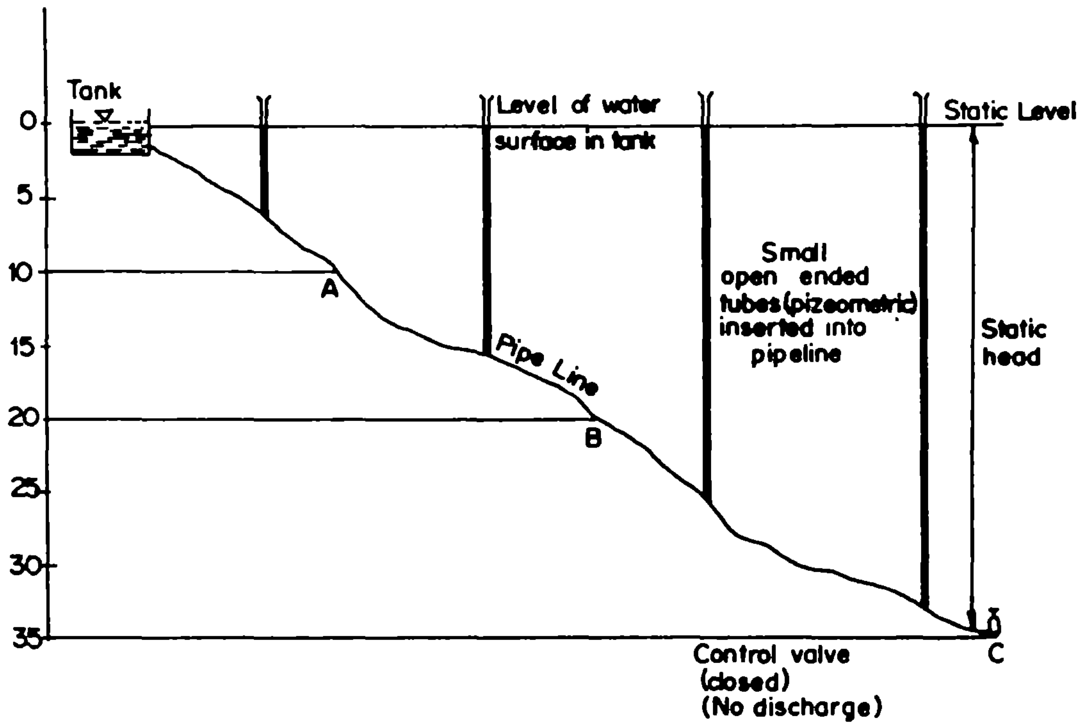


Fig. 10·1 STATIC EQUILIBRIUM

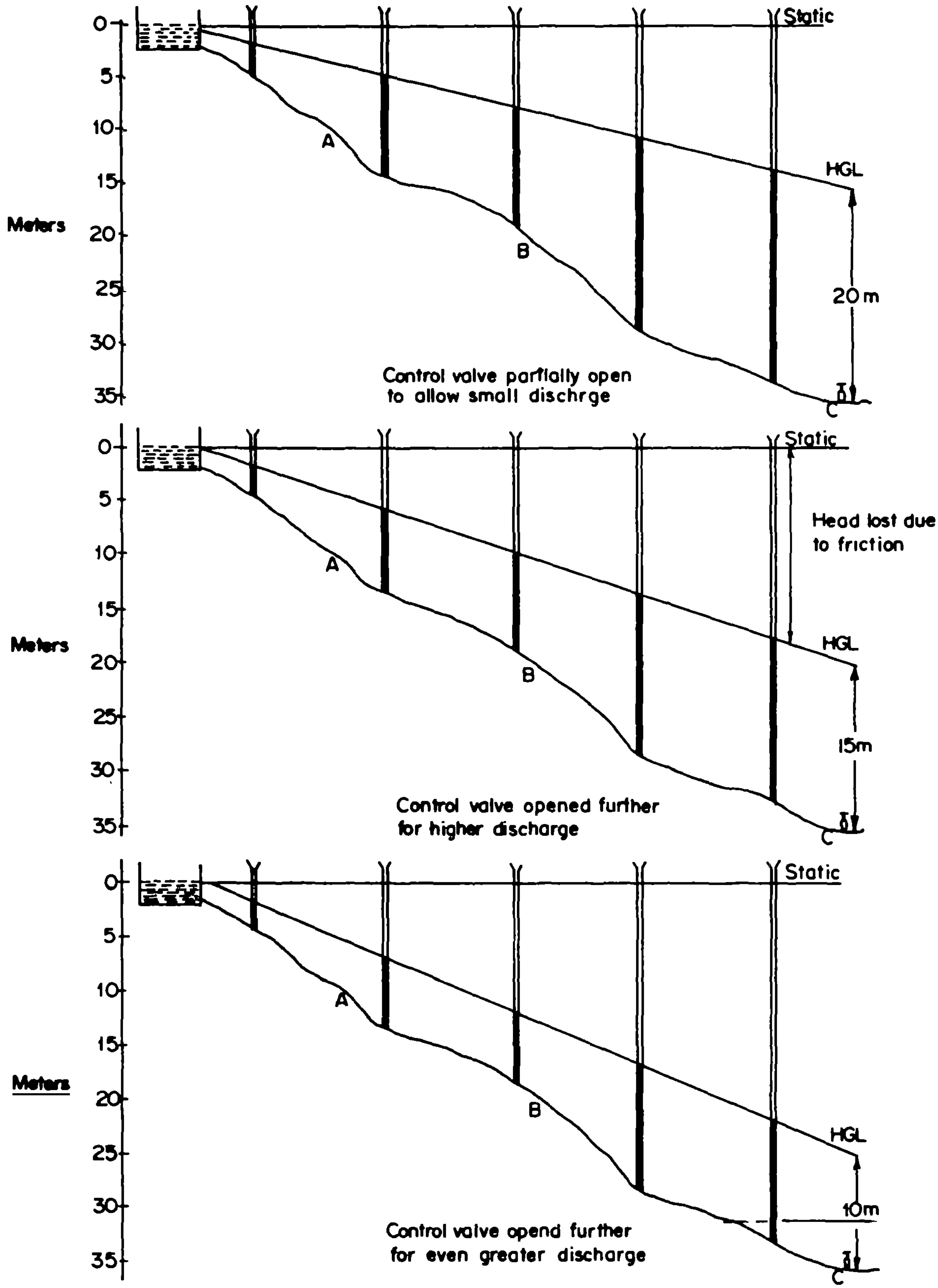


Fig. 10·2 DYNAMIC EQUILIBRIUM

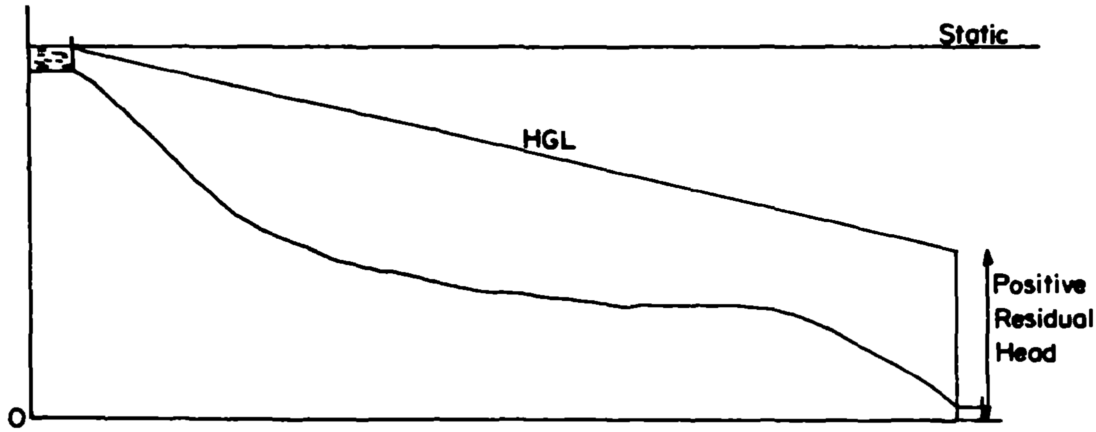


Fig. 10·3 a.

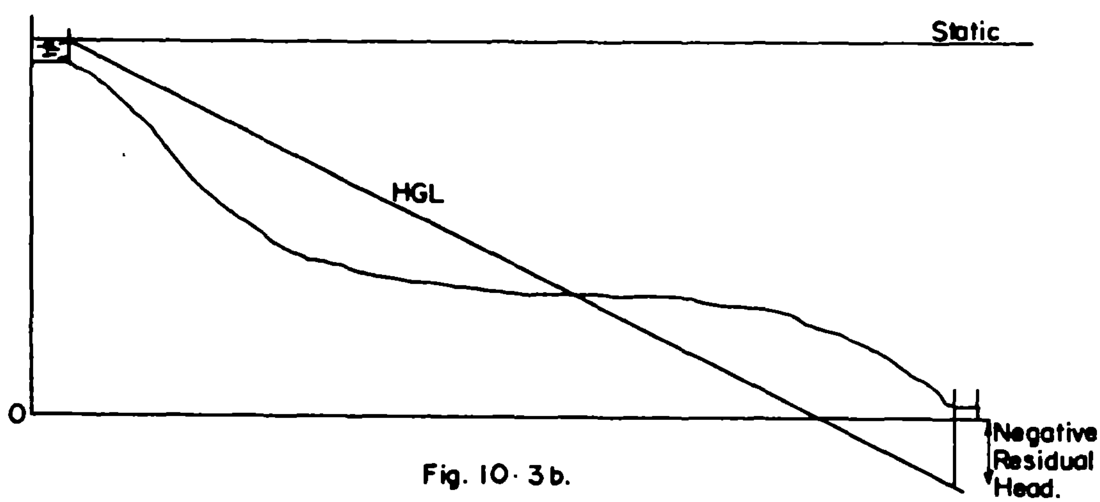


Fig. 10·3 b.

Fig. 10·3 EXAMPLES OF POSITIVE AND NEGATIVE RESIDUAL HEADS

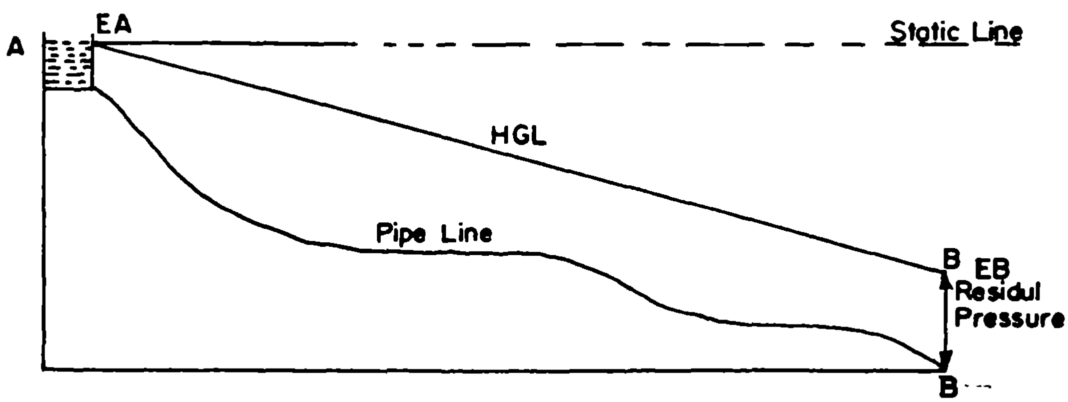


Fig. 10·4

Fig. 10·4 CALCULATION OF HGL AND PRESSURE

Chapter 11

OPTIMISED DESIGN OF PUMPING MAIN AND PUMPS

CHAPTER 11

OPTIMISED DESIGN OF PUMPING MAINS AND PUMPS

CONTENTS

LIST OF ANNEXURES

LIST OF TABLES

CHAPTER 11

OPTIMISED DESIGN OF PUMPING MAINS AND PUMPS

1 INTRODUCTION

Purpose and Scope

1.1 Following technical calculations to select pipeline and pumps sizes / capacities economics analysis is carried out to establish the optimum design combination of both the pipe and the pump. A standard computer format has been developed for both technical and economic elements of design on this project. This chapter sets out to explain the philosophy behind the optimised design and use of the computer format.

1.2 With the total daily demand of the scheme as the known volume of water to be pumped over 8 hours, the designer must determine a diameter of pumping main for which the total capital costs together with the power consumption for pumping against the dynamic head over the 10 years design life, is at a minimum.

Definition

1.3 The "pumping main" or "rising main" denotes the pipeline which conveys water from a pump at a source which has an elevation lower than the distribution tank.

Limitation

1.4 It is recommended at this time that all pumping mains should use medium duty GI pipe.

2 DESIGN PROCEDURE & CALCULATIONS

Formulae

2.1 In order to determine the most economical diameter of pipe, economic analysis is carried out on various possible hydraulic designs based on **Net Present Value** method. This method assesses all the related capital and operational costs of a scheme by considering the value of all expenditure over the design life as if it was all spent at year"0" i.e at present.

2.2 Velocity and frictional losses through the pipes are calculated by using the Hazzen William equations as under:

$$S = H/L = 10.666 \times C^{-1.85} \times D^{-4.87} \times Q^{1.85} \quad \ldots \quad 11.1$$

$$V = 0.8492 \times C \times R^{0.63} \times S^{0.54} \quad \ldots\ldots\ldots\ldots \quad 11.2$$

Where

H	=	head loss (meters)
L	=	Length of pipe (meters)
C	=	Coefficient of pipe friction*
D	=	Diameter of pipe (meters)
Q	=	flow in cubic meter/sec
R	=	Hydraulic Mean Radius (R = D/4 for pipe flowing full)
S	=	Slope of hydraulic grade line

* Hazzen William constant "C" for pipe friction is 120 for GI pipe.

2.3 By substituting the "S" in equation no 11.2 or by using Continuity equation i.e " Q = A x V " and solving for pipe diameter of pipe it becomes:

$$D = 1.13 \sqrt{(Q/V)} \quad \ldots\ldots\ldots\ldots\ldots \quad 11.3$$

2.4 One commonly used rule of thumb for estimating the least cost diameter is to adopt a flow velocity between 0.8 m/sec to 1.4 m/sec. Thus by using a velocity of 1.0 m/sec in equation no 11.3, it further reduced to:

$$D = 1.13 \sqrt{Q} \quad \ldots\ldots\ldots\ldots\ldots \quad 11.3a$$

2.5 For a given flow equation no 11.3a gives an estimated pipe diameter to proceed further with the analysis.

2.6 On the computer format three options for the pipe diameters can be analysed. The estimated option assessed from the equation no 11.3a, is placed in the middle row along with two adjacent pipe diameters (i.e one smaller and other bigger than the estimated). The design outputs are calculated automatically in the spread sheet for the comparative optimised hydraulic design. Designer should use actual internal pipe diameters which are generally bigger than the nominal diameters in the case of GI pipes.

2.7 Table 11.1 below represents the selected specifications namely nominal and actual internal pipe diameter and weight of medium duty GI pipe.

SELECTED SPECIFICATIONS FOR MEDIUM DUTY GI PIPE		
Nominal Dia (mm)	Actual Min. Internal Dia (mm)	Weight (Kg/meter)
15	15.80	1.22
20	21.30	1.58
25	26.90	2.44
32	35.60	3.14
40	41.50	3.61
50	52.50	5.10
65	68.10	6.51
80	80.10	8.47
100	104.30	12.10

Table 11.1:Selected Specification for M.D G.I Pipe (Adapted from BSS 1387)

Frictional/Dynamic Head and Velocity

2.8 The spread sheet calculates the frictional losses through the pipe of respective diameter by using equation 11.1. The frictional losses calculated by using equation no 11.1 is then added to the static head given as input to spread sheet which equates as the value for the "dynamic head". The capacity of the pump to convey the water against this dynamic head is thus determined.

2.9 For the given slope of the hydraulic grade line, the flow velocity through the respective pipe diameter is calculated by using equation no 11.2.

2.10 The dynamic head and velocity calculated by computer spread sheet should be observed carefully. The dynamic head in any case should not ever be more than 250 meters, which is normally the maximum limit for a centrifugal pump. For lifts greater than 250 meters a second booster pump must be designed and installed. With respect to the design criteria the flow velocity should be in the range of 0.75 m/sec to 3.0 m/sec with absolute minimum of 0.3 m/sec.

Pumps and Motor

2.11 For the given discharge and dynamic head the capacity of the motor i.e the Break horse power (BHP) or Kilowatts (KWs) is calculated by using following formulae.

$$BHP = QH/(76x\eta) \quad \ldots \quad 11.4$$

$$KWs = 0.746 \times BHP \quad \ldots \quad 11.5$$

Where BHP = Break Horse Power (Hp)
Q = Discharge (lps)
η = Combined efficiency of pump and motor.

2.12 The combined efficiency of the pump and motor is a variable parameter which is required in the hydraulic data input area. It would normally be expected to obtain an efficiency of above 60% , which is used as a conservative estimate in the absence of other information.

2.13 However it is recommended to use the value for combined efficiency of pump and motor as stipulated by the manufacture/supplier. In Pakistan this parameter has wide range as a result of limited availability of pump sizes and it also depends upon the working conditions of the pump. If the efficiency is lower, then higher Bhp will be required to pump the same quantity of water, and higher will be the operational costs to be paid by consumers.

Economic Analysis

2.14 One definition of the word "economy" may be "the wise expenditure of money". In terms of pumping this means that all the design criteria and parameters are to be satisfied at the minimum cost.

2.15 For the economic analysis, the sum of money analyzed is composed of both capital cost and the operational or running cost. The major component of the running cost is power cost. The spread sheet considers the power cost over the design life of the scheme in relation to the hydraulically designed pipeline and pump.

Least cost system

2.16 The least cost option is where the most efficient pump(s) is coupled to the most efficient pipe line for the minimum capital and operational cost.

2.17 For the pumping main, as the diameter increases, the capital cost increase, but the frictional losses decreases. Reduced frictional losses lead to the reduced power cost. Thus for all pumping schemes the above variables i.e the capital cost of the pipe and the power cost can be correlated to find the one pipe diameter and pump size which gives minimum cost of both capital and running.

3 NOTE ON ECONOMIC ANALYSIS

Net Present Value (NPV) Method

3.1 There are various method to carry out the economic analysis by examining the capital and running costs. Economic analysis to find the least cost of the three hydraulically designed pipe sizes, is carried out by adopting "Net Present Value Method"

3.2 This method is concerned with finding a sum of money which represents a combination of:

(i) Capital costs, paid out in lump sum in year "0".
(ii) Residual value of assets at the end of design life.
(iii) Running cost, paid out in regular intervals over the design life.

3.3 So the "Present Value" of a scheme is the sum of the money required at the beginning of the scheme which will cover all the costs of scheme throughout its design life if this sum is invested carefully to obtain the required rate of return.

3.4 To establish the Net Present Value of expenditure from the above three types of cost over the design life, it is only the running cost which is to be invested at certain interest rate at the beginning of the project which will pay all the running cost for the design life of the project i.e 10 years. The money which is required today to meet all the future expenditures is calculated by using equation 11.6 as follows:

$$S = \frac{S_A \times (1+i)^n - 1}{i(1+i)^n} \quad \ldots\ldots\ldots\ldots\ldots \quad 11.6$$

Where
- S = Money required at the beginning of the project.
- S_A = Money required to meet the running expenditure at end of each "n" years
- n = no of years i.e design life 10 years.
- i = Interest rate which is termed as "Discounting Rate" for N.P.V method. It is commonly taken as 10% (World Bank general practice)

3.5 By substituting the value of "i = 10%" i.e discount rate and for "n = 10 years" design life in equation no 11.6 the equation is reduced to;

$$S = S_A \times 6.1445 \quad \ldots\ldots\ldots\ldots\ldots \quad 11.6a$$

3.6 Equation 11.6 shows that "S" is the amount required to be invested today at 10% discount rate over a period of 10 years, which is 6.1445 times the total amount S_A i.e the required sum to meet the running expenditure at the end of each year.

