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PILOT PROJECT FOR FARMER-MANAGED IRRIGATED AGRICULTURE UNDER THE LEFT BANK OUTFALL DRAIN STAGE 1 PROJECT, PAKISTAN

MAINTENANCE PLANS FOR IRRIGATION FACILITIES OF PILOT DISTRIBUTARIES IN SINDH PROVINCE, PAKISTAN

Volume One
Dhoro Naro Minor, Nawabshah District

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FOREWORD

The Water Users Federation (WUF) for each pilot distributary was established in mid-December, 1996. Three weeks later, a walk-thru survey was conducted along each distributary channel, where farmer leaders and IIMI staff walked together discussing the many maintenance and operational problems along the way. While walking, numerous farmers were encountered and discussions were held with them. There was a great deal of enthusiasm among the participants, even though it was Ramazan.

One year later, two days were spent with each WUF. The first day was spent conducting another walk-thru survey very similar to the survey conducted a year earlier. The second day was a large meeting to discuss the maintenance program, operational situation with particular emphasis on achieving equitable water distribution among the watercourses, and the combined management of the irrigation and drainage facilities.

The Dhoro Naro Minor WUF managed the desilting campaign during June and July of 1997 at a cost of Rs.63,500 (US $ 1.00 = Rs. 44). Stabilizing the embankments cost another Rs.142,500. Thus, the total cost of deferred maintenance was Rs.206,000. In addition, Rs.163,000 were spent on various improvements. Project funds were used to pay half of these costs, while the WUF also paid half. Their achievements durisng 1997 are highly impressive.

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1. INTRODUCTION

Pakistan has a huge gravitational surface irrigation network. An efficiently organized irrigation system was started during the colonial regime. Since then, considerable efforts have been made to manage it efficiently and effectively. But due to ignorance of environmental changes, increasing demands for good drainage system, increasing sedimentation (siltation) problems in the irrigation reservoirs and conveyance system, social and political influence in irrigated agriculture, input-output budgetary imbalances, and a lack of an adequate technological and institutional framework for operating the system in accordance with design criteria, this huge system has steadily become more dysfunctional.

With these concerns the Government of Sindh decided to implement a participatory approach in irrigation management through establishing Water Users Organizations at the secondary canal level in a pilot project mode. In this connection, an action research project has been launched in the three Left Bank Outfall Drain (LBOD) Districts: Nawabshah, Sanghar and Mirpurkhas. For this purpose, the Dhoro Naro Minor in Nawabshah District was selected as a Pilot Project Command Area. Implementation responsibilities were assigned to the International Irrigation Management Institute, Pakistan National Program, with consultation of donor agencies (World Bank and Swiss Development Cooperation). The broad purpose of this action research project was to test the viability of farmers in managing their combined irrigation and drainage facilities so that more efficient and equitable water distribution can be achieved. The second motivated fact was that completion of the LBOD project facilities would again drastically increase the budgetary imbalance for proper maintenance of the canal and drainage systems of Sindh.

Maintenance and operations needs continuous and long-term planning as compared with planning for a construction program. For irrigation development projects, it is important to evaluate the maintenance deficiencies of a particular irrigation system, then correct all maintenance deficiencies that interfere with the proper operation of the irrigation system (Skogerboe & Merkley, 1996)

The first step in this venture is to gather existing information about the irrigation system. Knowledge about system history changes, the water supply situation, water distribution patterns, irrigation structures, channel physical conditions, existing maintenance strategies, roles of beneficiaries and agencies, and possible constraints.

After having acquired a good knowledge of maintenance needs, all maintenance requirements are categorized into different maintenance programs. A good economical action maintenance plan should be prepared and implemented to fulfill the maintenance requirements of the channel for providing equitable water distribution to each farmer. With proper maintenance of the water conveyance system and irrigation control structures, the irrigation conveyance efficiency can be improved, which should lead to more equitable and reliable water distribution, improved farm water management, and increased cropping intensities.

2. PHYSICAL DESCRIPTION OF DHORO NARO MINOR

Dhoro Naro Minor is off-taking from Gajrah Branch of Nasrat Branch of Rohri Canal at RD 91.4. The old design discharge of the minor is 51.62 cusecs and the total length is 9.84 km (RDs 32+275). A location map of the pilot project minor is shown in Figure 2.1. A total of 25 outlets are off-taking from the minor and irrigating about 13,495 acres of cultureable command area. Out of the 25 watercourses, 16 watercourses are lined and 9 are unlined.

According to irrigational jurisdiction, Dhoro Naro Minor comes under the Irrigation Sub-Division of Nawabshah. It lies under the east minors / distributaries of the Gajrah Branch and off-taking just east of Nawabshah City. The head regulator is rectangular in shape and functioning as a free flow rectangular orifice. The command map of Dhoro Naro Minor is shown as Figure 2.2.

The name Dhoro Naro is a pure sindhi word, with Dhoro meaning low lying area and Naro denoting flow, thereby meaning a minor flowing with good water conveyance velocity. About twelve years ago, there was no shortage of water at the tail of the minor; also, there was no sedimentation problem at that time. But after that, a change in the head regulator of Chan Babu Distributary was made by placing a small additional gate, which is located just downstream of the Dhoro Naro Head Regulator on the Gajrah Branch, and functions as a cross regulator for Dhoro Naro and Khairyoon minors. This small change of installing a new gate in the cross regulator resulted in more sediment load in the Dhoro Naro Minor. This was told by the water users during interviewing and visiting of the World Bank representatives in November 1996. On the request of water users, this was also shown to Dr. Khalid Mohamood a renowned Professor and a specialist in sediment transport at George Washington University in Washington D.C., during his visit to this pilot minor in November 1996.

3. OPERATIONS CONTROL MAINTENANCE SURVEY

3.1. ESSENTIAL STRUCTURAL MAINTENANCE (ESM)

Essential structural maintenance (ESM) is the required maintenance for flow control structures that will also allow the structure to be used for discharge measurement after calibration (Skogerboe and Merkley, 1996). Thus ESM is a prerequisite for improved operation of irrigation system through water measurement so that the water deliveries can be better managed.

As stated by Skogerboe and Merkley (1996):

> "Essential Structural Maintenance (ESM) is considered to be the minimum level of investment that should be made in order to improve water deliveries." "Essential Structural Maintenance is the required maintenance for flow control structures that will also allow the structures to be used for discharge measurement after calibration".

In ESM, all field data collected during the Operations Control Maintenance Survey of essential flow control structures is used to identify different problems. The ESM is actually the summarized result of this field survey. From these results, the condition of structures will be understood. During this survey of Dhoro Naro Minor, the structures to be observed are the head regulator and the outlet, structures.

3.2. HEAD REGULATOR

3.2.1. Location

The head regulator of Dhoro Naro Minor offtakes at RD 91.4 at about 90 degrees towards the East from Gajrah Branch. This structure is working in good condition and is always experiencing free orifice flow conditions.

3.2.2. Type of Regulator

The gate of the Dhoro Naro Minor Head Regulator is vertical. This gate moves between an angled iron frame by a geared gate rod (threaded rod), which is squared at the top and moves with a lever type key. The dimensions of gate are as under.

Width of gate:	3.985 ft
Height of gate:	5.547 ft
Height of frame:	10.08 ft

The wing walls of the head regulator upstream and downstream are in good condition. The Bridge over the regulator is in good condition, but its shoulders are damaged. The crest of the regulator is cemented and in good shape. The upstream gauge at the head regulator is not in good condition because its painting and scale is not clearly readable, whereas the downstream controlling gauge of Dhoro Naro Minor is in good condition and the painting and scale (graduations) is very readable.

3.2.3. Working Performance

The head regulator works properly, except for a little leakage from the bottom when it is fully closed. But, there is no leakage from the sides. Due to more silt deposition, the downstream gauge does not give the true discharge. The calibration of the downstream gauge has not been adjusted for a very long time.

3.2.4. Status

The head regulator, in all aspects, is in fair condition.