Pipes Residual Value

3.7 The useful life of the pipes is assumed to be 25 years. The design life of schemes is 10 years in this project therefore at the end of 10 years there will be residual valve remaining for the pipes. It is assumed that there will be "straight line" or linear depreciation of the pipes. Thus the residual value of pipes are calculated as under:

$$R.V = CP_o - \frac{CP_o \times \text{Design life}}{\text{useful life}} \quad \ldots\ldots\ldots \quad 11.7$$

Where
- $R.V$ = Residual Value.
- CP_o = Cost of pipe in year "0".

3.8 By substituting the value for design life i.e 10 years and for useful life i.e 25 years in equation no 11.7 it is reduced to:

$$R.V_{\text{(at year 10)}} = CP_o - 0.4\ CP_o$$

$$\Rightarrow R.V_{\text{(at year 10)}} = 0.6\ CP_o \quad \ldots\ldots\ldots\ldots\ 11.7a$$

3.9 From equation no 11.7a it is clear that Residual Value of the pipe at the end of year "10" is 60% of the capital cost of pipe at year "0". Thus at year 10, then 60% of the value remains and 40% is written off.

3.10 The Residual Value of pipe at year "10" is brought back to the value worth at year "0" which will be the Net Present Value (NPV) for the residual value of pipes.

3.11 The NPV for the residual value of pipes is calculated by using equation no 11.8.

$$NPV_{\text{(at year 0)}} = \frac{R.V_{\text{(at year 10)}}}{(1 + i)^n} \quad \ldots\ 11.8$$

3.12 Equation no 11.8 is used to calculate the Net Present Value (NPV) at the interest rate "i" and at any "n" years of any future Residual Value (R.V).

3.13 By substituting the values of "i = 10%" and "n = 10 years" in equation no 11.8 it reduces to:

$$NPV_{\text{(at year 0)}} = \frac{R.V_{\text{(at year 10)}}}{2.5937} \quad \ldots\ldots\ 11.8a$$

3.14 Within the standard computer format, equation no 11.8a is used to calculate the NPV $_{\text{(at year "0")}}$ for the R.V $_{\text{(at year 10)}}$. The NPV of pipes is accounted for in the summary as negative in order to subtract this amount from the total cost of pipes paid at year "0".

Net present value analysis

3.15 For each pipe size the following costs are calculated:

(i) Capital cost of pipe.
(ii) Capital cost of pumps and motors.
(iii) NPV of Residual Value of pipe by using the equation no 11.8a. This cost is to be subtracted from the capital cost of pipe.
(iv) Power cost required at year "0" to meet the running expenditure by using eg no 11.6a (where SA in this case the power cost required for one year only).

3.16 The arithmetic summation of all the four cost sectors represent the total Net Present Value for the respective size of pipe. Among the options, the least cost option which fulfils the design criteria will be the most efficient pump coupled with most efficient pipe line. The analysis should be repeated unless and until the least cost Net Present Value is the middle diameter.

4 COMPLETION OF ECONOMIC ANALYSIS COMPUTER SPREAD SHEET

4.1 A standard computer format for the optimised design of pumping main and pumps is attached as annexure 11.1. In the attached format only the shaded portion is the area required for the data input by AEs. The rest of the calculations will be completed by the computer automatically.

4.2 Area "A" is for the hydraulic data input which is required for the calculations. In this area the following parameters are entered.

(i) **Flow (lps):** As per design criteria, maximum pumping duration is eight hours in a day to pump the daily demand. Therefore in order to calculate flow in litre per second, use the figure of 8 hours in a day.

(ii) **Length (m):** Length of pumping or rising main should be in meters.

(iii) **Static Head (m):** Static head is the sum of delivery head and suction head. In case of bore holes the suction must be inclusive of maximum drawdown.

(iv) **Pump efficiency (%):** It is a variable parameter, however Combined efficiency of pump and motor is normally taken as 60% for detail see para 2.12 and 2.12.

(v) Coefficient of Friction "C": Value for Hazzen William constant "C" is taken as 120 for GI pipe.

4.3 After entering this above data the computer will show an estimated pipe diameter (mm), in the same area. This estimated pipe diameter will guide the engineer to input an appropriate actual internal pipe diameter options with two adjacent actual internal pipe diameters (As already explained in para 2.6).

4.4 After introducing the three pipe diameter options, the computer will give the result to the hydraulic design for the pumping main and pump.

4.5 **Area "B"** The data required to enter in this region is in the following sequence.

(i) **No. of Households:** This information is used in order to calculate the power cost to be paid by each house per month for the designed system.

(ii) **Pipe Rate**: Pipe rate used in this section used be valid for the scheme under design to carry out analysis close to reality. The cost use in this section is in Rs per meter length of pipe.

(iii) **Cost of Pumps and Motors:** Rates used in this section must be current/valid for the scheme. In order to give fair idea about the prices for pumps and motors, an analysis was carried out based on the budget prices received from GRUNDFOS on 29 Jan 1995, and two best fit graphs were plotted for submersible and centrifugal pumps respectively. These two graphs are attached as annexure. 11.2 and annexure 11.3. These graphs can be used to assess the budget prices for the pumps and motors for the design purpose. Note these graphs are based on the budget prices in Jan 1995, therefore if these graphs are referred after long time, the prices should be inflated accordingly.

4.6 Following this input the economic analysis will be completed by the computer automatically. A sample design sheet for the optimised design of pumping main and pumps is attached as annexure 10.4.

ANNEXURES

ANNEXURE 11 1

ECONOMIC ANALYSIS & DESIGN OF PUMPING MAIN AND PUMPS

SCHEME DATA
Water Supply Scheme:
Scheme No:

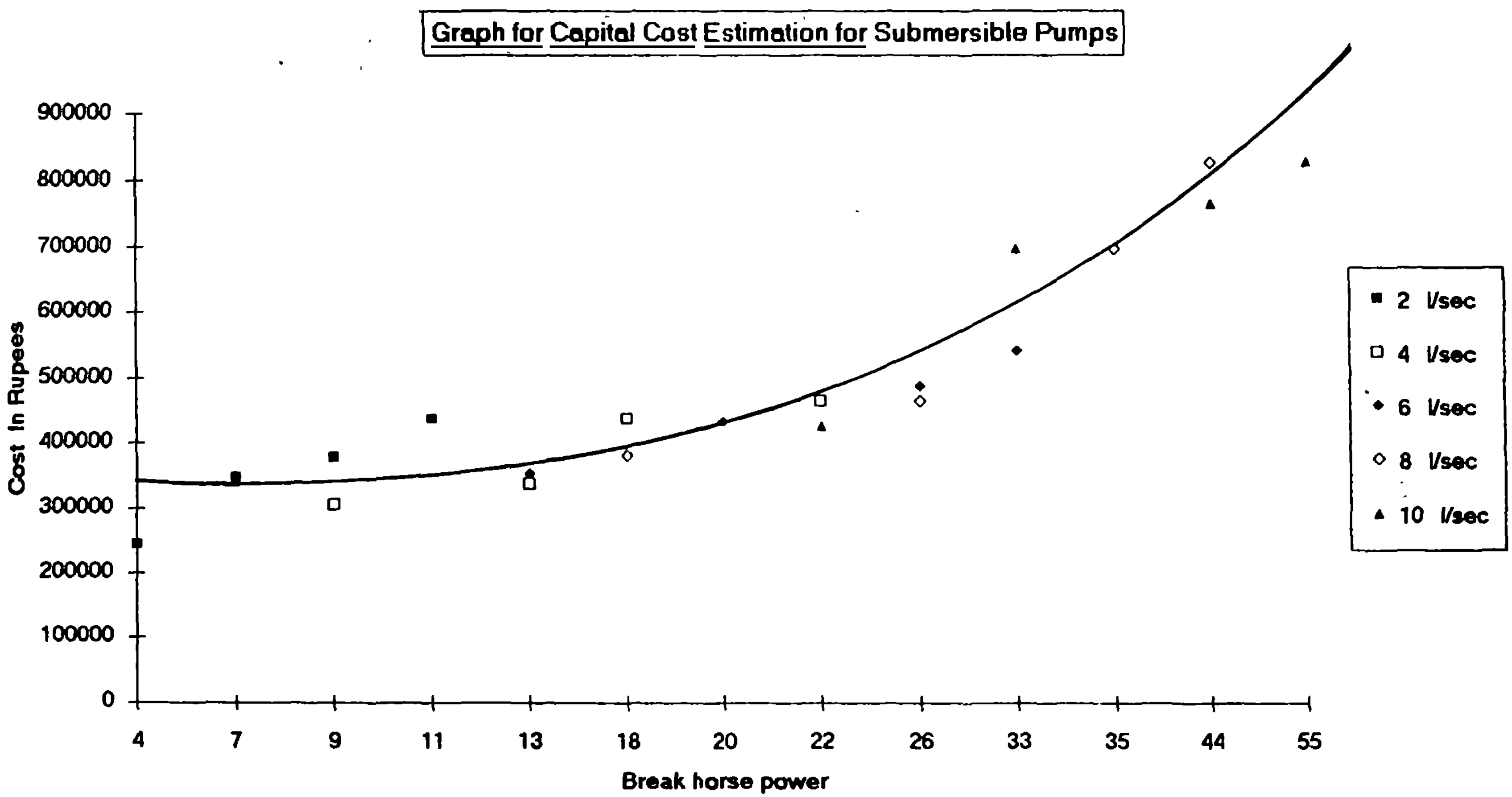
A. AREA FOR HYDRAULICS DATA INPUT			
Hydraulic Data		Pipe Dia options (mm)	
Flow (lps)	0.00	Option 1	0
Length (m)	0 00	Option 2	0
Static Head (m)	0 00	Option 3	0
Pump Effeciency (%)	0%	Coefficient of Friction (C)	
Est Pipe Dia (mm)	0	C Value	0

Details	Actual Internal Diameter of Pipes (mm)		
	Option 1	Option 2	Option 3
	0	0	0
Hyraulic Design for:			
1 **Pumping Main.**			
1 1 Flow (lps)	0 00	0 00	0 00
1 2 Length (Meters)	0 00	0 00	0 00
1 3 Total Static Head (Meters)	0 00	0 00	0 00
1 4 Frictional Head (Meters)	ERR	ERR	ERR
1 5 Dynamic Head (Meters)	ERR	ERR	ERR
1 6 Velocity (m/sec)	ERR	ERR	ERR
2 **Pumps & Motors**			
2 1 Dynamic Head (Meters)	ERR	ERR	ERR
2 2 Horse Power (HP)	ERR	ERR	ERR
2 3 KiloWatts (Kw)	ERR	ERR	ERR

B. AREA FOR COSTING DATA INPUT			
Discount Rate %	10 00%	No. H/Holds	0
Design Life (Years)		Useful Life (Years)	
Pipes	10	Pipes	25
Pumps	10	Pumps	10
Dia Of Pipes (mm)	0	0	0
Pipe Rate / meter	0	0	0
Pump Cost	0	0	0
WAPDA TARRIF	Fixed Rate	Per Kwh	Tax
From 1-20 kws	46	2 43	360
From 21-70 kws	60	2 43	360
From 71-500 kws	167	1.85	360

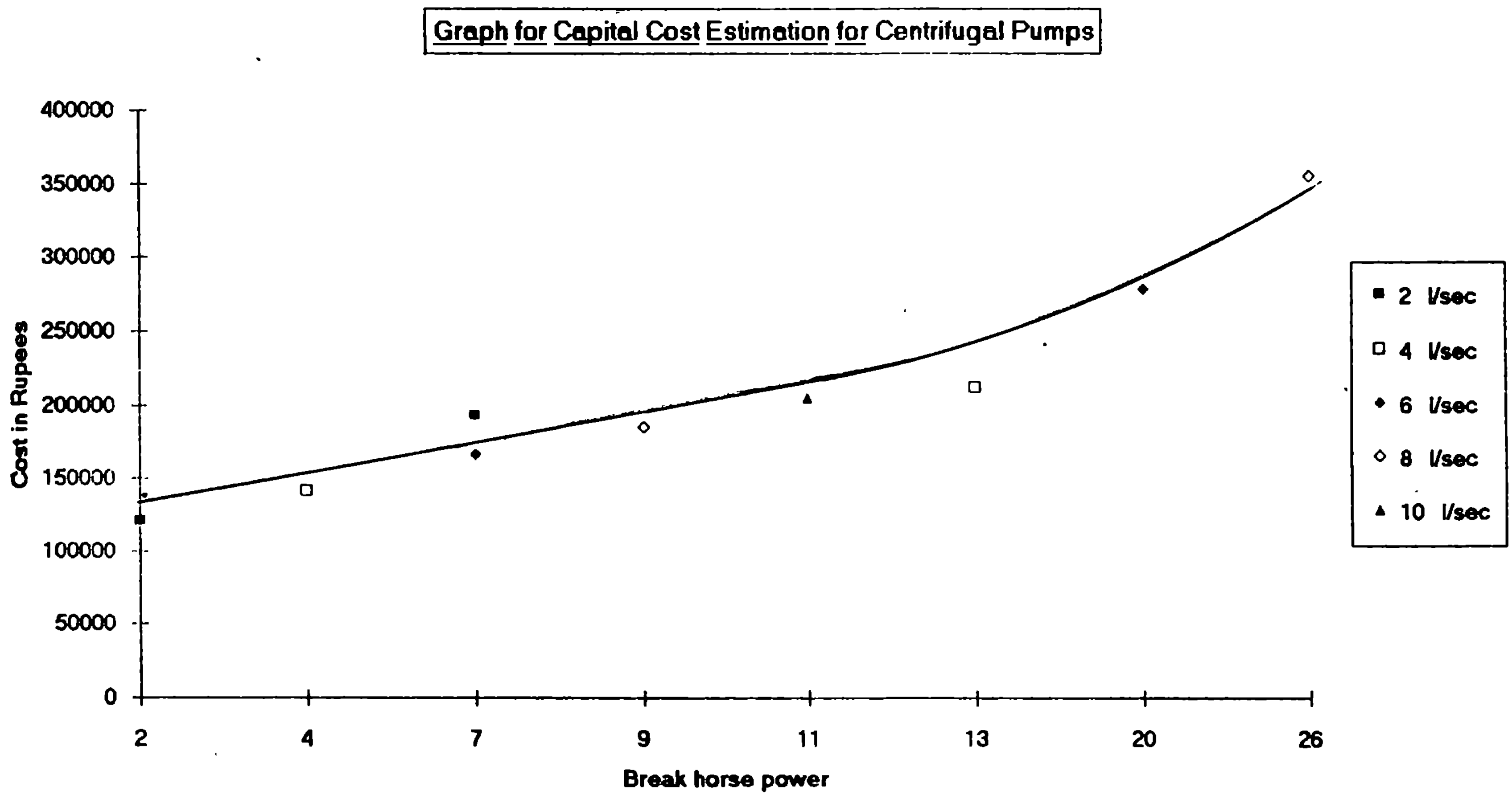
Details	Actual Internal Diameter of Pipes (mm)		
	Option 1	Option 2	Option 3
	0	0	0
1 **Capital Costs**			
1.1 Costs for Pumps & Motors	0	0	0
1 2 Cost of Pipes	0	0	0
1 3 Total Capital Cost	0	0	0
2 **Power Costs**			
2 1 Per Annum	ERR	ERR	ERR
2.2 Per Month / House	ERR	ERR	ERR
3 **Net Present Value (Over 10 Years Design Life)**			
3.1 Pipes	0	0	0
3.2 Pipes Residual Value	0	0	0
3.3 Pumps & Motors	0	0	0
3.4 Power Cost	ERR	ERR	ERR
Total Net Present Value (Sum items 3.1 to 3.4)	ERR	ERR	ERR

ANNEXURE 11 - 2



Note. Data is based on information given by GRUNDFOS on 29 Jan. 1995 The actual cost will vary by some ±10% according to the actual head and flow required.

ANNEXURE 11 - 3



Note: Data based on information given by GRUNDFOS on 29 Jan 1995. The actual cost will vary by some ±10% according to the actual head and flow required.

ANNEXURE 11.4
ECONOMIC ANALYSIS & DESIGN OF PUMPING MAIN AND PUMPS

SCHEME DATA	
Water Supply Scheme:	Sample
Scheme No: 1234	

A. AREA FOR HYDRAULICS DATA INPUT			
Hydraulic Data		Pipe Dia options (mm)	
Flow (lps)	2 46	Option 1	52 5
Length (m)	1066 80	Option 2	68 1
Static Head (m)	166 42	Option 3	80
Pump Effeciency (%)	60%	Coefficient of Friction (C)	
Est Pipe Dia (mm)	56	'C' Value	120

	Details	Actual Internal Diameter of Pipes (mm)		
		Option 1 52.5	Option 2 68.1	Option 3 80
	Hyraulic Design for·			
1	Pumping Main:			
1 1	Flow (lps)	2 46	2 46	2 46
1 2	Length (Meters)	1066 80	1066 80	1066 80
1 3	Total Static Head (Meters)	166 42	166 42	166 42
1 4	Frictional Head (Meters)	41 27	11 63	5 31
1 5	Dynamic Head (Meters)	207 69	178 05	171 73
1 6	Velocity (m/sec)	1 15	0 68	0 49
2	Pumps & Motors			
2 1	Dynamic Head (Meters)	207 69	178.05	171 73
2 2	Horse Power (HP)	11 20	9 61	9 26
2 3	KiloWatts (Kw)	8 36	7 16	6 91

B. AREA FOR COSTING DATA INPUT			
Discount Rate %	10 00%	No. H/Holds	240
Design Life (Years)		Useful Life (Years)	
Pipes	10	Pipes	25
Pumps	10	Pumps	10
Dia Of Pipes (mm)	52 5	68 1	80
Pipe Rate / meter	174	220	318
Pump Cost	375,000	330,000	310,000
WAPDA TARRIF	Fixed Rate	Per Kwh	Tax
From 1-20 kws	46	2 43	360
From 21-70 kws	60	2 43	360
From 71-500 kws	167	1 85	360

	Details	Actual Internal Diameter of Pipes (mm)		
		Option 1 52.5	Option 2 68.1	Option 3 80
1	Capital Costs			
1 1	Costs for Pumps & Motors	375,000	330,000	310,000
1.2	Cost of Pipes	185,623	234,696	339,242
1.3	Total Capital Cost	560,623	564,696	649,242
2	Power Costs			
2 1	Per Annum	68,217	59,096	57,152
2.2	Per Month / House	24	21	20
3	Net Present Value (Over 10 Years Design Life)			
3.1	Pipes	185,623	234,696	339,242
3 2	Pipes Residual Value	-42939	-54291	-78476
3 3	Pumps & Motors	375,000	330,000	310,000
3 4	Power Cost	419,163	363,119	351,174
	Total Net Present Value (Sum items 3.1 to 3.4)	936,846	873,524	921,940

Chapter 12

PIPELINE QUANTITIES AND SCHEDULES

LIST OF FIGURES

CHAPTER 12

PIPELINE QUANTITIES AND SCHEDULES

1 INTRODUCTION

1.1 This chapter sets out to provide LGRDD technical and design staff guideline on how to estimate quantities and to prepare the pro forma schedules to indicate the schedule of pipe quantities and fittings required to be ordered for each scheme. This process of estimation may be developed to be fully computer aided in future. Presently it is manually generated by detailed examination of CAD hydraulic design for the total pipe lengths required for each pipe diameter along with abstraction of pipe fittings for specific applications from schedules contained herein.