3.3. OUTLETS

There are 25 outlets along the Dhoro Naro Minor. All outlets are the open flume type. The location of these outlets is given RD-wise in Annex A. During the walk-thru surveys and discharge measurements twice a week at each outlet, it has been observed that 85% of the outlets were tampered (throat and crest is usually tampered by water users for getting more water). Two outlets (tail outlets) were not tampered; however, their throat width is larger than the designed throat width.

At the head and middle reaches, the tampering ratio is more than in the tail reach. Due to this frequent tampering of outlets, the calibration of outlets have been done many times to obtain data on water distribution. A lot of time has been consumed on re-calibration of outlets. Water users also tamper the outlets by making a side opening (Wanghi in local language). Side openings were observed during discharge measurements on Outlets 1-L and 3-R. Due to frequent tampering and damage to outlets, almost all outlets are now dysfunctional (dysfunctional means functioning not as per design).

During the walk-thru survey, it can be said that all of the outlets were observed to have been significantly tampered. The crest of the outlets was badly damaged and lowered, while the sides were broken. At some outlets, water users had placed sand bags just near the outlet entrance for the raising water level so that the outlet would receive a greater flow of water. Due to this placing of sand bags and lowering the crest level, sediment deposition has occurred near the entrance.

The repair and maintenance of outlet structure is a very sensitive problem so it can only be solved by consulting with the water users. Outlets require complete repair so that they could be functional and distribute water equally. In addition, only open flume outlets exist, which means that large discharge increases at the head regulator would provide very little additional water at the tail reach, thus, the outlets must be converted to orifice structures. Approximate estimated costs for repairing is given in Section 6.

If numerous outlets have been tampered, say 25% or more, then the situation is not likely to be corrected by technical measures alone. This becomes an extremely difficult social problem that must be dealt with by all parties concerned, including both irrigation department staff and farmers (Skogerboe & Merckely, 1996).

4. ESSENTIAL STRUCTURAL MAINTENANCE PLAN

4.1. INTRODUCTION

After conducting the Operations Control Maintenance Survey of all essential flow control structures, many significant problems would be identified and detailed solutions prepared. Then a detailed plan can be prepared for the initial structural maintenance.

A detailed " Essential Structural Maintenance Plan" should be prepared that includes:

1. Physical description of irrigation system;
2. Proposed flow measurement program for equitably distributing water supplies;
3. Proposed flow measurement program for evaluating channel losses;
4. Essential structural maintenance(ESM);
5. Cost of ESM;
6. ESM implementation plan; and
7. Field notes and sketches.

Once an ESM plan has been approved, detailed cost records should be kept of actual expenditures during ESM implementation. This is important for planning similar investments in other irrigation networks, because these costs reflect the minimum investment that should be made in upgrading the irrigation channel operations. Accumulating this information for many irrigation systems will allow planners to allocate more realistic funding for upgrading other irrigation projects in their region or country (Skogerboe & Merkly, 1996).

4.2. FLOW MEASUREMENT PROGRAM FOR EQUITABLE WATER DISTRIBUTION

4.2.1. Establishment of Benchmarks

A benchmark is referred to as a reference elevation point (above mean sea level). These benchmarks are established at outlet structures or some other permanent structures along the minor so that they may not be removed. These marks were made by making scratches (square) by an iron arrow on plastered structure and white marked with oil paint. The field team spent about five days on establishing benchmarks. The survey was started from the crest of the head regulator with the help of an Engineer's level. Before calibrating an outlet it is necessary to establish permanent whitemarks on the upstream (u/s) and downstream (d/s) sides of the outlet structure so that the upstream and downstream water heads can be easily measured.

With the help of these reference elevations, water levels can be measured using a tape. These benchmarks (BM), particularly after hydraulic calibration of the head regulator for the minor, as well as the outlet structures, will serve as reference points for measuring water levels. The main purpose of these white marks (WMs) is to develop a simple methodology for observing water levels that can be converted into a flow rate at each structure. The white marks have been placed on each head wall so that the u/s & d/s water levels can be measured using a tape. Using observed water surface elevation data, the upstream flow depth (h_u) and downstream flow depth

(h_d) can be easily calculated, which can be used in conjunction with the field discharge rating for each hydraulic structure in order to establish the discharge rate (Lashari, Skogerboe and Siddiqui 1997).