2 ITEM CODING

2.1 Each type of item has a unique four digit code. The first two digits are the "Prefix Code" in which first and second digit represent item diameter and pipe material respectively. The last two digits are the "Suffix Code" which represents the actual item description. When there are four digits indicated on the drawing or pipe schedule it represent that the fittings are fixed and standard for the job i.e the pipe diameter and pipe material are final along with item description in use. But if "Suffix Code" only is indicated on drawings or schedule, i.e last two digits, it represents that the item description in use is specific to the design and "Prefix Code" i.e first two digits shall be assigned after finalization of pipe diameter and material according to the specific requirement of design.

2.2 Presently medium duty (M.D) galvanized iron (GI) socketed pipe along with some uPVC pipe for tapstands is being used on this project. But in future "light duty (L.D) GI pipe, flanged GI pipe and different pressure rated polyethylene pipe (Pe) may be used in combination with M.D GI pipe on this project. Representative digit in the suffix code for the possible pipe material which can be used on this project is allocated and shown in the attached annexure 1 titled as "Prefix Code Schedule".

2.3 The first digit of the prefix code is indicative of pipe diameter for the respective pipe material as per "Prefix Code Schedule" attached as annexure 12.1. Three different pipe materials are indicated by the second digit in the "Prefix Code Schedule" namely GI, uPVC and Pe.

(i) **GI Pipe:** GI pipe is further classified into M.D, L.D and flanged pipes representing second digit of "0", "1" and "2" of the prefix code for respective materials.

(ii) **uPVC Pipe:** uPVC pipe is classified in three categories depending on pressure rating i.e 'B" , "C" and "D" class representing second digit of "3", "4" and "5" of the prefix code for the respective pipe materials.

(iii) **Pe Pipe:** Pe pipe is classified into three types of 6, 10 and 12 bars pressure rating with the second digit of "6", "7" and "8" of the prefix code for the respective pipe materials. Pe pipe rated at 6 bar is available but will not be ude on this project. The smaller sizes avialable upto 60 mm are 12 bar pressure rated whereas the larger size available are rated at 10 bar.

3 SCHEDULE OF QUANTITIES

3.1 In keeping with the philosophy of item prefix and suffix code explained above, seven number schedule of quantities i.e Schedule A,B,C,D,E, and F for all the various types of pipe materials and fittings likely to be used on this project have been prepared and attached to this chapter as annexure 2, 3, 4, 5, 6, and 7 respectively. The district design staff are to complete in these schedules depending on the requirement of pipe materials/fittings required for the particular scheme and process the schedule for the procurement of materials. The attached schedules are self explanatory.

4 STANDARD COMPONENT QUANTITIES FOR PIPES AND SPECIALS

Tanks

4.1 This section describes how to quantify the pipes and specials required at standard design structures. There is a standard set of fittings which are required for each component such as washout, outlet, inlet etc., for storage tank, break pressure tank and spring collection box. Particular diameters are dependant upon the specific hydraulic design i.e. diameters (and numbers) of inlet(s) outlet(s), overflow, vent pipes, washout etc.

4.2 These quantities are scheduled and prepared for future computer aided processing. In the meantime these are to be manually abstracted from the respective standard drawings or pipe schedules attached to this chapter. The quantities scheduled are for one tank/box. These quantities can be multiplied by the total number of units in the scheme to arrive at the total quantities required. Pipe schedule for water storage tank for 1000 -4500 gallons and for 5000 - 20000 gallons is attached as annexures 12.8 and 12.9 respectively. Whereas annexures 12.10 and 12.11 attached to this chapter are Pipe schedules for the break pressure tank and spring collection box respectively.

Tapstands

4.3 There is a standard set of fittings which are required for three tapstand options. During the planning stage of scheme these options are to be discussed with the community and the WSC should identify which options householders want for themselves. The designs for these options are essentially similar to each other but with difference in cost of construction. The pipe quantities for each option is scheduled and is to be abstracted either from respective standard drawings or from the schedules attached as annexures 12.12, 12.13 and 12.14. The quantities scheduled are meant only for one single tapstand unit.

Valve Protection Sleeve

4.4 Valve protection sleeve is designed to protect valves from tampering. The valve protection sleeve is required for all valves upto 4 " diameter on all distribution mains. The pipe material required for the construction of valve protection sleeve is scheduled which can either be abstracted from the drawing no TAU/023 or from the pipe schedule attached as annexure 12.15.

5 STANDARD QUANTITIES FOR SPECIALS AT TEES, WASHOUTS & AIRVALVES

5.1 Quantities for mains branches, washouts and airvalves are to be estimated using the specific scheme hydraulic design and abstracting the quantities using the details provided on the attached sheets, which are produced from respective standard drawings, for the particular diameter required at each location.

Pipe Line Branches

5.2 The pipe line branches are broadly divided into two parts as below:

a) Where the supply line is of dias up to 50 mm dia:

5.3 Tee piece shall be specific according to size of the supply main and the branch. A bush reducer item 70 to 77 may be needed according to the design of the mainline i.e in case of reduction in pipe diameter downstream of junction. A sketch showing detail for standard fittings required at each branch is detailed in attached Fig. 12.1. In the case of supply or branch lines of Pe pipe materials, then location for the GI to Pe connector is also indicated in the Figure.

b) Where the supply line is of 50 mm dia or greater:

5.4 Tee piece shall be specific according to size of main and diameter of Tee branch with Bush-hexagon reducers if necessary according to design sizes of branches downstream of junction. The specials required at each branch is illustrated in attached Fig. 12.2. In the case of supply or branch lines of Pe pipe materials, then location for the GI to Pe connector is also indicated in the attached Fig. 12.2.

Washouts

5.5 Washouts shall normally be provided at low points / depressions. For the washout line an equal tee piece will be utilised for this purpose. The fittings required are detailed in attached Fig. 12.3. The washout discharge pipe shall be at least 3 m long and shall properly drain to a lowland area so as not to cause undue erosion and muddy area formation at discharge point. In the case of supply lines of Pe pipe materials, then location for the GI to Pe connector is also indicated in the attached Fig. 12.3.

Air valves

5.6 Air valves are normally provided at high points / crests in the pipe line route. The air valve used on pipelines of 50 mm and above will normally be of 1 inch (25 mm) dia and for pipelines less than 50 mm will normally be 15 mm diameter.

5.7 It will be necessary to utilise Tee piece with 1 inch (25 mm) dia branch for the air valve fittings. The air valve fittings is installed vertically and be protected in an air valve chamber as detailed in attached Fig. 12.4.

5.8 The diameters of pipe used on this project is small (4 inch diameter and below), and small orifice air valves are normally adequate to serve the purpose. For further detail refer to chapter 11 of construction manual (ENM3). Single small orifice and large orifice air valve is detailed in attached Fig. 12.5 and Fig. 12.6 respectively.

Air Vent/Breather Pipes

5.9 Breather pipes required immediately downstream of the outlet valve at every tank (including spring collection and break pressure tanks) to avoid creating negative pressures i.e. through sucking in any pollution when the main outlet valve on the tank is closed. These are detailed on the reservoir detail drawings TAU/011.

6 ESTIMATE OF FITTINGS - GENERAL

6.1 The estimation for GI pipe and fittings is explained in this section. Estimate for other types of pipe materials (Pe and/or LDGI) can be made keeping the basic philosophy same.

Medium duty GI Pipes: 6 m long - items No 01

6.2 Take the total length of each pipe diameter from the hydraulic design and add 5% for contingency and wastage. Note that each pipe length will be provided complete with one socket.

Medium duty GI Pipes: 7" long - items No 02

6.3 These items are required on either side of each valve to permit fitting for the uPVC valve sleeve protection and valve access for buried pipes. For each diameter following the assessment of the number of valves (items 81 an 82) required for that diameter multiply that figure by two and add further 5% or 2 Nos which ever is more as contingency.

Medium duty GI Pipes: 2'10" long - items No 03 to 05

6.4 This item is for the tapstand and thus is normally restricted to 0.5" dia (i.e. code 1003)

Medium duty GI Pipes: various lengths - items No 06 to 24

6.5 These pipes are for the reservoirs and quantities are as scheduled on the reservoir drawings (TAU 010 to 017).

Unions Coupling items No 26

a) For pipes up to 40 mm dia inclusive:

6.6 One union is to be placed after every 10-15 lengths (60-90 meters).
For each dia: 0.1 x total length / 6

b) For pipes of 50 mm dia and greater:

6.7 One union is to be provided after every 5 lengths (30 m).
For each dia: 0.2 x total length / 6

Socket - items No 27

6.8 Each standard length of pipe will be delivered complete with one socket as per specification. With the substitution of union couplings some of these sockets will be available. As contingency further 1% of the total numbers of each pipe diameter should be included.

For each dia: 0.01 x total length / 6

Nipple - Hexagon - items No 25

6.9 These are required throughout the scheme on air valves, tapstands and as indicated on drawings. Apart from scheduled quantities add an additional quantities as contingency. For each of these should be estimated at 1% of total number of pipe lengths of that diameter or 2 numbers which ever is more.

For each dia: 0.01 x total length / 6

90°, 45° and 22.5° Bends, D.socket - items Nos 30, 31, 32

6.10 These will be required on all pipelines according to topographic demands. Provisions is made for each of these at 5% of total number of pipe lengths of that diameter.

For each dia: 0.05 x total length / 6

90°, 45° and 22.5° Bends, Male/Female - items Nos 35, 36, 37

6.11 These will be required at tanks on the vent pipes and rarely on pipelines. Provision is made for each of these at 1% of total number of pipe lengths of that diameter or 2 numbers which ever is more.

For each dia: 0.01 x total length / 6

Elbow - items No 39

6.12 These will be required at tanks and tapstand and add 1% of total number of elbows for that diameter or 2 which ever is more.

Tee piece - items Nos 40 to 48

6.13 These will be required:
a) specific to pipe layout
b) for each washout

6.14 Add one or 5% of total number of Tee pieces required, which ever is more.

Reducers Double socket (Bell Reducers) - items Nos 50 to 57

6.15 These will be needed specific to pipe layout. Add one or 5% of number for each diameter required on the scheme as contingency which ever is more.

Plugs and End caps - items Nos 60 and 65

6.16 These are required in particular during pipe laying to keep the pipe ends closed during construction to prevent entry of dirt and other foreign bodies into the pipe. The requirement is to be a minimum of 3 number per diameter used in the scheme or 2 percent of total pipe lengths required whichever is lesser.

For each dia: 0.02 x total length / 6

Bush-Hexagon Reducers - items Nos 70 to 77

6.17 These will be needed specific to pipe layout they are useful to reduce diameters at tee branches. Add one or 5% of number for each diameter required on the scheme which ever is greater as contingency.

Gate Valves - items Nos 80

6.18 In accordance with section 4 and 5 above these are required at:
a) Washouts
b) Air valves
c) Reservoirs

6.19 As contingency and as spare for maintenance purpose an additional 2 or 20% is to be added to the total for each diameter, which ever is more.

Seat Valves (Globe Valves) - items Nos 81

6.20 The requirement of these will be at:
a) For tapstands
b) Reservoir inlet/outlet
c) Spring collection box
d) at all distribution branches

6.21 As contingency and as spare for maintenance purpose an additional 2 or 20% is to be added to the total for each diameter, which ever is more..

Bib Cocks/tap: 60 psi - items Nos 82

6.22 Low pressure ones may be provided at consumer points where the static pressures are within allowable limits i.e. below 40 m head.

6.23 As contingency and as spare for maintenance purpose an additional 2 or 30% is to be added to the total for each diameter, which ever is more.

Bib Cocks/tap: 300 psi - items Nos 83

6.24 High pressure ones are recommended to be used where high static pressures (above 35 m head) are occurring at consumer points.

6.25 As contingency and as spare for maintenance purpose an additional 2 or 30% is to be added to the total for each diameter, which ever is more.

Ball Valve - items Nos 84

6.26 These will be required at each air valve; for large diameters these are usually integral to the unit.

6.27 As contingency and as spare for maintenance purpose an additional 2 or 30% is to be added to the total for each diameter, which ever is more.

Ball Float Valve (Angular) - items Nos 87

6.28 Good quality float valves are required to automatically control the inflow to reservoirs. This is type of ball float valve is more robust and appropriate for the pressures normally found on hill schemes. Maximum rated working pressures is 10 bar (100 m).

6.29 As contingency and as spare for maintenance purpose an additional 2 is to be added to the total.

Non Return Valve - items Nos 88

6.30 These are required on each pumped transmission main at the pump house. As contingency and as spare for maintenance purpose an additional 2 is to be added to the total.

Air Valve - items Nos 89

6.31 These are required specific to the pipe line layout and topography. As contingency and as spare for maintenance purpose an additional 2 or 30% is to be added to the total for each diameter, which ever is more.

Water Meter - items Nos 90

6.32 Water meters are used to measure and monitor the flows from pumps and tanks. This assists the WSC to distribute flows and control supply to consumers, particularly in villages where the supply from the source is critical (i.e. demand is greater than supply). At this stage water meters will be included on all pumps for recording production of pumps. An additional 1 must be added to the total number of water meters required for each diameter as a spare reserve.

ANNEXURES

PREFIX CODE SCHEDULE

Annexure 12.1

Prefix Code Schedule

Indicating Pipe Diameter and Material

A: G.I Pipe

Medium Duty G.I Pipe 2nd Digit of Prefix Code "0"		Light Duty G.I Pipe 2nd Digit of Prefix Code "1"		Flanged G.I Pipes 2nd Digit of Prefix Code "2"	
Code	Dia (in)	Code	Dia (in)	Code	Dia (in)
1 0	0.50	1 1	0.50	1 2	0.50
2 0	0.75	2 1	0.75	2 2	0 75
3 0	1.00	3 1	1.00	3 2	1.00
4 0	1.25	4 1	1.25	4 2	1 25
5 0	1 50	5 1	1 50	5 2	1 50
6 0	1.75	6 1	2.00	6 2	2.00
7 0	2.00	7 1	2.50	7 2	2.50
8 0	3.00	8 1	3.00	8 2	3.00
9 0	4.00	9 1	4.00	9 2	4 00

B: uPVC Pipe

"B" Class uPVC Pipe 2nd Digit of Prefix Code "3"		"C" Class uPVC Pipe 2nd Digit of Prefix Code "4"		"D" Class uPVC Pipe 2nd Digit of Prefix Code "5"	
Code	Dia (in)	Code	Dia (in)	Code	Dia (in)
1 3	3.00	1 4	3.00	1 5	3.00
2 3	4.00	2 4	4.00	2 5	4.00
3 3	5.00	3 4	5.00	3 5	5.00
4 3	6.00	4 4	6.00	4 5	6.00
5 3	8.00	5 4	8.00	5 5	8.00

C: Pe: Pipe

"6 Bar" P.E Pipe 2nd Digit of Prefix Code "6"		"10 Bar" P.E Pipe 2nd Digit of Prefix Code "7"		"12 Bar" P.E Pipe 2nd Digit of Prefix Code "8"	
Code	Dia (mm)	Code	Dia (mm)	Code	Dia (mm)
1 6	20	1 7	20	1 8	20
2 6	25	2 7	25	2 8	25
3 6	32	3 7	32	3 8	32
4 6	40	4 7	40	4 8	40
5 6	60	5 7	60	5 8	60
6 6	90	6 7	90	6 8	90
7 6	110	7 7	110	7 8	110

SCHEDULE A

Annexure 12.2

SCHEDULE A: SCHEDULE OF QUANTITIES FOR MEDIUM DUTY G.I. PIPES

Village Scheme No:

WATER AND SANITATION COMMITTEE: MARKAZ: DISTRICT:

Item No.	Description	Unit	Pipe diameters in inches (mm) : Item Prefix Code								
			0.5":(10)	0.75":(20)	1":(30)	1 25":(40)	1.5":(50)	2" (60)	2.5":(70)	3":(80)	4":(90)
01	M D GI Pipes 6 Mtr long	Total Mtr									
02	M.D GI Pipes 0'–7" long	No									
	Standposts										
03	M D GI Pipes 2'–10" long	No									
04	M D GI Pipes 1'–2" long	No									
05	M D GI Pipes 5 – 3" long	No									
	Outlet and Washout Pipe										
06	M D GI Pipes 9'–0" long (H)	No									
	Inlet Pipes										
07	M D GI Pipes 3'–9" long (H)	No									
08	M D GI Pipes 5'–3" long (V)	No									
09	M D GI Pipes 6'–9" long (V)	No									
10	M D GI Pipes. 3'–3" long (H)	No									
11	M D GI Pipes 5'–9" long (H)	No									
12	M.D GI Pipes 9'–6" long (V)	No									
	Overflow Pipes										
13	M D GI Pipes 3'–6" long (H)	No									
14	M.D GI Pipes 4'–6" long (V)	No									
15	M.D GI Pipes 3'–3" long (H & V)	No									
16	M D GI Pipes 3'–0" long (H)	No									
17	M.D GI Pipes 5'–10" long (H)	No									
18	M D GI Pipes 7'–6" long (V)	No									
91	M D G I Pipe 2'–00" long	No									
	Breather Pipes										
19	M D GI Pipes 7'–6" long (V)	No									
20	M D GI Pipes 10' -0" long (V)	No									
	Air Vent Pipe & Man Hole Lock										
21	M.D GI Pipes 1'–2" long (V)	No									
22	M D GI Pipes 4'–8" long (H)	No									
92	M D G I Pipe lock 4'–00" long	No									

Notes. 1. Each individual item can be identified by 4 figure code, the first two numbers are the "Item Prefix Codes", of which the first digit represent the pipe diameter and the second digit represents the pipe material The The last two digits indicates the "Item Suffix Codes" for the actual item description

2. All lengths of pipe (Item Nos 01 to 22 inclusive) to be threaded both ends and supplied bundled together

3. H = Horizontal. V = Vertical.

Name of Chairman WSC .... Signature with Date ....

Verified by Assistant Engineer LG&RDD .... Signature with Date ....

Approved by APD/SE LG&RDD .... Signature with Date ....

SCHEDULE B

Annexure 12.3

SCHEDULE B: SCHEDULE OF QUANTITIES FOR LIGHT DUTY G.I. PIPES

Village Scheme No:

WATER AND SANITATION COMMITTEE: **MARKAZ:** **DISTRICT:**

Item No.	Description	Unit	Pipe diameters in inches (mm) : Item Prefix Code								
			0.5":(11)	0.75":(21)	1":(31)	1.25":(41)	1.5":(51)	2":(61)	2.5":(71)	3":(81)	4":(91)
01	M.D GI Pipes. 6 Mtr long	Total Mtr									
02	M.D GI Pipes 0'-7" long	No									
	Standposts										
03	M.D GI Pipes 2'-10" long	No									
04	M D GI Pipes 1'-2" long	No									
05	M D GI Pipes 5'-3" long	No									
	Outlet and Washout Pipe										
06	M D GI Pipes. 9'-0" long (H)	No									
	Inlet Pipes										
07	M.D GI Pipes 3'-9" long (H)	No									
08	M.D GI Pipes 5'-3" long (V)	No									
09	M.D GI Pipes 6'-9" long (V)	No									
10	M D GI Pipes 3'-3" long (H)	No									
11	M.D GI Pipes 5'-9" long (H)	No									
12	M D GI Pipes 9'-6" long (V)	No									
	Overflow Pipes										
13	M.D GI Pipes 3'-6" long (H)	No									
14	M.D GI Pipes 4'-6" long (V)	No									
15	M D GI Pipes 3'-3" long (H & V)	No									
16	M D GI Pipes 3'-0" long (H)	No									
17	M D GI Pipes 5'-10" long (H)	No									
18	M D GI Pipes: 7'-6" long (V)	No									
91	M D G I Pipe 2'-00" long	No									
	Breather Pipes										
19	M D GI Pipes 7'-6" long (V)	No									
20	M D GI Pipes 10'-0" long (V)	No									
	Air Vent Pipe & Man Hole Lock										
21	M.D GI Pipes 1'-2" long (V)	No									
22	M.D GI Pipes 4'-8" long (H)	No									
92	M.D G.I Pipe lock 4'-00" long	No									

Notes:
1. Each individual item can be identified by 4 figure code, the first two numbers are the "Item Prefix Codes", of which the first digit represent the pipe diameter and the second digit represents the pipe material. The The last two digits indicates the "Item Suffix Codes" for the actual item description.
2. All lengths of pipe (Item Nos 01 to 22 inclusive) to be threaded both ends and supplied bundled together
3. H = Horizontal, V = Vertical

Name of Chairman WSC .... Signature with Date ....

Verified by Assistant Engineer LG&RDD .... Signature with Date ....

Approved by APD/SE LG&RDD .... Signature with Date ....

SCHEDULE C

Annexure 12.4

SCHEDULE C: SCHEDULE OF QUANTITIES FOR G.I. FITTINGS

Village Scheme No:

WATER AND SANITATION COMMITTEE: MARKAZ: DISTRICT:

Item No.	Description	Unit	Pipe/Fitting diameters in inches : Item Prefix Nos								
			0.5":(10)	0.75":(20)	1":(30)	1.25":(40)	1.5":(50)	2":(60)	2.5":(70)	3":(80)	4":(90)
25	Nipple–Hexagon	No									
26	Union Coupling	No									
27	Socket	No									
30	Bend (90°) D.Socket	No									
31	Bend (45°) D.Socket	No									
32	Bend (22.5°) D.Socket	No									
35	Bend (90°) M/F	No									
36	Bend (45°) M/F	No									
37	Bend (22.5°) M/F	No									
39	Elbow	No									
40	Tee Piece (0.5" branch)	No									
41	Tee Piece (0.75" branch)	No									
42	Tee Piece (1" branch)	No									
43	Tee Piece (1.25" branch)	No									
44	Tee Piece (1.5" branch)	No									
45	Tee Piece (2" branch)	No									
46	Tee Piece (2.5" branch)	No									
47	Tee Piece (3" branch)	No									
48	Tee Piece (4" branch)	No									
50	Reducers (to 0.5") D.Socket	No									
51	Reducers (to 0.75") D.Socket	No									
52	Reducers (to 1.00") D.Socket	No									
53	Reducers (to 1.25") D.Socket	No									
54	Reducers (to 1.5") D.Socket	No									
55	Reducers (to 2.00") D.Socket	No									
56	Reducers (to 2.50") D.Socket	No									
57	Reducers (to 3.00") D.Socket	No									
60	Plug Male	No									
65	End Cap	No									
70	Bush–Hexagon Reducer to 0.5"	No									
71	Bush–Hexagon Reducer to 0.75"	No									
72	Bush–Hexagon Reducer to 1"	No									

Annexure 12.4

SCHEDULE C: SCHEDULE OF QUANTITIES FOR G.I. FITTINGS

WATER AND SANITATION COMMITTEE: MARKAZ: Village Scheme No DISTRICT:

Item No.	Description	Unit	Pipe/Fitting diameters in inches : Item Prefix Nos								
			0.5":(10)	0.75":(20)	1":(30)	1.25":(40)	1.5":(50)	2":(60)	2.5":(70)	3":(80)	4":(90)
73	Bush–Hexagon Reducer to 1.25"	No									
74	Bush–Hexagon Reducer to 1.5"	No									
75	Bush–Hexagon Reducer to 2"	No									
76	Bush–Hexagon Reducer to 2.5"	No									
77	Bush–Hexagon Reducer to 3"	No									
80	Gate Valves	No									
81	Seat Valves	No									
82	Bibcock/tap : 60 psi	No									
83	Bibcock/tap : 300 psi	No									
84	Ball Valve	No									
87	Ball Float Valve (Angular)	No									
88	Non Return Valve	No									
89	Air Valve (Single Small Orifice)	No									
90	Water Meter	No									

Notes. 1 Each individual item can be identified by 4 figure code, the first two numbers are the "Item Prefix Codes", of which the first digit represent the pipe diameter and the second digit represents the pipe material The The last two digits indicates the "Item Suffix Codes" for the actual item description

2 D Socket = Double Socketed i e fitting has socket at each end

3 M/F = male/female i.e. one end of fitting is male, the other end is female

4 H = Horizontal, V = Vertical

5 All "Bends" are long radius.

Name of Chairman WSC.. Signature with Date: ....

Verified by Assistant Engineer LG&RDD.. Signature with Date: ....

Approved by APD/SE LG&RDD.. Signature with Date: ....

SCHEDULE D

Annexure 12.5

SCHEDULE D: SCHEDULE OF QUANTITIES FOR FLANGED PIPE AND FITTINGS

WATER AND SANITATION COMMITTEE. MARKAZ: Village Scheme No DISTRICT:

Item No.	Description	Unit	Pipe/Fitting diameters in inches : Item Prefix Nos								
			0.5":(12)	0.75":(22)	1":(32)	1.25":(42)	1.5":(52)	2":(62)	2.5":(72)	3":(82)	4":(92)
01	Flanged Pipes: 6 Mtr long	Total Mtr									
25	Nipple–Hexagon	No									
26	Union Coupling	No									
27	Socket	No									
28	Tied Flange Adapter	No									
30	Bend (90°)	No									
31	Bend (45°)	No									
32	Bend (22.5°)	No									
35	Bend (90°)	No									
36	Bend (45°)	No									
37	Bend (22.5°)	No									
39	Elbow	No									
40	Tee Piece (0.5" branch)	No									
41	Tee Piece (0.75" branch)	No									
42	Tee Piece (1" branch)	No									
43	Tee Piece (1.25" branch)	No									
44	Tee Piece (1.5" branch)	No									
45	Tee Piece (2" branch)	No									
46	Tee Piece (2.5" branch)	No									
47	Tee Piece (3" branch)	No									
48	Tee Piece (4" branch)	No									
50	Reducers (to 0.5")	No									
51	Reducers (to 0.75")	No									
52	Reducers (to 1.00")	No									
53	Reducers (to 1.25")	No									
54	Reducers (to 1.5")	No									
55	Reducers (to 2.00")	No									
56	Reducers (to 2.50")	No									
57	Reducers (to 3.00")	No									

Annexure 12.5

SCHEDULE D: SCHEDULE OF QUANTITIES FOR FLANGED PIPE AND FITTINGS

Village Scheme No·

WATER AND SANITATION COMMITTEE MARKAZ: DISTRICT:

Item No.	Description	Unit	Pipe/Fitting diameters in inches : Item Prefix Nos								
			0.5":(12)	0.75":(22)	1":(32)	1.25":(42)	1.5":(52)	2":(62)	2.5":(72)	3":(82)	4":(92)
60	Plug Male	No									
65	End Cap	No									
70	Bush-Hexagon Reducer to 0.5"	No									
71	Bush-Hexagon Reducer to 0.75"	No									
72	Bush-Hexagon Reducer to 1"	No									
73	Bush-Hexagon Reducer to 1.25"	No									
74	Bush-Hexagon Reducer to 1.5"	No									
75	Bush-Hexagon Reducer to 2"	No									
76	Bush-Hexagon Reducer to 2.5"	No									
77	Bush-Hexagon Reducer to 3"	No									
80	Gate Valves	No									
81	Seat Valves	No									
82	Bibcock/tap : 60 psi	No									
83	Bibcock/tap : 300 psi	No									
84	Ball Valve	No									
87	Ball Float Valve (Angular)	No									
88	Non Return Valve	No									
89	Air Valve (Single Small Orifice)	No									
90	Water Meter	No									

Notes:
1. Each individual item can be identified by 4 figure code, the first two numbers are the "Item Prefix Codes", of which the first digit represent the pipe diameter and the second digit represents the pipe material The The last two digits indicates the "Item Suffix Codes" for the actual item description
2. All lengths of pipe (Item Nos 01 to 22 inclusive) to be threaded both endsand supplied bundled together
3. H = Horizontal, V = Vertical
4. All "Bends" are long radius

Name of Chairman WSC.. Signature with Date: ....

Verified by Assistant Engineer LG&RDD.. Signature with Date: ....

Approved by APD/SE LG&RDD.. Signature with Date: ....

SCHEDULE E

Annexure 12.6

SCHEDULE E: SCHEDULE OF QUANTITIES FOR 10 BARS Pe PIPES AND FITTINGS

WATER AND SANITATION COMMITTEE: MARKAZ:

Item No.	Description	Unit	Pipe/Fitting diameters in millimeters : Item Prefix Nos	
			90 mm (67)	110 mm (77)
01	Pe Pipes	Total Mtr		
30	Pe – GI Connector	No		

Notes 1 Each individual item can be identified by 4 figure code, the first two numbers are the "Item Prefix Codes". of which the first digit represent the pipe diameter and the second digit represents the pipe material The The last two digits indicates the "Item Suffix Codes" for the actual item description.

Name of Chairman WSC.. Signature with Date: ....

Verified by Assistant Engineer LG&RDD.. Signature with Date: ....

Approved by APD/SE LG&RDD.. Signature with Date: ....

SCHEDULE F

Annexure 12.7

SCHEDULE F : SCHEDULE OF QUANTITIES FOR 12 BARS Pe PIPES AND FITTINGS

WATER AND SANITATION COMMITTEE: **MARKAZ:**

Item No.	Description	Unit	Pipe/Fitting diameters in millimeters : Item Prefix Nos				
			20mm.(18)	25 mm:(28)	32 mm:(38)	40 mm:(48)	60 mm:(58)
01	Pe Pipes	Total Mtr					
30	Pe–GI Connector	No					

Notes 1 Each individual item can be identified by 4 figure code, the first two numbers are the "Item Prefix Codes", of which the first digit represent the pipe diameter and the second digit represents the pipe material. The The last two digits indicates the "Item Suffix Codes" for the actual item description

Name of Chairman WSC.. .... Signature with Date: ....

Verified by Assistant Engineer LG&RDD.. .... Signature with Date: ....

Approved by APD/SE LG&RDD.. .... Signature with Date: ....

PIPE SCHEDULE

Annexure 12.8

Pipe Schedule

Water Storage Tanks 1000 – 4500 Gallons

S.No.	Item Code Nos.	Description	Qty
		Washout Pipes	
1	60 0 2	2" dia M.D. G.I pipes 0' – 7" long	1
2	60 0 6	2" dia M.D. G.I pipes 9' – 0" long	1
3	60 2 5	2" dia Nipple Hexagon	1
4	60 2 6	2" dia Union Coupling	1
5	60 3 9	2" dia Elbow	1
6	60 8 1	2" dia Seat Valve	1
		Sump,Outlet Pipe & Distribution Line	
		Sump & Outlet Pipe	
1	0 2	M.D. G.I pipes 0' – 7" long	2
2	0 6	M.D. G.I pipes 9' – 0" long	1
3	2 1	M.D. G.I pipe 1' – 2" long (Vertical)	1
4		Reducer D. Socketed (Item Nos 50 to 57)	
5	2 5	Nipple Hexagon	1
6	2 6	Union Coupling	2
7		Tee Piece (Item Nos 41 to 47)	1
		(This item not required if only one distribution line)	
8	8 1	Seat Valves	1
		One Distribution Line	
1	0 2	M.D. G.I pipes 0' – 7" long	2
2	2 5	Nipple Hexagon	1
		(This item not required if only one distribution line)	
3	2 5	Nipple Hexagon	2
4	30 2 5	1" dia Nipple Hexagon (for breather pipe)	1
5	2 6	Union Coupling	2
6	30 3 9	1" dia Elbow	1
7	41 to 47	Tee Piece (Item Code Nos 41 to 47 can be used)	1
8	30	1" dia Tee Piece (With branch from Item Nos 41 to 47)	1
9	50 to 57	Reducer D. Socketed (Item Code Nos 50 to 57 can be used)	1
10	6 0	Plug Male	1
11	8 1	Seat Valves	1
		Inlet Pipe	
1	0 2	M.D. G.I pipes 0' – 7" long	2
2	0 7	M.D. G.I pipes 3' – 9" long (Horizontal)	2
3	0 8	M.D. G.I pipes 5' – 3" long (Vertical)	1
		(This item is for Brick Masonary tanks only)	
4	0 9	M.D. G.I pipes 6' – 9" long (Vertical)	1
		(This item is for Stone Masonary tanks only)	
5	2 6	Union Coupling	3
6	3 9	Elbow	2
7	8 1	Seat Valves	1
8	8 7	Ball Float Valve (Angular)	1

Pipe Schedule

Water Storage Tanks 1000 – 4500 Gallons

S.No.	Item Code Nos.	Description	Qty
		Overflow Pipe	
1	1 3	M.D. G.I pipes 3' – 6" long (Horizontal) (This item is for Stone Masonary tanks only)	1
2	1 4	M.D. G.I pipes 4' – 6" long (Vertical) (This item is for Stone Masonary tanks only)	1
3	1 5	M.D. G.I pipes 3' – 3" long (Horizontal & Vertical) (This item is for Brick Masonary tanks only)	2
4	3 9	Elbow	2
		Breather Pipe	
1	30 1 9	1" dia M.D. G.I pipe 7' – 6" long (Vertical)	1
2	30 3 5	1" dia Bend 90 degree (Male/Female)	2
3	30 4 2	1" dia Tee Piece with 1" branch	1
		Air Vent Pipe	
1	30 2 1	1" dia M.D. G.I pipe 1' – 2" long (Vertical)	1
2	30 3 5	1" dia Bend 90 degree (Male/Female)	2
3	30 4 2	1" dia Tee Piece with 1" branch	1
		Manhole Lock	
1	20 2 1	3/4" dia M.D. G.I pipe 1' – 2" long (Vertical)	2
2	20 2 2	3/4" dia M.D. G.I pipe 4' – 8" long (Horizontal)	1
3	20 2 7	3/4" dia Socket	2
4	20 4 2	3/4" dia Tee Piece with 1" branch	2

Annexure 12.9

Pipe Schedule

Water Storage Tanks 5000 – 20000 Gallons

S.No.	Item Code Nos.	Description	Qty
		Washout Pipes	
1	60 0 2	2" dia M.D. G I pipes 0' – 7" long	1
2	60 0 6	2" dia M.D. G.I pipes 9' – 0" long	1
3	60 2 5	2" dia Nipple Hexagon	1
4	60 2 6	2" dia Union Coupling	1
5	60 3 9	2" dia Elbow	1
6	60 8 1	2" dia Seat Valve	1
		Sump,Outlet Pipe & Distribution Line	
		Sump & Outlet Pipe	
1	0 2	M.D. G.I pipes 0' – 7" long	2
2	0 6	M.D. G.I pipes 9' – 0" long	1
3	2 1	M.D. G.I pipe 1' – 2" long (Vertical)	1
4	50 to 57	Reducer D. Socketed (Item Code Nos 50 to 57 can be used)	1
3	2 5	Nipple Hexagon	1
4	2 6	Union Coupling	2
5	41 to 47	Tee Piece (Item Code Nos 41 to 47 can be used) (This item not required if only one distribution line)	1
6	8 1	Seat Valves	1
		One Distribution Line	
1	0 2	M.D. G.I pipes 0' – 7" long	2
2	2 5	Nipple Hexagon (This item not required if only one distribution line)	1
3	2 5	Nipple Hexagon	2
4	30 2 5	1" dia Nipple Hexagon (for breather pipe)	1
5	2 6	Union Coupling	2
6	30 3 9	1" dia Elbow	1
7		Tee Piece (Item Code Nos 41 to 47 can be used)	1
8	30	1" dia Tee Piece (With branch from Item Nos 41 to 47)	1
9	50 to 57	Reducer D. Socketed (Item Code Nos 50 to 57 can be used)	1
10	6 0	Plug Male	1
11	8 1	Seat Valves	1
		Inlet Pipe	
1	0 2	M.D. G.I pipes 0' – 7" long	2
2	1 0	M.D. G.I pipes 3' – 3" long (Horizontal) (This item is for RCC / Brick Wall tanks only)	2
3	1 1	M.D. G.I pipes 5' – 9" long (Horizontal) (This item is for Stone Masonary tanks only)	1
4	1 2	M D. G.I pipes 9' – 6" long (Vertical)	1
5	2 6	Union Coupling	3
6	3 9	Elbow	2
7	8 1	Seat Valves	1
8	8 7	Ball Float Valve (Angular)	1

Pipe Schedule

Water Storage Tanks 5000 – 20000 Gallons

S.No.	Item Code Nos.	Description	Qty
		Overflow Pipe	
1	1 6	M.D. G.I pipes 3' – 0" long (Horizontal)	1
		(This item is for RCC / Brick Wall tanks only)	
2	1 7	M.D. G.I pipes 5' – 10" long (Horizontal)	1
		(This item is for Stone Masonary tanks only)	
3	1 8	M.D. G.I pipes 7' – 6" long (Vertical)	2
4	3 9	Elbow	2
		Breather Pipe	
1	30 2 0	1" dia M.D. G.I pipe 10' – 0" long (Vertical)	1
2	30 3 5	1" dia Bend 90 degree (Male/Female)	2
3	30 4 2	1" dia Tee Piece with 1" branch	1
		Air Vent Pipe	
1	30 2 1	1" dia M.D. G.I pipe 1' – 2" long (Vertical)	1
2	30 3 5	1" dia Bend 90 degree (Male/Female)	2
3	30 4 2	1" dia Tee Piece with 1" branch	1
		Manhole Lock	
1	20 2 1	3/4" dia M.D. G.I pipe 1' – 2" long (Vertical)	2
2	20 2 2	3/4" dia M.D. G.I pipe 4' – 8" long (Horizontal)	1
3	20 2 7	3/4" dia Socket	2
4	20 4 2	3/4" dia Tee Piece with 1" branch	2

Annexure 12.10

Pipe Schedule

Break Pressure Tank

S.No.	Item Code Nos.	Description	Qty
		Inlet Pipe	
1	0 2	M.D.G.I pipe 0'–7" long	2
2	2 6	Union Coupling	2
3	3 9	Elbow	2
4	8 1	Seat Valve	1
5	8 7	Ball Float Valve (Angular)	1
6	9 1	M.D.G.I pipe 2'–0" long.	2
		Outlet Pipe	
1	0 2	M.D. G.I pipes 0' – 7" long	1
2	2 5	Nipple Hexagon	2
3	2 6	Union Coupling	1
4	3 9	Elbow	1
5	4 2	Tee piece 1" branch	1
6	50 to 57	Reducer (Item Code Nos 50 to 57 can be used)	1
7	8 1	Seat Valve	1
8	9 1	M.D.G.I pipe 2'–0" long.	1
		Washout Pipe.	
1	60 0 2	2" dia M.G.G.I pipe 0'–7" long.	1
2	60 2 6	2" dia Union Coupling.	1
3	60 8 1	2" dia Seat Valve	1
4	60 9 1	2" dia M.D.G.I pipe 2'–0" long.	1
		Overflow Pipe.	
1	3 9	Elbow	1
2	9 1	M.D.G.I pipe 2'–0" long.	1
		Breather Pipe	
1	30 2 5	1" dia Nipple Hexagon	1
2	30 3 5	1" dia Bend M/F	2
3	30 3 9	1" dia Elbow	1
4	30 4 2	1" dia Tee piece 1" branch	1
5	30 9 1	1" dia M.D.G.I pipe 2'–0" long.	1
		Locking Arrangement	
1	20 0 2	3/4 " dia M.D.G.I pipe 0'–6" long.	2
2	20 1 0	3/4 " dia M.D.G.I pipe 3'–3" long.	1
3	20 2 7	3/4 " dia G.I Socket	2
4	30 4 1	1" dia Tee Piece 3/4" branch	2