From these BM elevations at permanent structures along the minor, the bed elevation of the minor and silt deposition can be calculated by taking different backshots from these WMs using an Engineer's level to establish bed elevations at various cross-sections along the minor.

A benchmark is a permanent elevation from which the elevation can be transferred or shifted to any other point or structure. After installment of piezometers along watercourses (three piezometers on each watercourse) in the Dhoro Naro Minor command area, the BM elevation on the outlet was transferred to each piezometer for measuring water table depth and establishing the groundwater elevation.

Flow measurement at the head regulator and each and every outlet provides the existing water duty allocation to each particular watercourse command area. Frequent measurements of discharge through each outlet also provides an understanding of actual discharges in terms of reliability.

The system providing equitable flow to tertiary units will provide the foundation for an equal distribution of water to farmers and promote their participation in operating and maintaining the tertiary system. The provision of a reliable water supply to the tertiary units should be a primary operational objective of a project. This objective was sometimes neglected in the past when the emphasis was placed on farmer participation and on-farm water management, without considering possible management upstream in the system (Plusquellec, 1988).

The improvement of water management practices invariably hinges upon the ability to measure flow rates and volumes at key location in an irrigation system. Water measurement is a fundamental basis for evaluating the performance of water management practices, and for quantifying the effects of improvements in those practices. Flow rate information can be used to calculate various performance indices, such as efficiency terms, from which comparative evaluations canc be made for different years and among irrigation systems (Skogerboe & Merkley, 1996).

4.2.2. Discharge at Head Regulator

In May 1997, the field team started periodic discharge measurements at the head of the Dhoro Naro Minor and all of the outlets twice a weak. This activity of discharge measurement is providing an average water duty for each outlet and reliability of the water supply at the head regulator. This information regarding discharge measurement eight times in a month will also be valuable in redesigning outlets for equal distribution of water.

Dhoro Naro Minor is being monitored with regards to discharge at the head regulator and all of the outlets to know the operational performance in terms of water supply and water distribution. For this purpose the head regulator and all of the outlets were monitored twice a week and section-wise discharge once a month. So far, the data that have been collected are briefly given below.

The collected data on discharge were analysed. The temporal coefficient of variability, which determines the degree of performance of the system at the head in terms of variability of water supply, was computed. A summary of the results are given in Table 4.1.

Table 4.1. Reliability of water supply at head of the Dhoro Naro Minor.

Month	Mean Water Duty (cfs/1000 acres)	Temporal Coefficient of Variability (CVt), in percent
May 1997	4.147	48
June 1997	3.807	19.5
July 1997	4.884	13
August 1997	4.217	19
September 1997	4.332	15

According to Molden and Gates (1990), if CVt is greater than 20 percent the supply is unsatisfactory.

4.2.3. Discharge at Outlets

At Dhoro Naro Minor, all 25 outlets had white marks established with reference to the crest level of the outlet in order to take tape measurements for calculating the water depths upstream and downstream of the outlet. Then, based on the field discharge rating, the discharge can also be calculated. Whereas different discharges were measured at different gate openings of the head regulator, so that a discharge rating graph could be plotted (Cd versus G) as calibration for the gate of the head regulator. The gate is operating under free orifice conditions. Similarly, an analysis of outlet discharge measurements were made to evaluate the distribution among the outlets. The spatial coefficient of variability, CVs, which determines the degree of variability in distribution of water was calculated. The summary of results is given in Table 4.2.

Table 4.2. Equity of water distribution among the outlets of the Dhoro Naro Minor.

Month	Mean Water Duty (cfs/1000 acres)	Spatial Coefficient of Variability (CVs), in percent
May 1997	4.15	72
June 1997	3.81	124
July 1997	4.88	81
August 1997	4.22	81

According to Molden and Gate (1990), if CVs is greater than 25%, the distribution is poor.

4.2.4. Water Distribution Among Reaches.

The Dhoro Naro Minor was divided into three reaches. The discharge at each reach was measured. These measurements were made to evaluate the water distribution along the channel. A summary of the results is shown in Table 4.3.