Annexure 12.11

Pipe Schedule

Spring Collection Box

S.No.	Item Code Nos.	Description	Qty
		Washout Pipes	
1	60 0 2	2" dia M.D.G.I. pipes 0'-7" long.	1
2	60 2 6	2" dia Union Coupling.	1
3	60 8 1	2" dia Seat Valve.	1
4	60 9 1	2" dia M.D.G.I. pipes 2'-07" long	1
		Outlet Pipes	
1	0 2	M.D. G.I pipes 0' - 7" long	1
2	2 5	Nipple Hexagon	2
3	2 6	Union Coupling	1
4	41 to 47	Tee Piece (Item Code Nos 41 to 47 can be used)	1
5	3 9	Elbow 90° degree	1
6	50 to 57	Reducer D. Socketed (Item Code Nos 50 to 57 can be used)	1
7	8 1	Seat Valves.	1
8	9 1	M.D.G.I pipe 2'-0" long.	1
		Breather Pipe	
1	30 2 5	1" dia Nipple Hexagon	1
2	30 3 5	1" dia Bend 90° degree (Male/Female)	2
3	30 3 9	1" dia Elbow.	1
4	30	1" dia Tee Piece	1
5	30 9 1	M.D.G.I. pipes 2'-0" long.	1
		Overflow Pipe	
1	3 9	Elbow	1
2	9 1	M.D.G.I. pipe 2'-0" long.	1
		Manhole Lock	
1	20 0 2	3/4 " dia M.D.G.I pipe 0'-6" long.	2
2	20 1 0	3/4 " dia M.D.G.I pipe 3'-3" long.	1
3	20 2 7	3/4 " dia G.I Socket	2
4	30 4 1	1" dia Tee Piece 3/4" branch	2

Annexure 12.12

Pipe Schedule

Tap Stand Type I

S.No.	Item COde Nos.	Description	Qty
		M.D G.I Pipe Fittings	
1	10 0 2	1/2" dia M.D. G.I pipes 0' – 7" long	4
2	10 0 3	1/2" dia M.D. G.I pipes 2' – 10" long	1
3	10 2 6	1/2" dia G.I Union Coupling	1
4	10 2 7	1/2" dia G.I Socket	2
5	10 3 9	1/2" dia Elbow 90°	2
6	10 8 1	1/2" dia Seat Valve	1
7	10 8 2	1/2" dia Bib Cock Tap 60 psi (This item is to be used when static pressure at tap is less than 60 Psi or 40 m)	1
8	10 8 3	1/2" dia Bib Cock Tap 300 psi (This item is to be used when static pressure at tap is over 60 Psi and < 300 Psi or 210 m)	1
		uPVC Pipe	
10	33 0 4	5" dia uPVC pipe 3' – 6" long	1

Annexure 12.13

Pipe Schedule

Tap Stand Type 2

S.No.	Item Code Nos.	Description	Qty
		M.D G.I Pipe Fittings	
1	10 0 2	1/2" dia M.D. G.I pipes 0' – 7" long	4
2	10 0 3	1/2" dia M.D. G.I pipes 2' – 10" long	1
3	10 2 6	1/2" dia G.I Union Coupling	1
4	10 2 7	1/2" dia G.I Socket	2
5	10 3 9	1/2" dia Elbow 90°	2
6	10 8 1	1/2" dia Seat Valve	1
7	10 8 2	1/2" dia Bib Cock Tap 60 psi (This item is to be used when static pressure at tap is less than 60 Psi or 40 m)	1
8	10 8 3	1/2" dia Bib Cock Tap 300 psi (This item is to be used when static pressure at tap is over 60 Psi and < 300 Psi or 210 m)	1
		uPVC Pipe	
10	33 0 4	5" dia uPVC pipe 3' – 6" long	1
11	33 0 6	5" dia uPVC unperforated pipe 6' – 6" long	1
12	33 6 5	5" dia uPVC End Cap	1

Annexure 12.14

Pipe Schedule

Tap Stand Type 3

S.No.	Item Code Nos.	Description	Qty
		M.D G.I Pipe Fittings	
1	10 0 2	1/2" dia M.D. G.I pipes 0' – 7" long	3
2	10 0 4	1/2" dia M.D. G.I pipes 1' – 2" long	1
3	10 0 5	1/2" dia M.D. G.I pipes 5' – 0" long	1
4	10 2 6	1/2" dia G.I Union Coupling	1
5	10 2 7	1/2" dia G.I Socket	2
6	10 3 9	1/2" dia Elbow 90°	2
7	10 8 1	1/2" dia Seat Valve	1
8	10 8 2	1/2" dia Bib Cock Tap 60 psi (This item is to be used when static pressure at tap is over 60 Psi and < 300 Psi or 210 m)	1
9	10 8 3	1/2" dia Bib Cock Tap 300 psi (This item is to be used when static pressure at tap is over 60 Psi and < 300 Psi or 210 m)	1

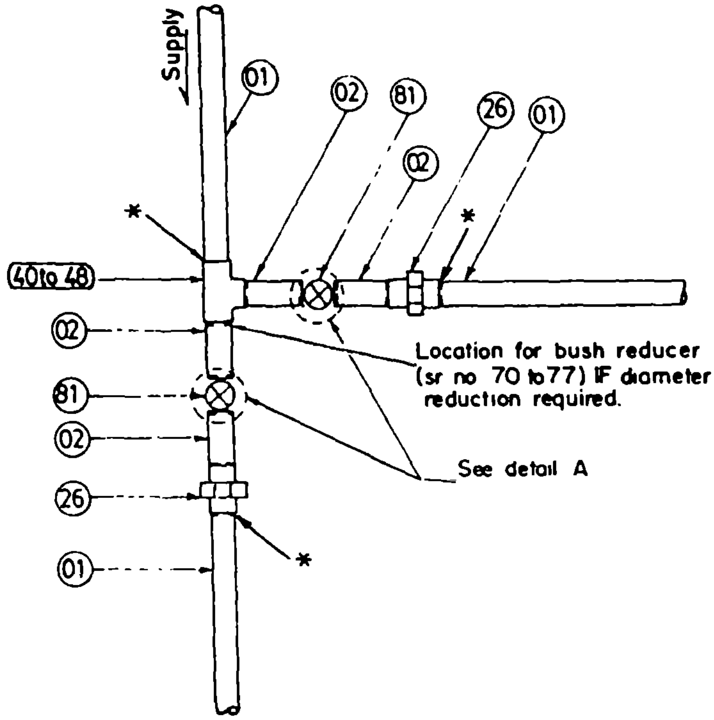
Annexure 12.15

Pipe Schedule

Valve Protection Sleeve

S.No.	Item Code Nos.	Description	Qty
		M.D G.I Pipe & Fittings	
1	10 0 2	1/2" dia M.D. G.I pipes 0' – 7" long (This item is used only for the seat valves upto 2" dia)	1
2	10 0 4	1/2" dia M.D. G.I pipes 1' – 2" long (This item is used only for the seat valves > 2" dia)	1
3	10 2 7	1/2" dia Socket	2
		uPVC Pipe & Fittings	
1	33 0 2	5" dia uPVC pipes 2' – 9" long (This item is used only for the seat valves upto 2" dia)	1
2	33 6 5	5" dia uPVC pipes End Cap (This item will be used only if item no 3302 is used)	1
3	43 0 2	6" dia uPVC pipes 2' – 9" long (This item is used only for the seat valves > 2" dia)	1
4	43 6 5	6" dia uPVC pipes End Cap (This item will be used only if item no 4302 is used)	1

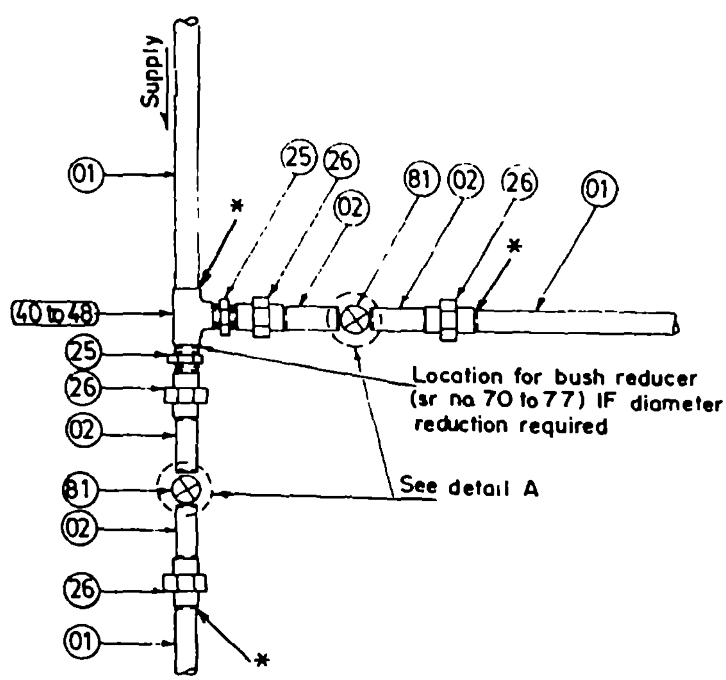
FIGURES



Tee Branch For Diameters < 2"

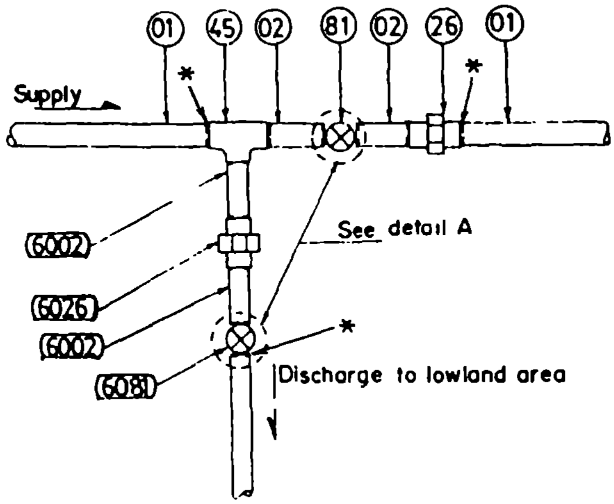
Fig 12·1

* Location for G.I to Pe connector (if applicable)



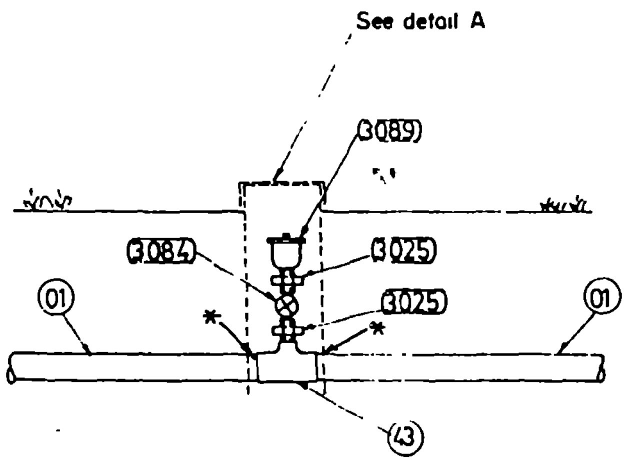
Tee Branch For Diameters ≥ 2"

Fig. 12·2



Washout Arrangement

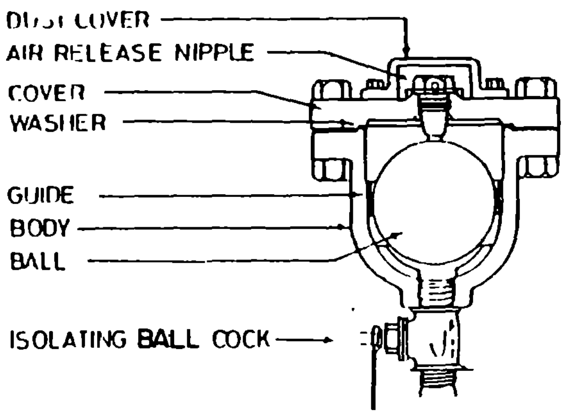
Fig. 12·3



Air Valve Arrangement (Section)

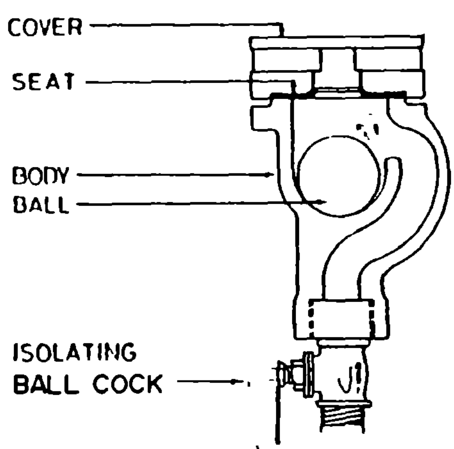
Fig. 12·4

* Location for G I to Pe connector (if applicable)



<u>Single small orifice</u>

Fig. 12·5



<u>Single large orifice</u>

Fig. 12·6

AIR VALVES

Chapter 13

COST ESTIMATES

CHAPTER 13

COST ESTIMATES

CONTENTS

LIST OF ANNEXURES

LIST OF TABLES

CHAPTER 13

COST ESTIMATES

1 INTRODUCTION

General

1.1 Once the design of the works has been finalised a cost estimate for all the works to be undertaken on each scheme is to be made. The cost estimate will identify the necessary financial contributions required from both the village community and from LGRDD. The estimate includes cost of structures, pumps and electrical connections as well as the cost of pipes and fittings. This activity will be computer assisted in part. The preparation of the cost estimate is step 12 of the design steps set out in chapter 7 of this manual. This chapter gives guidance on the preparation of the Cost Estimate for each scheme.

1.2 The cost estimate will give the WSC a figure for what funds are required to be raised by the community. Some of the works, such as manual labour for excavation of pipeline trenches or source protection, or transportation of pipes and/or materials, may be undertaken voluntarily. However such significant subsidy to the WSC cost must be reflected as part of the financial contribution to the scheme by the community.

Essential Community Involvement

1.3 The rates for each of the elements of the works must be those agreed by the community as appropriate to the location of the village and the works. The villagers themselves know the costs of local materials and transportation within their village and this local knowledge must be incorporated into the cost estimation process. The Cost Estimate must be discussed and agreed by the WSC so that the community is aware and in agreement to the expected cost which the people will have to bear. This agreement of the villagers is to be signified by the signature of the WSC representative on the cost estimate pro forma.

LGRDD Assessment

1.4 The figure of the projected cost per capita is of particular importance to LGRDD. This figure will enable government to assess whether or not the cost of the scheme is acceptable to government.

2 COST ESTIMATION DETAILS

2.1 This section gives guidance on how to complete the scheme cost statement pro forma which is included in annexure 13.1. In the attached scheme cost statement shades in the respective boxes reflects the responsibility of cost to be born against respective items shown.

Land Purchase

2.2 Any land which is required to be purchased in a village for the placement of structures for a water supply scheme is the responsibility of the community itself. It is likely that in most cases the land will be given freely by community member. However a cost should be reflected in the cost estimate, whether the land is given freely or not, as it is important to recognise this vital contribution of the community to the scheme in financial terms.

2.3 Land costs should be determined for the areas of land for source protection, tanks, pump houses and tapstands. A figure for the total area of land required for these structures is to be calculated or can be assessed from the drawings except for the source works which is site specific.

2.4 The village community knows what is the cost of land within the village. Typically the cost may be in the order of Rs 60 to Rs 80 per square foot. However the WSC is requested to give the actual cost in that particular village. The total area of land to be allotted is then multiplied by the community rate and entered into the column under WSC contribution.

Source Development

2.5 The cost of development and protection of the source is to be estimated according to the following guidelines:

(a) Springs

2.6 This cost is to be borne entirely by the community. Dependant upon the size of the spring and the relative scope of the protection work required the cost will vary from say Rs 5,000 to a maximum of Rs 40,000 for a large complex springs. An average cost may be in the order of Rs 15,000. Although the community may give labour freely, this contribution should be reflected as a cost on the estimate. This cost is inclusive of spring collection box.

(b) Hand-dug Well Rehabilitation

2.7 The cost rehabilitation and protection of a hand- dug well is the responsibility of LGRDD. The cost may be in the order of Rs 25,000 for smaller diameter wells to Rs 50,000 for those of larger diameter.

(c) Boreholes

2.8 The cost of a borehole is the responsibility of LGRDD and according to present experience, is approximately Rs 900,000.

Pipelines

2.9 For pipelines the capital cost is to be borne by LGRDD whereas the labour cost for pipe laying is to be borne by the community. The capital cost for GI pipe (medium duty) should be entered under the column for LGRDD, for each diameter according to the prices of the last order placed in the particular district.

2.10 Until more exact costs are obtained, the capital cost for polyethylene (Pe) pipe should be entered under the column for LGRDD, for each diameter according to 50% of the prices of the last order placed for GI pipe in the particular district.

2.11 The cost for laying of GI pipe is calculated by the spread sheet attached as annexure 13.4. The labour rate for laying of respective pipe diameters used to calculate the arrive at pipe laying cost is tabled as under:

LABOUR RATE FOR PIPE LAYING	
PIPE DIAMETER	**RATE / METER LENGTH OF PIPE**
0.50" to 1.00"	Rs 3.00
1.25" to 2.00"	Rs 6.00
0.50" to 1.00"	Rs 9.00

Table 13.1: Labour Rate for Pipe Laying

2.12 The rate for laying of Pe pipe may be estimated at 50% of the above costs and entered under the column for WSC cost.

Fittings

2.13 The rate for fittings should be at 10% of the total capital cost for GI pipe. If GI and Pe pipe is to be used then the rate shall be at 15% of the total capital cost of the GI and Pe pipe combined.

Tanks

2.14 The costs for tanks shall be as per the estimates which are included as annexure 9.1 of chapter 9 of this manual. The cost of tanks should be inflated in accordance with the latest premium on Composite Schedule of Rates (CSOR) 1979.

Tapstands, Valve Protection and Tapstands

2.15 Tapstands are to be estimated in accordance with the current estimates. In April 1994 this was estimated at Rs 1234 per tapstand according to the PCI rate of Rs 845 inflated by annual rate of inflation upto Jan 1994. As of present date the rate would have increased further by an amount of inflation upto Jan 1995.

Pumps

2.16 The capital and installation costs for pumps is to be borne by LG&RDD. Capital cost shall be as per estimate used in the design spread sheet for the optimised design of pumping main and pumps, which is explained in Chapter 11 of this manual. The estimated cost for pumps are represented graphically and attached as annexures 11.2 & annexure 11.3 of Chapter 11.

Electrical Connections

2.17 Electrical connections for connecting pump houses to the mains is to be borne by LGRDD and can be estimated from experience to date according to the following range of costs for the length of electrical connection to be installed:

RATES FOR ELECTRIC CONNECTION WITH RESPECT TO DISTANCE	
DISTANCE (meters)	**COST (Rs /meter length of line)**
Up to 150 meter	Rs 600 / meter
From 150 m to 500 m	Rs 475 / meter
Over 500 m	Rs 350 / meter

Table 13.2: Rates for Electric Connection

Transportation Costs

2.18 This project is to build water supply and sanitation facilities in rural areas and for this purpose significant quantities of material will need to be transported to various sites throughout the village. These sites will rarely be serviced by road and as such there will be substantial porterage required by mule or hand. However, the CSOR price rates for porterage are unrealistic and not usable.