4.3. EVALUATION OF CHANNEL LOSSES BY INFLOW-OUTFLOW METHOD

The increasing demand for improved irrigation water management practices has also created a need for more comprehensive evaluation on seepage of irrigation water from canals and tertiary channels. Seepage losses from channels have significant importance. In Pakistan, there is constant continuous irrigation water flow from unlined channels, so that it is of great importance to calculate the seepage of water through the channels, branch canals, distributaries, minors and watercourses.

In order to truly distribute irrigation water in equal shares, then the seepage variation in the irrigation system is an important parameter to be considered. A seepage study can answer such questions as:

(a) How much does a given canal or canal reach seep?
(b) Where are the major seepage areas?
(c) Should a channel be lined?
(d) Is an irrigation channel lining effective?

Some of the more obvious factors that effect the rate of seepage from an irrigation channel are: (1) permeability of soil traversed by channel; (2) surface seal in the channel by silt and clay; (3) depth of water; (4) location of ground watertable relative to the channel invert; (6) soil and water chemistry; and many more (Skogerboe & Merkley, 1996).

4.3.1. Inflow-Outflow Method

The Inflow-Outflow Method is commonly used for the measurement of seepage rates from canals and distributaries. The discharge at the head and tail of the distributaries is measured. The difference of discharges between two locations is the seepage rate per channel length having a measured area of wetted perimeter. For the computation of net seepage, the discharges are measured at the head and tail of the selected reach. All of the inflow and outflow discharges from the distributary, including watercourses offtaking from the distributary, are measured nearly simultaneously. The seepage rate can be calculated using the following equation.

$$S_r = (Q_h - Q_o - Q_t) * A_w \qquad (4.1)$$

Where

S_r = Seepage rate per wetted area (cfs/ft^2).
Q_h = Discharge measured at head of the channel (cfs).
Q_o = Discharge of outlets in reach (cfs)
Q_t = Discharge measured at tail of the reach (cfs)
A_w = Area of wetted perimeter in the reach (ft^2).

Table 4.3. Section-wise discharge measurement.

REACH	D.W.D.	MAY 1997			JULY 1997			AUGUST 1997			SEPTEMBER 1997		
		Q1	Q2	A.W.D	Q1	Q2	A.W.D	Q1	Q2	A.W.D	Q1	Q2	A.W.D
HEAD	3.5	58.35	31.99	6.12	73.13	36.36	6.94	62.65	26.84	5.12	66.16	30.24	5.77
MIDDLE	2.8	26.36	16.70	4.49	36.77	25.62	6.88	35.81	24.26	6.52	35.91	23.20	6.24
TAIL	3.1	9.21	9.20	2.03	11.15	11.15	2.46	11.55	11.55	2.55	12.88	12.88	2.84

D.W.D = Design water duty.
A.W.D = Actual Water Duty.
Q1 = Discharge measured at point.
Q2 = Net discharge for reach.

But Dhoro Naro was considered as one reach, so that the Equation 4.1 becomes,

$$S_r = \left(\frac{Q_h - Q_o}{A_w} \right) \quad (4.2)$$

4.3.2 Seepage Rate of Dhoro Naro Minor

For calculating the seepage rate for the minor, the inflow-outflow test was conducted from 31st of July to 3rd of August 1996. The minor length was divided into three reaches. The results obtained were not satisfactory. Again, the field staff conducted the same exercise on August 6, 1996 by considering the full length of the minor as one reach. The discharge at the head regulator was considered as the inflow and the summation of discharges from all outlets was considered as the outflow. The results obtained were quite satisfactory. The following data were observed from the inflow-outflow test for Dhoro Naro Minor:

Q_h = 79.036 cusecs;
Q_o = 76.322 cusecs; and
A_w = 547874.48 ft. sq.

Now, by putting this data into Equation 4.2:

S_r = (79.036-76.322)/547874.48
S_r = 4.953*10-6 cfs/ft.sq.

But usually, it is traditional practice to express the seepage rate in cusecs per million square feet of wetted perimeter (cfs/msf), so that the above relation may be calculated by multiplying by one million.

$S_r = 4.953*10^{-6}*10^{6}$
S_r = 4.95 cfs/msf

Therefore, the seepage rate for Dhoro Naro Minor is 5 cfs/msf.

5. ESSENTIAL STRUCTURAL MAINTENANCE (ESM).

As mentioned previously, ESM plays a major role in controlling the flow of water. During the walk-thru survey, it was observed that most of the outlets of Dhoro Naro Minor are damaged and tampered; therefore, more attention is needed for their improvement. Tampering and Dikka (Dikka means an obstruction placed at the crest of the outlet to decrease the discharge which is done by I.D who call it Rectification of Outlets) are the main causes of outlet damage. Due to frequent tampering, the equitable water distribution has been greatly affected and could not be achieved during the period of discharge measurements.

At Dhoro Naro Minor outlet all of the structures are open flume outlets. These were observed carefully to estimate the amount of material, labor and other related repairs to be needed. Following is the detail of material required for the repair of outlets, culverts and bridge.

Table 5.1. Required bricks for repair of each outlet.

Sr. No.	Outlet No.	Number of Bricks Required
01	1-R	500
02	1-DL	200
03	2-R	700
04	1-L	1000
05	3-R	800
06	1-AL	100
07	1-BL	1000
08	1-CL	100
09	2-L	500
10	2-AL	800
11	4-R	600
12	3-L	200
13	4-L	100
14	4-BL	600
15	4-AL	1000
16	5-R	1300
17	6-R	300
18	5-L	1200
19	6-AR	600
20	6-L	600
21	7-R	700
22	7-L	600
23	10-L	200
24	11-Tail	200
Total Number of Bricks:		15200

Mortar material required for one brick	=	0.0004 cu.m.
Mortar required for 15,200 bricks	=	0.0004 * 15,200
	=	6.08 cu.m.
Cement required for One cu.m. mortar	=	7.2 Bags.
Cement required for 6.08 cu.m. mortar	=	7.2 *6.08
	=	36.966 Bags
Say	=	37 Bags.
Sand required for one cu.m. mortar	=	1.00 cu.m.
Sand required for 6.08 cu.m. mortar	=	6.08 * 1
	=	6.08 cu.m.

Table 5.2. Showing sub-total of the material.

Type of structure	Bricks in Number	Cement in Bags	Sand in cu.ft.
Outlets	15200	37.00	214.545

Labor

Masons required one for 15.2 days, say 16 days.

Labor required two Nos. for 15.2 days, say 16 days.

6. DIAGNOSTIC WALK-THRU MAINTENANCE SURVEY

6.1. GENERAL DESCRIPTION

Diagnostic walk thru maintenance phase is a conduct of a detailed diagnostic walk-thru that lists all deferred maintenance needs along the canal, branch canal, distributary and minor including the inlet structures to each tertiary sub-system. In this connection, the annual Walk-Thru Maintenance Survey for Dhoro Naro Minor was conducted from January 13-15, 1997. IIMI staff, along with members of the WUF, walked along the minor from the head regulator to the tail watercourses. All of the major and minor deferred maintenance needs of the minor were comprehensively discussed with farmers. Special attention was given to the depth of silt deposited, wider sections of the minor and their effect on hydraulics and consequent sediment deposition, as well as outlet structures and their effect on water distribution among outlets.

The main purposes undertaking this survey in conjunction with farmers were:

(1) to realize more sensitivity about maintenance problems;

(2) to gain farmers views about maintenance problems; and

(3) to obtain historical and social aspects about specific irrigation system difficulties.

After realizing the various situations discussed with the farmers, the water users came to the conclusion that ignoring the deferred maintenance needs could create major problems for the future; therefore, these deficiencies should be handled quickly so that related problems like water distribution, breaches, etc. could be overcome. Similarly, for Essential Structural Maintenance, they were of the view that the outlets should be redesigned and a cast iron frame should be fixed for a small amount of money (Rs. 4,000-5,000).