2.19 Porterage rates will vary from village to village according to several factors but topography is the major consideration. The porterage rates will be well known in the village and will be advised by the WSC. A typical rate quoted by LGRDD in late 1994 was : Rs 80 per 40 Kg for 3 Km porterage uphill (ie Rs 0.7/Kg/Km uphill). However, this appears to be excessive and a figure of Rs 0.15/Kg/Km is considered to be more realistic.

2.20 A spreadsheet has been prepared (see Annexure 13.2) from which the total estimated weight of materials for structures which will need portering, can be calculated. An assessment must be made by project staff and the WSC of the distance from the road to a selected central location within the scheme. The WSC will then advise the current porterage rate prevailing in the village. These two figures are then input as data to the spreadsheet. Estimates of the transportation cost will then be generated by the spreadsheet and the porterage cost for component materials for each of the structures can be abstracted and totalled.

2.21 In case stones are quarried locally to the site where a structure is to be built, then the weight and transportation cost is consequently reduced. A second spreadsheet (see Annexure 13.3) has been prepared to reflect these reduced costs and can be used in the same way as described above.

2.22 The spread sheet attached as Annexure 13.4 is used to calculate the total weight of GI pipe materials for all diameter used on the scheme. In order to calculate the porterage cost of all required pipes for the scheme, the suggested rate of 0.15 /Kg/Km up hill or prevailing rate in the village along with distance is entered in the spread sheet which calculate automatically to give results of total weight of pipe materials alongwith porterage cost. This spread sheet also yield results for the labour cost to lay same quantity of GI pipe as explained in para 2.11 above.

ANNEXURES

ANNEXURE 13.1
LG&RDD RWSS Project (IDA) AJ&K
Completed Scheme Cost Statement

Village/Scheme Name: **Village/Scheme No:**
Design Pop: **Date:** 22-Mar-95

Items	WSC Cost	LG&RDD Cost	Total Cost
1. Land Purchase			
2. Source Development			
2.1 Spring (Nos)			
2.2 Well - Hand dug			
2.3 Borehole			
3. Pipelines			
3.1 0.50" dia			
3.2 0.75" dia			
3.3 1.00" dia			
3.4 1.25" dia			
3.5 1.50" dia			
3.6 2.00 dia			
3.7 2.50 dia			
3.8 3.00" dia			
3.9 4.00" dia			
4. Fittings (10% of Pipe Cost)			
5. Tanks			
5.1 gallons			
5.2 gallons			
5.3 gallons			
5.4 gallons			
Collection Box/Break Pressure Tank			
6. Structures			
6.1 Tapstands (Nos)			
6.2 Valve Protection (Nos)			
6.3 Pump Houses (Nos)			
7. M&E Equipment (Pumps)			
7.1 (KW)			
7.2 (KW)			
8. Electrical Connection			
8.1 (Nos)			
9. Transportation Cost			
Totals			

Projected Power Cost:	**Rs /Month**	**Cost / Capita:**	
Pump 1 (KW)		Total Cost	ERR
Pump 2 (KW)		LG&RDD Cost	ERR
		WSC % Contrib.	ERR

For LG&RDD Directorate Use only

IDA expenditure categories	Total Cost	LG&RDD Cost	IDA Reimb.
Civil works (75% Reimbursable by IDA)			
Material & Equip. I (100% Reimb. by IDA)			
Material & Equip. II (50% Reimb. by IDA)			
Total:-			

ANNEXURE 13.2
SUMMARY OF TRANSPORTATION COST
FOR CONSTRUCTION MATERIALS
(Inclusive Of Stone Weight)

WATER STORAGE TANK CAPACITY (Gallons)	Transportation Rate (Rs/gal/Km) RCC / Brick Work Cost (Rs)	Stone Masonry Cost (Rs)
For 1000 Gallons	3.68	4.50
For 1500 Gallons	3.10	3.60
For 2000 Gallons	2.78	3.15
For 2500 Gallons	2.52	2.82
For 3000 Gallons	2.35	2.60
For 3500 Gallons	2.23	2.44
For 4000 Gallons	2.14	2.29
For 4500 Gallons	2.07	2.17
For 5000 Gallons	2.34	4.32
For 6000 Gallons	2.15	3.98
For 7000 Gallons	1.99	3.69
For 8000 Gallons	1.89	3.47
For 9000 Gallons	1.80	3.27
For 10000 Gallons	1.73	3.14
For 11000 Gallons	1.65	3.00
For 12000 Gallons	1.60	2.88
For 13000 Gallons	1.58	2.77
For 14000 Gallons	1.54	2.69
For 15000 Gallons	1.50	2.60
For 16000 Gallons	1.45	2.53
For 17000 Gallons	1.43	2.47
For 18000 Gallons	1.39	2.40
For 19000 Gallons	1.36	2.34
For 20000 Gallons	1.34	2.29
Other Civil Structures		Cost (Rs/kg/Km)
Spring Collection Box		450
Break Pressure Tank		750
Spring Protection Works		750
Pump House		2250

SUMMARY OF TRANSPORTATION COST FOR CONSTRUCTION MATERIALS (Exclusive Of Stone Weight)

Portrage Cost : Rs /Kg /Km	0.15	Distance In Kms :	1.00

DETAIL OF WORKS	TYPES OF WATER STORAGE TANKS			
	RCC / Brick Work		Stone Masonry	
	Weights	Cost (Rs)	Weights	Cost (Rs)
1. Water Storage Tanks				
FOR 1000	24.500	3.675	9.900	1.485
FOR 1500	31.000	4,650	11.880	1.782
FOR 2000	37.000	5,550	13.860	2.079
FOR 2500	42.000	6,300	15,510	2,327
FOR 3000	47.000	7,050	17.160	2.574
FOR 3500	52,000	7,800	18.810	2,822
FOR 4000	57,000	8,550	20.130	3,020
FOR 4500	62,000	9,300	21,450	3,218
FOR 5000	78,000	11,700	61,920	9,288
FOR 6000	86,000	12,900	68,370	10,256
FOR 7000	93,000	13,950	73,960	11,094
FOR 8000	101,000	15,150	79,550	11,933
FOR 9000	108,000	16,200	84,280	12,642
FOR 10000	115,000	17,250	89,870	13,481
FOR 11000	121,000	18,150	94,600	14,190
FOR 12000	128,000	19,200	98,900	14,835
FOR 13000	137,000	20,550	103,200	15.480
FOR 14000	144,000	21,600	107,930	16,190
FOR 15000	150,000	22,500	111,800	16,770
FOR 16000	155,000	23,250	116,100	17,415
FOR 17000	162,000	24,300	120,400	18,060
FOR 18000	167,000	25,050	123,840	18,576
FOR 19000	172,000	25,800	127,710	19,157
FOR 20000	178,000	26,700	131,150	19,673

ANNEXURE 13.3

SUMMARY OF TRANSPORTATION COST FOR CONSTRUCTION MATERIALS (Exclusive Of Stone Weight)

WATER STORAGE TANK CAPACITY (Gallons)	Transportation Rate (Rs/gal/Km)	
	RCC / Brick Work Cost (Rs)	Stone Masonry Cost (Rs)
For 1000 Gallons	3.68	1.49
For 1500 Gallons	3.10	1.19
For 2000 Gallons	2.78	1.04
For 2500 Gallons	2.52	0.93
For 3000 Gallons	2.35	0.86
For 3500 Gallons	2.23	0.81
For 4000 Gallons	2.14	0.75
For 4500 Gallons	2.07	0.72
For 5000 Gallons	2.34	1.86
For 6000 Gallons	2.15	1.71
For 7000 Gallons	1.99	1.58
For 8000 Gallons	1.89	1.49
For 9000 Gallons	1.80	1.40
For 10000 Gallons	1.73	1.35
For 11000 Gallons	1.65	1.29
For 12000 Gallons	1.60	1.24
For 13000 Gallons	1.58	1.19
For 14000 Gallons	1.54	1.16
For 15000 Gallons	1.50	1.12
For 16000 Gallons	1.45	1.09
For 17000 Gallons	1.43	1.06
For 18000 Gallons	1.39	1.03
For 19000 Gallons	1.36	1.01
For 20000 Gallons	1.34	0.98

ANNEXURE 13.4
SUMMARY OF TRANSPORTATION COST FOR MEDIUM DIUTY G.I PIPES

Portrage Cost : Rs /Kg /Km	0.15	Distance In Kms :	1.00

DETAIL	Transportation Cost and Rate (Rs /m/Km)			
Medium Duty GI Pipes	Length	Total Weight	Total Cost	Rate
(Nominal Diameter)	Meter	Kgs	Rs	Rs /m/Km
1. 0.50 in (15 mm)	0	0	0	ERR
2. 0.75 in (20 mm)	0	0	0	ERR
3. 1.00 in (25 mm)	0	0	0	ERR
4. 1.25 in (32 mm)	0	0	0	ERR
5. 1.50 in (40 mm)	0	0	0	ERR
6. 2.00 in (50 mm)	0	0	0	ERR
7. 2.50 in (65 mm)	0	0	0	ERR
8. 3.00 in (80 mm)	0	0	0	ERR
9. 4.00 in (100 mm)	0	0	0	ERR
Totals:	0	0	0	

ANNEXURE 13.4
SUMMARY OF M.D GI PIPE TRANSPORTATION AND LAYING COST

Portrage Cost : Rs /Kg /Km	0.15	Distance In Kms :	1.00

DETAIL	M.D GI Pipe Transportation and Laying Cost			
Medium Duty GI Pipes (Nominal Diameter)	Length in Meters	Total Weight (Kgs)	Total Porterage Cost (Rs)	Total Laying Cost (Rs)
1. 0.50 in (15 mm)	0	0	0	0.00
2. 0.75 in (20 mm)	0	0	0	0.00
3. 1.00 in (25 mm)	0	0	0	0.00
4. 1.25 in (32 mm)	0	0	0	0.00
5. 1.50 in (40 mm)	0	0	0	0.00
6. 2.00 in (50 mm)	0	0	0	0.00
7. 2.50 in (65 mm)	0	0	0	0.00
8. 3.00 in (80 mm)	0	0	0	0.00
9. 4.00 in (100 mm)	0	0	0	0.00
Totals:	0	0	0	0

Chapter 14

CONSTRUCTION PROGRAMMES AND PROGRESS REPORTING

CHAPTER 14

CONSTRUCTION PROGRAMMES AND PROGRESS REPORTING

CONTENTS

CHAPTER 14

CONSTRUCTION PROGRAMMES AND PRORESS REPORTING

1 INTRODUCTION

1.1 Although the village WSC are primarily responsible for the implementation of schemes, the LGRDD field staff are required to advise, support and check, the development of all village schemes under their responsibility. This can most effectively be achieved through the timely preparation and observation of construction programmes and through the gathering of data for routine reports.

1.2 This is a diverse project where there are many schemes throughout AJK in various stages of design and construction; significant government funds are being dispersed at numerous sites and many LGRDD support staff are engaged. It is very important for the management of LGRDD at district, divisional and directorate levels to be able to monitor project progress. This is achieved by the routine submission of reports by the individual field staff and their subsequent inspection.

1.3 The purpose of this chapter is to describe how to prepare construction programmes and reports. It also sets out to identify the benefits of preparing construction programmes and the importance of making regular and routine progress reports for the purposes of project monitoring.

2 CONSTRUCTION PROGRAMME

Why prepare a Construction Programme?

2.1 It has been observed that usually in AJK construction projects are slow to implement. This may be for many and complex reasons, but with the proper planning and monitoring of projects many of these delays can be avoided. Significant delay is often caused by the late approval and/or availability of funds for works. Accurate forecasting through proper planning will assist village WSC and government alike to improve progress. The construction programme which schedules and timetables the work to be implemented facilitates such planning.

What is a Construction programme?

2.2 A construction programme is a bar chart which indicates all the individual activities to be undertaken (on the "X" axis) and schedules the time over which these activities should be made (on the "Y" axis). The activities should include all the necessary operations required to build the scheme.

2.3 For larger schemes, separate individual programmes can be prepared to give greater detail for each major activity. For example it is advisable to prepare individual detailed programmes for the construction of a tubewell or for each large capacity tank.

2.4 Construction programmes are an essential planning aid which can be used by the WSC and/or contractor to prepare the resources required in advance. Thereby the responsible persons can arrange in good time for the funds, materials and labour to be made ready at site.

2.5 During actual construction the construction programme may be easily referred to in order to monitor progress of individual elements of the work. The programme readily illustrates the status of the works at the particular date. It can therefore be seen as to whether the work is ahead or behind forecast.

Who prepares the Construction Programmes?

2.6 The construction programme for a scheme is prepared by the LGRDD (IDA) design engineering staff with close consultation and agreement of the WSC. The WSC Supervisor should be directly involved in the preparation of this programme. Project staff must remember that the villagers will not be familiar with such programmes and the staff must therefore allow sufficient time for explanation during programme formulation. The programme is an aid for the community to be able to implement their work and it is vital that the WSC and the WSC Supervisor in particular are fully conversant with all aspects of the Construction Programme for their scheme.

Time Duration for Individual Activities

2.7 It is important that the Construction Programme represents a realistic assessment of the time it will take to undertake each item of work. Such assessments generally will be outside of the experience of the village. It is important that the programme times are not underestimated, as delays in construction will dishearten the community. Project staff therefore have a direct responsibility to give proper advice to the WSC.

2.8 From experience and discussion with LGRDD staff, WSC representatives and contractors throughout AJK, a table has been developed which give guidance on the time each activity will take to complete (see table 5.1). The time estimates given are approximate. As experience on the project grows, these figures can be revised as necessary.

2.9 The time required for the mobilisation of the resources to undertake the activities must also be considered and included. It takes time to arrange for funds and to identify, agree and organise the necessary labour and materials. This must all be allowed for in the programme.

2.10 Both project staff and the community must consider and allow for particular local conditions in the preparation of the construction programme. For example, it may be that certain area of the site are only accessible at certain times of year due to the presence of crops or snow. Or local people may only be available for contributory work at certain times of the year or possibly only for limited times during the day. Such local circumstances must be included in the programme and be mentioned in an accompanying note.

Monitoring the Construction Programme

2.11 The construction programme will be periodically and regularly monitored by the WSC and LGRDD core field staff who are supporting the village construction activities. It is suggested that this is done at intervals of two weeks and at least monthly. Such monitoring is acheived by drawing a line down through the programme according to the percentage of actual progress along each individual item bar. The line should start and finish at the top and bottom of the programme chart at the date at which the monitoring is made. It is useful but not essential that this line should be drawn in coloured ink. This line will indicate as to whether progress is as planned or behind schedule.

What to do if Progress is behind that Programmed?

2.12 Examination of the programme will highlight where problems may exist. If progress is found to be behind programme, then specific problems can be discussed and appropriate means of resolution and action can then be determined by the WSC and/or LGRDD to improve the rate of progress.

2.13 In extreme cases where progress is falling behind that scheduled, the programme may then lose relevance. It then becomes necessary for the construction programme to be remade. This will require further detailed discussion with the WSC to develop and agree a more realistic construction programme to which implementation progress can that the truly be kept by all parties. It is appropriate that the IDA assistant engineer, who was responsible for the design and the making of the original programme, should be present during this exercise.

Construction Programme Examples

2.14 An example of two typical construction programmes are attached as Figures 5.1 and 5.2. These programme were prepared by the TAU to schedule the completion of two of the Phase 1 schemes in District Bagh. Examples of how to draw a line indicating progress, as described in paragraph 2.11, above is included on Figures 5.1 and 5.2 for the end of July.

3 SCHEME CONSTRUCTION PROGRESS REPORTS

Why prepare a Scheme Construction Progress Report?

3.1 Progress reports are required to empower project management staff to monitor the progress of the works of individual village schemes, of construction phases and of the project as a whole. The actual preparation of progress reports also prompts and enables the district staff field staff to identify where progress may be late. Thus reasons for delay can be investigated and necessary remedial action can be determined with the WSC.

What is a Scheme Construction Progress Report?

3.2 A scheme progress report is a simple one page sheet upon which all the necessary information regarding scheme construction is summarised. The pro forma for a construction progress report is attached as Figure 5.3. The form has been designed so that it is simple and easy to complete following a visit to the site by project staff, usually the core overseer and/or the core AE. Thus the amount of pipe laid can be reported and also the percentage progress can be given for each of the individual elements of construction, such as source works, tanks, pumphouses etc.

Who prepares the Scheme Construction Progress Report?

3.3 Once a scheme design is made and before it can be finally approved by the APD/SE, a pro forma for the Progress Report which is specific for that individual scheme, is prepared by the Assistant Engineer (AE) responsible for the design. The standard pro forma is available on the district computer in Word Perfect. The AE will prepare a specific typed pro forma for each individual scheme using this standard pro forma. This will be included in the design report for the scheme.

3.4 The information required to make each periodic progress report is collated by the core overseer. Each report is prepared by the core AE with the assistance from the AE (IDA) as required. It is intended that each of the scheme construction progress reports should be prepared on the district computer in typed format. The updating of each report may therefore be simply achieved by recalling the previous report from computer file and updating it with the necessary amendments. Thus the making of these reports is not an onerous or time consuming task.

When is the Scheme Construction Progress Report prepared?

3.5 A progress report for each scheme in construction within each phase is to be submitted twice monthly, or as otherwise instructed by the LGRDD Directorate. The first report is to be received by LGRDD Directorate by the 2nd day of each month and the second shall be received by the 16th day of each month.

What happens to Scheme Construction Progress Reports?

3.6 The LGRDD Directorate will examine, collate and process all the submitted scheme progress reports from each district onto a spreadsheet for each construction phase. This spreadsheet summarises the reported data for each phase and has in-built calculations to generate an overall estimate of the percentage progress for each individual scheme, for each individual village and also within each construction phase. For this purpse the data is evaluated and weighted with due consideration of the respective scheme populations.

3.7 An example of a LGRDD Directorate spreadsheet indicating a typical Phase Construction Progress Status is appended as Figure 5.4. The following percentage weightings are assigned to each element to make up the overall construction progress percentage of 100%:

Source:	10%
Tanks:	15%
Pipelaying:	45%
Standposts:	15%
Pumphouse:	5%
Pump installation:	5%
Commissioning:	5%
Total:	100%

Note that if there are no pumps/pumphouses then the "unused" balance (10%) is distributed by allocating an additional 5% each to tanks and standposts respectively.

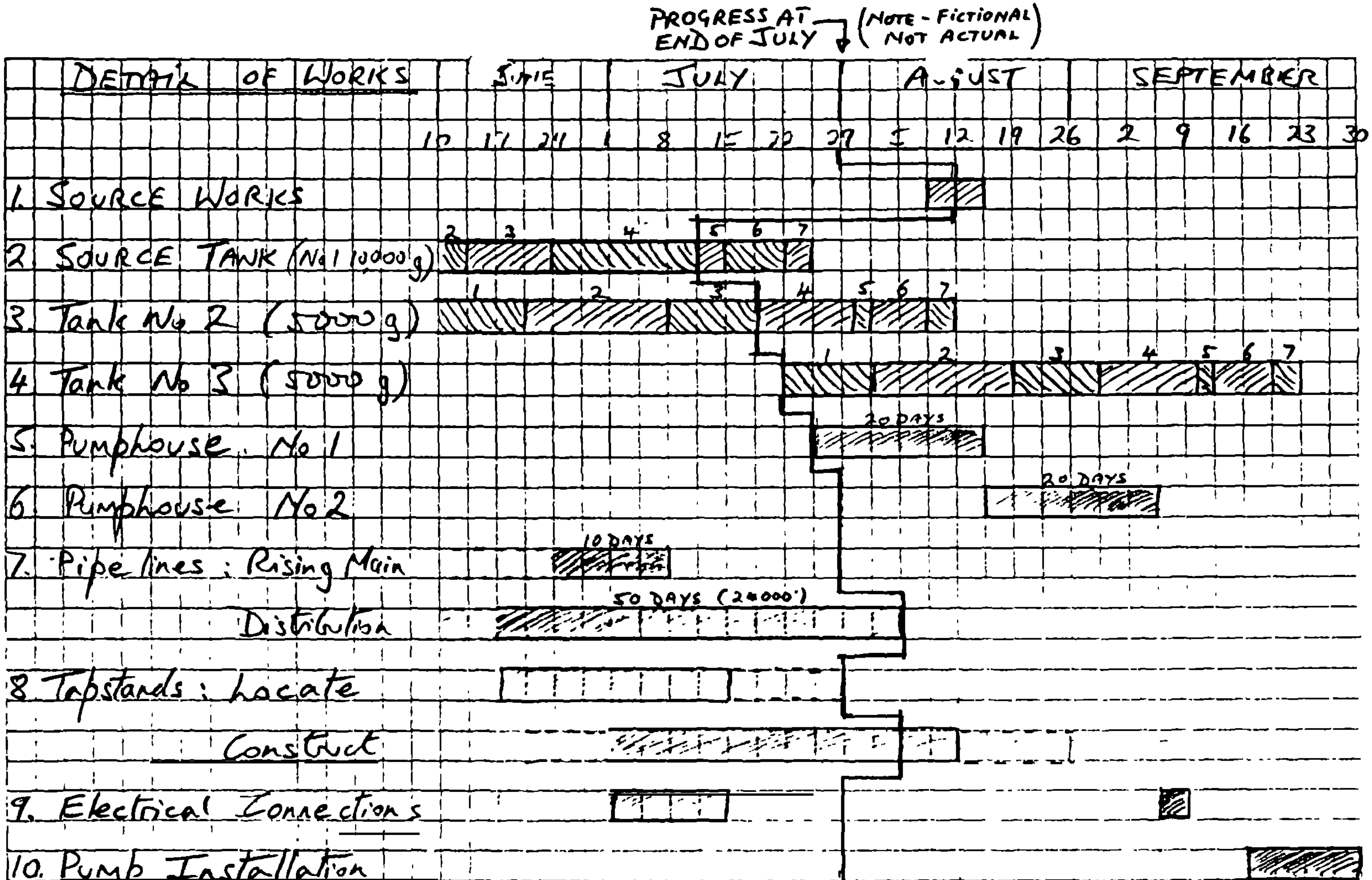
TYPICAL CONSTRUCTION ACTIVITY TIMES		
ACTIVITY	**TIME**	**REMARKS**
EXCAVATION		
Ordinary Soil	60 cft/man/day	Quantities based on 7 hours per day.
Gravel Soil	45 cft/man/day	
Boulder Mix	30 cft/man/day	
Medium Rock	20 cft/man/day	
MASONRY WORK		
Stone / Brick Work	20-25 cft/man/day	Quantities based on 7 hours per day.
Plaster Work	100 sqft/man/day	
CONCRETE WORK		
Concrete	130 cft/team/day (for 8 men team) 210 cft/2teams/day (for 13 men team)	For detail refer to Chapt 8, para 4.23
Stripping of Formwork	4-16 days	For detail refer to Chapt 8, para 6.7 to 6.8.
Curing Time	7-11 days	For detail refer to Chapt 8, para 10.15 to 10.22
WATER STORAGE TANKS		
1000 gallons	40 days	Assuming all materials are ready at site and working with 13 men team for concrete work. For detail refer to Chapt 8, para 4.23
5000 gallons	45 days	
10000 gallons	60 days	
20000 gallons	75 days	
PIPELAYING		
½" - 1½"	35-50 lengths/day	Assuming pipelaying by 1 Plumber with 2 assistants. For details refer to Chapt 11, para 2.2
2.0" - 3.0"	15-25 lengths/day	
4.0" - 6.0"	5-10 lengths/day	

Table 14.1 Typical Construction Activity Times

FIGURES

BINNIE, HUNTING, TECHRED JOINT VENTURE
Rural Water Supply & Sanitation Project

Job: HULLER - Scheme 1
Subject: CONSTRUCTION PROGRAMME - COMPLETION
Date: 17/6/94 Page 1 of 1
Job No: 6005.1 Calc. by: JTA Chkd: MMJ



TANK WORKS

	Tank 1	Tanks 2 & 3
1. EXCAVATION/FOUNDATION/BLINDING	- days	7 days
2. OUTER WALL	2 "	15 "
3. BASE SLAB	10 "	8 "
4. INNER WALL/CORE WALL	15 "	10 "
5. PLASTER INNER FACE	2 "	2 "
6. ROOF - SHUTTER/STEEL FIX/POUR	7 "	6 "
7. BACKFILL & PLASTER/PAINTING	3 "	4 "
Totals with holidays	46 days	60 days

ESTIMATE OF LGRDD FUNDS REQUIRED BY LISC.

A. Tank Materials	By 17/6	Rs 60,000
	By 24/6	Rs 60,000
	By 8/7	Rs 60,000
	By 29/7	Rs 60,000
B. Tank Labour	By 24/6	Rs 25,000
	By 8/7	Rs 25,000
C. Pipe Fittings		Rs 30,000
		Rs 3,20,000

Fig. 14.1 Huller (6005): Construction Programme - Scheme 1 completion

BINNIE, HUNTING, TECHRED JOINT VENTURE
Rural Water Supply & Sanitation Project

Date 9/6/94 Page 1 of 1

Job HUMA MOHRA Job No. 6002 Calc. by JTA

Subject CONSTRUCTION PROGRAMME - SCHEME COMPLETION Chkd

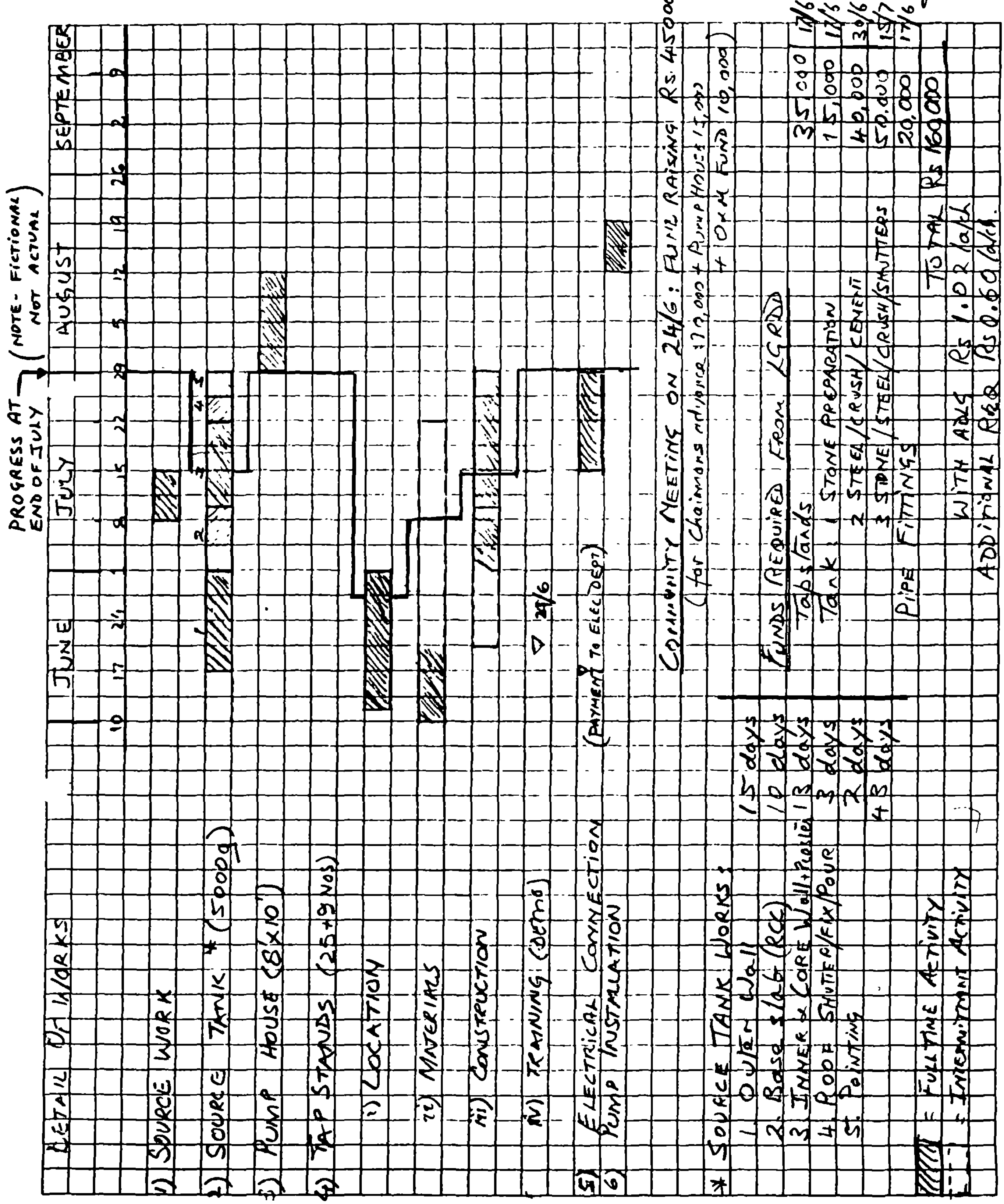


Fig 14.2 Huma Mohra (6002): Construction Programme - Scheme completion

SCHEME LG&RDD – RWSS (IDA)
Assistant Engineers Scheme Construction Progress Report

District	:	Date	:
Village Name	:	Village No	:
Scheme Name	:	Scheme No	:

SOURCE WORK % complete

Source No 1

Source No2

PIPE LAYING

Diameter (inch)	Total Required (m)	Total Received (m)	Total Laid (m)	Balance in stock (m)
0.50"				
0.75"				
1.00"				
1.25"				
1.50"				
2.00"				
2.50"				
3.00"				
4.00"				
Total:–				

Overall % pipelaying complete:

TANKS < 5000 GALLONS: Capacity % complete

No 1

No 2

No 3

No 4

TANKS > 5000 GALLONS: Capacity % complete

No 1

No 2

No 3

STANDPOSTS: Total Nos Required: Nos Completed:

PUMPHOUSE (S) % complete

No 1

No 2

etc

ELECTRICAL CONNECTION: outstanding/in progress/complete/N.A.

PUMP INSTALLATION: outstanding/in progress/complete/N.A.

REMARKS:

Signed: Position: Date:

Figure 14.3 Construcion Progress Report Proforma

Phase I Construction Progress Status

A.J.K LG& RDD IDA Assisted RWSS Project

Total Designed Population Of Phase I 17285
Over All Progress Of Phase I w.r.t Population 67%
Over All Progress Of Phase I w.r.t Schems 69%

STATUS DATE & NAME OF VILLAGE	DSGN. POP	SCHEME NO	TOTAL NO OF SCHEMES	TOTAL COST	SOURCE WORK %	WATER STORAGE TANKS < 5000 NOS	WATER STORAGE TANKS < 5000 %	WATER STORAGE TANKS > 5000 NOS	WATER STORAGE TANKS > 5000 %	PIPE LAYING (Ft) % COMPLETE TOTAL	PIPE LAYING (Ft) % COMPLETE %	STAND POST NOS % COMPLETE TOTAL	STAND POST NOS % COMPLETE %	PUMP HOUSE % COMPLETE	PUMPS % INSTALL	SCHEME COMMISSION YES/NO	OVER ALL PROGRESS %
DISTRICT MUZAFFARABAD																	
05-Jul-94 Unan Saran	920	5204	1	1,863,490	90%	2	100%	n a	n a	26000	38%	14	0%	n a	n a	No	46%
05-Jul-94 Hale	976	5305	2	506,057	100%	6	100%	n a	n a	18122	100%	22	73%				89%
	520	5305.1			100%	2	100%	n a	n a	7103	100%	13	46%	n a	n a	No	84%
	456	5305.2			100%	4	100%	n a	n.a	11019	100%	9	100%	n a	n.a	No	95%
12-Oct-94 Salmia	1100	5401	1	663,101	98%	3	83%	n.a	n a	23870	77%	22	36%	n.a	n.a	No	68%
District Progress			4	3,032,648	96%	11	94%	n a	n a	67992	68%	58	40%	n a	n.a		67%
DISTRICT BAGH																	
12-Oct-94 Huma Mohra	1080	6002	1	1,450,555	85%	1	0%	1	100%	22330	77%	25	0%	0%	0%	No	50%
12-Oct-94 Chatter	1768	6003	2	624,622	100%	5	100%	n a	n a	20100	100%	17	94%				94%
	1136	6003.1			100%	2	100%	n a	n a	14120	100%	17	94%	n a	n.a	No	94%
	632	6003.2			100%	3	100%	n a	n a	5980	100%	n a	n a	n a	n a	No	95%
12-Oct-94 Chowki	1995	6004	2	2,454,619	100%	6	100%	n a	n a	49020	59%	57	37%				67%
	815	6004.1			100%	4	100%	n a	n a	22810	11%	27	0%	n a	n a	No	35%
	1180	6004 2			100%	2	100%	n a	n a	26210	100%	30	73%	n a	n a	No	90%
12-Oct-94 Hullar	3111	6005	3	2,579,425	83%	3	100%	3	40%	46610	29%	79	0%	0%	0%		34%
	2137	6005 1			50%	1	100%	3	40%	33370	21%	50	0%	0%	0%	No	23%
	364	6005 2			100%	1	100%	n a	n a	6600	6%	10	0%	n a	n.a	No	33%
	610	6005.3			100%	1	100%	n a	n a	6640	92%	19	0%	n a	n a	No	71%
12-Oct-94 Basti Pul Ban	1307	6211	3	679,739	67%	3	67%	n a	n a	30070	69%	34	88%				62%
	410	6211.1			100%	1	100%	n a	n a	14440	100%	13	100%	n a	n.a	No	95%
	378	6211.2			100%	1	100%	n a	n.a	6300	100%	10	100%	n a	n.a	No	95%
	519	6211 3			0%	1	0%	n a	n a	9330	0%	11	64%	n a	n a	No	13%
12-Oct-94 Bai Dharah	1557	6212	3	1,019,486	100%	5	100%	n.a	n a	35280	98%	59	54%				86%
	696	6212 1			100%	1	100%	n.a	n a	14500	100%	26	88%	n.a	n.a	No	93%
	531	6212 2			100%	3	100%	n a	n a	13240	100%	20	50%	n a	n.a	No	85%
	330	6212 3			100%	1	100%	n.a	n a	7540	89%	13	23%	n.a	n.a	No	75%
District Progress			14	8,808,446	89%	23	78%	4	23%	203410	58%	271	38%	n a	n a		57%
DISTRICT MIRPUR																	
12-Oct-94 Uymberyala Jandpir	3471	9101	1	2,518,816	100%	15	100%	n a	n a	41925	74%	60	0%	100%	100%	No	68%

Fig. 14 4 Phase Construction Progress Status

Chapter 15

MEMORANDUM OF UNDERSTANDING

CHAPTER 15

MEMORANDUM OF UNDERSTANDING (MOU)

CONTENTS

CHAPTER 15

MEMORANDUM OF UNDERSTANDING (MOU)

1 INTRODUCTION

1.1 The Memorandum of Understanding (MOU) is the formal agreement which sets out the responsibilities and obligations of both the community and LG&RDD in the implementation of a water and sanitation scheme. The signing of the MOU is step 4.4 of the Project Implementation Steps which are described and set out in chapter 2.

1.2 A sample pro forma of the MOU is attached as annexure 15.1. This is the modified and improved version of the approved MOU, which was issued by the TAU to LGRDD in October 1994 and should be adopted in the near future.

2 WHEN IS THE MOU SIGNED ?

2.1 The community (WSC) and government (LG&RDD) are the two parties represented in the MOU. Once the community through the WSC agree the design and the cost estimates for a scheme, and the design has received Final Approval from the competant authority in LGRDD, then the MOU between the can be signed.

3 WHAT DOES THE MOU CONSIST OF ?

3.1 The MOU will comprise three parts:

(i) The MOU (The standard copy of the MOU detailing responsibilities);

(ii) The design report for the scheme; and

(iii) Schedules specific to the schemes including:

- amounts and expected dates of lump sum payments to be made to the village by LG&RDD for construction of LG&RDD funded works; and
- schedule of materials to be supplied by government to the village such as pipes and fittings

3.2 The MOU will also detail procedures for the handling of any disputes which cannot be resolved through discussion and compromise within the WSC.

4 WHO SIGNS THE MOU ?

4.1 The MOU should be signed by the WSC Chairman, Secretary and at least one other WSC member along with the representatives of the LG&RDD such as ADLG, AE and EO. The signing of the MOU should be witnessed by the villagers and attested by a member of the local judiciary. To ensure that the MOU can be properly attested. The WSC will need to paste a four rupee court revenue stamp to the top of the first page of the standard MOU.

5 WHO RECEIVES THE MOU ?

At least two copies of the MOU should be signed in original:

- one copy for the WSC
- one copy for the LG&RDD District Office

ANNEXURES

ANNEXURE 15.1

MEMORANDUM OF UNDERSTANDING (MOU)

(space for revenue ticket)

MEMORANDUM OF UNDERSTANDING (MOU)

First Party : Water and Sanitation Committee______________________

Village_______________Union Council ________________

Markaz _______________ District______________________

Second Party: LG & RDD, Azad Jammu and Kashmir through Assistant Director_________District________________________

Whereas it is declared that this MOU is signed on _________________ at _________________ between the parties in order to provide clean water and sanitation facilities to the rural population. Both the parties agreed on the following rights and obligations respectively:-

a. Rights and obligations of the Party - I

1. Constitute a committee for the whole village or the scheme.
2. Cooperate with the second party for surveying, planning, and designing of the scheme(s).
3. Complete the assigned implementation work in the scheme(s) with sincerity and dedication.
4. Open the Bank account and deposit into it local donations and Govt contribution and fees etc.

5. Collect the water rates/dues as well as emergency contributions from consumers.

6. Undertake 100% responsibility of operation and maintenance on self help basis after completion of scheme(s).

7. Prevent damage to scheme(s) and loss of water.

8. Facilitate training of suitable persons from the community in such aspects as:

   - pipe installation and jointing
   - maintenance of different parts of the scheme and particulariy standposts
   - correct operation of the scheme

9. Acquire the land and water sources without any compensation as per design requirements.

10. Where the water source is a shared one, arrange for a separate written agreement to be made covering access to, and maintenance of any shared facilities.

11. Settle all the local disputes by reconciliation.

12. Give all possible assistance to the representatives of the second party.

13. Maintain accounts (income/expenditures) in such a manner as advised by the second party.

14. Involve the women in scheme(s) matters effectively.

15. Educate the water users on the issues of hygiene and sanitation.

16. <u>**Before Start of Work**</u>

    (a) Prepare a list of all the water users and households.

    (b) Collect water rate fee and local contribution.

    (c) Deposit Govt. contributions into official account of committee.

    (d) Keep the accounts up to date.

17. <u>During construction of the scheme(s)</u>

(a) Provide local material like sand, stone, clay gravel etc.

(b) Arrange the transportation for material from nearest mettled road head to site and bear the cost.

(c) Fitting and burial of pipes as per design.

(d) Control store stock of the material provided by the second party.

(e) Provide services of skilled/unskilled labour voluntarily as and where required by the second party for the scheme(s).

(f) Adhere to design and technical advice.

(g) Return all the unused material to the second party.

18. <u>After completion</u>

(a) Prevent unauthorised connections.

(b) Disconnect unauthorised connections if any.

(c) Authorise connection after prior approval of the Assistant Engineer.

(d) Take immediate measures for repairs and maintenance and ensure uninterrupted service of the scheme(s).

(e) Collect any emergency contribution water rates and deposit into official committee accounts.

b. <u>Rights and obligations of the Party - II</u>

1. Prepare technical design of the project.

2. Give information on the scheme(s) to the committee.

3. Arrange Govt. contributions for the scheme(s) in cash and material as agreed.

4. Prepare work schedules and time-tables and follow them and also help the committee to follow them.

5. Impart training to plumbers and technicians who are deputed by committee.

6. Advise on the proper maintenance of the office records of the committee.

7. Arrange the supervision of the scheme(s) during construction and after the completion.

8. Provide assistance to the committee to rehabilitate scheme(s) affected by natural calamities. Assistance for making up the losses may be up 25 % of the cost of the scheme(s).

9. Monitor the scheme(s) after completion.

c. **Misappropriation**

1. If there is any misappropriation of money or materials provided by the first party, then punitive action can be initiated by the second party to recover the money or materials.

Date:________________

Party I

Chairman with Father's Name

Secretary with Father's Name

Member with Father's Name

Party II

Assistant Director Local Govt.

Attested

Magistrate Class I

Chapter 16

DESIGN REPORT

CHAPTER 16

DESIGN REPORT

CONTENTS

LIST OF ANNEXURES

ANNEXURE 16.2

MODEL DESIGN REPORT

Challani
District Bagh
Village/Scheme No 6501.1

CONTENTS

APPENDICES

Not included.

CHAPTER 16

DESIGN REPORT

1 INTRODUCTION

1.1 The design report represents the culmination of work by the design teams to produce a scheme design. The preparation of the design report is Design Stage 13 of the Design Procedures which are described in chapter 7 of this manual.

1.2 The Design report collates the design work of the LGRDD design team on a scheme. The design report is the key document which will be used by the WSC and the LGRDD core staff to arrange and construct the works. This chapter gives guidance on the preparation of the Design Report. Design Reports must be neatly produced and in typed format.

1.3 A design report should be produced for each scheme. Design Reports may be grouped together to cover several schemes in the same revenue village. However this is only recommended when:

(i) the schemes to be implemented are in the same construction phase; and
(ii) the village has an homogeneous population under a strong WSC.

1.4 In July 1994 a model Design Report was produced by the TAU for the village Salmia as a prototype. The text of this report has been developed and is reproduced in Annexure 16.2 as an example for a typical village. A hypothetical village called Challani has been invented for the purposes of illustration. Appendices are not included with the example. The format of designs report on this project will be similar to this model. The text of the model is available to LGRDD staff on computer diskette for use and amendment for ease of developing future design reports.

2 PURPOSE OF THE DESIGN REPORT

2.1 The purpose of a Design Report for a scheme is to make a concise summarised record of all the essential details of what is to be built on the scheme. This report will serve as a ready record of the design for the scheme. The WSC and in particular the WSC Supervisor, will regularly need to refer to this report. The core staff of LGRDD who are responsible to support the WSC in their construction activities will also need to use this report.

3 WHO PREPARES THE DESIGN REPORT ?

3.1 The Design report shall be prepared by LGRDD staff who participated in the construction of the scheme. The Assistant Engineer (IDA) will have the primary responsibility for this work with direct assistance from overseers, draughtsman, extension officer, extension staff, The Design Report should be in typed format produced on the LGRDD District computer as a standard document. The Technical Resource Pool (TRP) should assist the district staff with the production of the reports in order to establish the standard procedures and format.

4 WHEN IS THE DESIGN REPORT PREPARED ?

4.1 When all the design review/summary work and related data, information, surveys, estimates and other documentation concerning the design of the scheme has been finalised the Design Report is prepared and submitted to the competent authority LGRDD for issue of Final Approval.

4.2 The contents of the Design Report are not difficult to prepare as essentially entails collation of the items which are required to be submitted for Final Approval. There is the addition of a descriptive text following a standard format. The district AE will begin to prepare the elements of the Design Report following "Approval in Principle" of the scheme design. The Design Report will be checked by the TRP before the report is copied and bound which may itself be under TRP supervision. This latter process can be undertaken at the Directorate who have the necessary resources readily available.

5 WHO RECEIVES THE DESIGN REPORT ?

5.1 Six copies of the Design Report are to be produced. Two copies of the Design Report should be distributed to each of the following:

(i) the scheme WSC;
(ii) the LGRDD district office; and
(iii) APD/SE LGRDD Directorate Muzaffarabad.

5.2 The Design Report will be formally presented to the community represented by the WSC at the signing of the MOU.

6 STORAGE OF MASTER DOCUMENTS

6.1 Proper management and storage of all information is vital. A suitable filing system must be correctly provided for in the District office of the AE where all the material can be safely kept. It is advised that the files are numbered according to the village and scheme numbers.

6.2 All the original masters of the sketches, drawings, completed pro forma, computer print outs and other documentation relating to the scheme are to be organised into a single file. This important file is to be registered and kept securely in a metal filing cabinet. The file must not be exposed to damp or moisture and must be protected from animals/insects which may consume paper. Drawings may be kept separately by the District draughtsman, but under the same number in a purpose made cabinet.

6.3 In order to have some contingency against risk of fire in offices, it is advised that all computer data and backup files which are recorded on computer disks should be kept properly and securely in a separate room from the paper files. Data must be kept in village directories with sub-directories for each scheme.

7 CONTENTS OF THE DESIGN REPORT

7.1 As described above the Design Report documents includes all the elements of the scheme design which has been agreed by the WSC on behalf of the village ready to receive Final Approval by the competent authority in LGRDD on behalf of the government. Project staff in the Districts will be able to readily abstract information from their existing files in order to compile the Design Report. The main elements of work are included in Annexure 16.1, titled "Contents of Scheme Design Report". A Model Design Report with the text only (ie without appendices) of a typical scheme is included in Annexure 16.2. This section describes the contents of the Design Report.

Section 1: Village Information

Sub-section 1.1 Description of Scheme

7.2 The text will indicate how the scheme was selected, and summarise data from the baseline survey. Description of the topography will be given together with explanation of the village schemes and of this scheme in particular.

Sub-section 1.2 Baseline Survey

7.3 The text will normally indicate basic data abstracted from the baseline survey (BLS). However if errors in the BLS have been found during the design period then details of these must be recorded here.

Sub-section 1.3 Scheme Coverage

7.4 The percentage of the total number of houses in the revenue village which are covered by this scheme must be stated here. The Village Coverage Monitoring Form (VCMF) will be attached to the Design Report as Appendix A (see annexure 7.4 of chapter 7).

Sub-section 1.4 Note on Specific Agreements

7.5 The text will refer to all agreements which the village may have made with third parties, which are specific to the scheme. This will typically include, for example, agreements concerning the securing of access rights to source(s), or concerning the sharing of common sources, or to land for the building of tanks. Copies of all such agreements are to be included in Appendix B.

Sub-section 1.5 Establishment of Village Water and Sanitation Committee

7.6 This will state the names and posts of the individuals appointed to the WSC and what date the WSC was formed.

Sub-section 1.6 LGRDD Staff Resources

7.7 The names of LGRDD staff who supported the design will be recorded here.

Sub-section 1.7 Construction Phase

7.8 This sub-section will record under which phase of the IDA project the scheme is to be constructed.

Section 2: Village Scheme Design

Sub-section 2.1 Design Criteria

7.9 The Design Report will state the design criteria under which the scheme has been designed. Any deviation from the criteria as set out must be indicated here. The design criteria is included in the appendix C attached to the Design Report (refer to chapter 6 of this manual).

Sub-section 2.2 Design Review/Summary

7.10 The Design Report will include all the completed pro forma for Design Review/Summary and all design calculations such as storage capacities, hydraulic statements. These will be included in Appendix D (see annexure 7.1 and annexure 7.2 of chapter 7).

7.11 For the first 70 villages, the text of the Design Report will indicate in summary the main changes made from the original Nespak design.

Sub-section 2.3 Source Yield Monitoring

7.12 A note will be written indicating how many source yield measurements have been recorded to date, before and during the design and construction periods. For springs this sub-section will include assessments of the maximum yield, the minimum yield, and the safe yield. For hand dug wells, the maximum and minimum rest, or static water levels are to be recorded. The source yield measurement record is to be included in Appendix D (see annexure 8.2 of chapter 8).

7.13 The WSC appointed scheme operator should continue to monitor the yield of springs or water levels of wells on at least a monthly basis. It remains necessary to know how much water is available for the community throughout the year. This is particularly important where:

(i) the safe yield is less than twice the demand which will directly influence to the WSC future decisions permitting on yardtaps and/or house connections; and

(ii) the safe yield is ever critical, ie safe yield is less than demand, where the information is required by the WSC for the purposes of determining possible rationing of water supplied.

7.14 Such readings taken by the operator should periodically be collected by LGRDD for record on file.

Sub-section 2.4 Transmission Mains Design

7.15 This sub-section will describe in summary the design of the transmission mains (refer to chapter 10 of this manual).

Sub-section 2.5 Storage Tank

7.16 This sub-section will describe in summary the design of the storage on the scheme (refer to chapter 9 of this manual).

Sub-section 2.6 Future Yardtaps or House Connections

7.17 The Design Report will include a record of the advice given to the community as to whether or not yardtaps or house connection should be permitted after the statutory two years after commissioning. If the source yield becomes at any time critical, (ie safe yield is less than demand) then such connections must never be permitted.

Sub-section 2.7 List of Tapstand Addresses

7.18 A list of the householders who are adjacent to each numbered tapstand is to be included in Appendix E.

Section 3 Scheme Statements

Sub-section 3.1 Signing Letter of Intent

7.19 As appropriate to village schemes after the first 70 villages the date of the signing of the letter of intent is to be included in this sub-section (see annexure 2.3 of chapter 2).

Sub-section 3.2 Schedule of Pipe and Fittings

7.20 A schedule of the quantities for pipes and fittings required for the scheme is to be prepared according to the guidelines set out in this manual and included in Appendix F to the Design Report (refer to chapter 12 of this manual).

Sub-section 3.3 Construction Programme

7.21 The construction programme which will have been developed in consultation with the WSC following the guidelines contained in this manual. The construction programme schedules completion of the scheme will be within included in Appendix G. The text will summarise the construction period and scheduled completion date (refer to chapter 14 of this manual).

Sub-section 3.4 Scheme Construction Report Pro forma

7.22 A pro forma for the reporting of construction progress is included in Appendix H. The pro forma will be used to easily complete biweekly reports by LGRDD staff

Sub-section 3.5 Note on the Cost Statement

7.23 The total cost of the scheme shall be estimated and calculated as described in chapter 13 of this manual and included in appendix I. The cost estimate state what funds are to be expended by government and the community respectively in order to build the scheme. The standard pro forma for the scheme cost estimate is to be signed by the WSC and includes calculations for the cost per capita and the percentage of the cost contributed by the community.

7.24 The text shall indicate:

(i) the total estimated cost of the scheme;
(ii) the total average cost per capita of design population; and
(iii) the percentage of the total cost which will be contributed by the village and government respectively

Sub-section 3.6 Approval in Principle

7.25 The text shall state the date when the competent authority in LGRDD gave approval in principle to the design and indicate what major changes, if any, were made to the design since this date.

Section 4 Drawings

7.26 Copies of each of the final fair copy of all the relevant drawings are to be included in Appendix J and mentioned here in the text.

8 APPENDICES

8.1 All the appendices required to be included with the design report, as listed in annexure 16.1, have been mentioned above and are further detailed in chapter 7 of this manual and chapters respective to the items / works in this manual.

ANNEXURES

ANNEXURE 16.1

CONTENTS OF SCHEME DESIGN REPORT

1 VILLAGE INFORMATION
Description of Scheme
Baseline Survey
Scheme Coverage
Note on Specific Agreements
Establishment of Village Water and Sanitation Committee
LGRDD Staff Resources
Construction Phase

2 VILLAGE SCHEME DESIGN
Design Criteria
Design Review/Summary
Source Yield Monitoring
Transmission Mains Design
Storage Tanks
Future Yardtaps or House Connections
List of Tapstand Addresses

3 SCHEME STATEMENTS
Signing of the Letter of Intent
Schedule of Pipe and Fittings
Construction Programme
Scheme Construction Report Proforma
Cost Estimate
Approval In Principle

4 DRAWINGS

5 APPROVAL IN PRINCIPLE

APPENDICES

A Village Coverage Monitoring Form
B Specific Agreements
C Design Criteria
D Completed Design Review Pro forma and Design Calculations including:
- CAD hydraulic design input data and outputs;
- Source Yield Measurement Records;
- Storage Assessment Calculations;
- Hydraulic Gradeline Profiles; and
- Optimised Design of Pumps and Pumping Mains (if applicable)

E List of Tapstands with address (name of Householders)
F Schedule of Pipe and Fittings
G Construction Programme
H Scheme Construction Report Proforma
I Cost Estimate with:
- Transportation Cost Spread Sheet;
- Transportation Cost Spread Sheet for Pipe and Laying; and
- Water Storage Tank Cost with Premium Applied.

J Design Drawings:
- Sketch Map of Revenue Village with Scheme Locations;
- Pipeline Layout Drawing; and
- Source Works Design Sketch.

ANNEXURE 16.2

MODEL DESIGN REPORT

Challani
District Bagh
Village/Scheme No 6501.1

1 VILLAGE INFORMATION

Description of Village Scheme

1.1 The village of Challani was selected by District and Government authorities in 1990 to be included in the LGRDD (IDA) supported Rural Water and Sanitation Project.

1.2 Challani is located in a hilly area on the east facing slope of a steep sided valley. There are seven small springs in the village which serve sources for drinking water. For the people of this scheme, the villagers identified a suitable source on the west side of the valley in a forested area in the neighbouring village of Chamlar. Water from this spring is to be piped to north side of Challani by gravity, where it is distributed via three tanks and serves 22 nos. standposts.

Baseline Survey

1.3 A baseline survey (BLS) was undertaken in October 1994 by the Extension staff of LGRDD in order to establish the demographic and other related information regarding the existing water and sanitation conditions in the village. The baseline survey can be inspected at LGRDD District or Directorate offices.

Scheme Coverage

1.4 The BLS indicates that village of Challani has 100 houses and a total population of 850. The actual average population per household is therefore 8.5 persons. There are two schemes each with its own WSC, and this scheme covers 65 (65%) of the present total number of houses in the village and a present population of 552 persons. The Village Coverage Monitoring Form is included in Appendix A.

1.5 Of the remaining 35 nos houses, 27 covered by a separate scheme (scheme No 6501.2) and which are separated from the main village by a ridge. However 5 houses are located above the scheme and can only be served by pumping from one of the tanks of this scheme and 3 houses are served by their own protected spring. Design proposals for this a pumped extension to the 5 houses above the scheme are being examined by the WSC.

Note on Specific agreements

1.6 The WSC obtained permission to use the spring source from the owner, a Mr Abdul Ali Khan, who has signed a formal "Dedication for public use" on 16 November 1994. A copy of this document is included in Appendix B.

Establishment of Village Water and Sanitation Committee

1.7 A Water and Sanitation Committee (WSC) was formed in July 1994 which consists of the following members:

- Ch. Nazir (Chairman)
- Raja Raffique Kiani (Secretary and Treasurer)
- Assim Qureshi (WSC Supervisor)
- Raja Khalid

LGRDD Staff resources

1.8 LGRDD supported the design of this scheme with the following staff (IDA incremental):

- Assistant Engineer	Raja Zaffar Hussain
- Extension Officer	Raja Abid Khan
- Extension Worker	Mustafa Khan
- Extension Worker	Khaddum Shah

Construction Phase

1.9 It is planned that this scheme will be implemented under Phase III of the IDA project.

2 VILLAGE SCHEME DESIGN

Design Criteria

2.1 The scheme was designed according to the design criteria adopted by LGRDD for the IDA project in July 1994 and is included in the Appendix C.

Design Review

2.2 The original design was prepared by national consultants, M/S NESPAK in 1990. The design was reviewed by LGRDD according to the above design criteria and following standard design review procedures. The review was reported on the standard LGRDD pro forma, which is included in Appendix D together with the design calculations.

2.3 The original scheme was designed by NESPAK to cover 45 houses. During the BLS and design review it was established that there are now 65 houses in the scheme area.

2.4 The original scheme was for a design population of 391 whereas the BLS data revealed that the present population for this scheme is 552, when factored by 1.34 i.e. at 3% growth rate over 10 years, the design population is 740, which represent an increase of 90%. Similarly the calculated design demand increased from 4700 gpd to 8700 gpd; this represents an increase of 85%.

Source Yield Monitoring

2.5 The source yield has been monitored over a six month period only.The dry season yield of the source measured in early June 1994 was found to be significantly less than the NESPAK measured yield. The safe yield of the source was found to be some 45% less than demand, but the indications are that for most of the year the yield is significantly greater than the demand. The minimum measured yield is less than demand. The maximum measured yield was over twice the demand.

Transmission Mains Design

2.6 The design of the transmission main was revised to permit a flow of water in excess of the demand so that almost twice the demand may be delivered to the village during periods of higher source yield. The water supply to Challani scheme 1 flows under gravity via a transmission main which is of 32 mm and 25 mm dia and totals 2281 m long. This main falls some 444 m to cross a nullah before

climbing to the main 1500 gallon tank which is some 88 m below the elevation of the source

Storage Tanks

2.7 This scheme requires storage for 33% of demand or 3000 gallons. One 2000 gallon storage tank had already been built by the community by the time of the review. The built storage capacity of this tank is more than adequate for its location. The two other storage 1000 gallon storage tanks would have given more than enough storage if built of conventional masonry. However the community has determined to produce two Pe tanks of 500 gallons each, which will meet the storage requirement and is less costly.

Future Yardtaps or House Connections

2.8 The community has been advised that house connections cannot be made in the first two years following commissioning. As the safe yield and the minimum measured yield is less than demand, the WSC has been cautioned that future yardtaps will not be recommended. The community has been advised and the WSC have agreed to continue to monitor spring yield on a regular monthly basis.

List of Tapstand Addresses

2.9 A list of the householders adjacent to each numbered tapstand is included in Appendix E.

3 SCHEME STATEMENTS

Schedule of Pipe and Fittings

3.1 A schedule of the quantities for pipes and fittings required for the scheme can be found in Appendix F.

Construction Programme

3.2 A construction programme has been developed with the WSC which schedules completion of this scheme within 12 months ie by 31 January 1996. The Construction programme is included in Appendix G.

Scheme Construction Report Proforma

3.3 A pro forma for the reporting of construction progress to be made biweekly by LGRDD staff is included in Appendix H.

Cost Estimate

3.4 A summary of the cost estimates can be found in Appendix I. The cost estimate has been made in consultation with the WSC who have agreed to the estimate. The cost of the scheme approximates to Rs 5.8 lakh or Rs 784 per capita for the design population.

3.5 The relative proportions of the total capital costs borne by the community and the government is 23% and 73% respectively.

Approval in Principle

3.6 The design of the scheme was approved in principle by LGRDD on 15 November 1994. The elevation of one standpost (No 14) was lowered to remain within required limits.

4 DRAWINGS

4.1 A sketch of the village and layout of the scheme are included in Appendix J.

4.2 Sketches for the source protection works, both for the layout and construction details, have been developed in consultation with the WSC Supervisor who understands what is to be constructed.