Following these days, the IIMI field team carried out a thorough diagnostic walk thru survey and noted in their field notebook the maintenance needs of essential flow control structures, measurement of existing cross sections of the minor, condition of banks, vegetation growth, silt deposition, and animal crossing paths. Possible causes and effects of maintenance needs were noted, along with sketches. All details of the maintenance surveys along with sketches are given in the annexures.

6.2. PHYSICAL CAUSES & EFFECTS OF MAINTENANCE PROBLEMS

A walk-thru survey gives a clear picture of causes and effects of maintenance problems. All maintenance needs come under the category of essential structural maintenance of deferred maintenance.

6.2.1. Sedimentation

Sediment carried by water coming from the upper basin of Indus River is estimated that nearly 350,000 acre feet of suspended silt enters the Indus River system every year. It is assumed that nearly 200,000 acre feet of sediment per year remains in the system and gets deposited in reservoirs and canal system.

Looking into this variable for two-and-a-half years, it was observed that more sediment load is entering into this minor as compared with other minors which are offtaking at the same branch canal junction.

Working with farmers and monitoring the system regularly, there was views comment from the farmers on their sediment deposition problem. In their opinion, more sediment has started coming into the Dhoro Naro Minor since the new side gate fixed in the cross regulator of Gajra Branch Canal was installed some 12 or 13 years ago.

To analyze the situation of silt deposition, the depth, cross-section and longitudinal section of the minor were measured. The situation shows that from RD 0+000 to RD 11+000, the silt deposition was about 1.0 foot in depth, while from RD 20+700 to 27+600 the silt deposition was 0.5 foot in depth. With this silt deposition, the water level was increased to a higher level and the velocity was significantly reduced; therefore, in that upper portion, the outlets were drawing more water and the tail reach was getting a lower share of water. Some observations at the head regulator were made before and after desilting the minor which are listed in Table 6.1 given below:

Table 6.1. Upstream and downstream water levels before and after desilting at the Dhoro Naro Minor Head Regulator.

BEFORE EXCAVATION			AFTER EXCAVATION		
Upstream water head (ft.)	Down-stream water head (ft.)	Water head difference (ft.)	Up stream water head (ft.)	Down stream water head (ft.)	Water head difference (ft.)
3.585	3.369	0.216	3.526	2.588	0.938
3.733	3.517	0.166	3.526	2.598	0.928

6.2.2. Vegetation

Vegetative growth is the natural phenomenon of wet soils. Dhoro Naro Minor was free from aquatic growth. Although vegetation growth was active and dense, especially from RDs 10+000 to 10+600, 12+980 to 15+600, and 22+400 to 24+170. Whereas, less and thinner vegetative growth was observed from RDs 15+600 to 21+900 and 24+400 to 32+275. The causes observed for this vegetation were the lack of normal maintenance and poor inspection path. Vegetation has adverse effects on flow, when it falls into the minor, which reduces the flow velocity that results in silt deposition, as well backwater effects that increase seepage. Also, this vegetation attracts animals for grazing.

6.2.3. Wider Cross Sections

Due to a lack of maintenance awareness, Dhoro Naro Minor has been affected greatly on its alignment. Therefore, this is the reason that the minor is wider at many portions as has been listed in Table 6.2. These wider sections have been mostly developed due to free grazing of animals and their bathing.

Table 6.2. Designed and actual bed width at different sections of Dhoro Naro Minor.

Location (RD)	Design Width (ft)	Actual Width (ft)
00+000 to 05+700	16.0	20.15
05+700 to 08+987	15.0	18.75
08+987 to 11+000	15.0	13.00
11+000 to 14+946	13.0	12.00
14+946 to 22+076	10.5	11.00
22+076 to 29+500	09.0	09.00
29+500 to 32+275	07.0	06.00

From the above observations, it can be said that the maximum wider sections are lying from RD 00+00 to 08+987. The reason is significant maximum buffalo wallowing. The wider section in the head reach of the minor tends to increase silt deposition. At the head reach of the minor from 00+000 to 08+987 averagely 3.00 ft 2.5 ft in depth with respect to downstream zero gauge level, and 1.00 ft 0.75 ft. with respect to sill level was observed.

6.2.4. Weak Banks

Banks are the main pillars to operate the minor safely. Unstable banks could result in breaches, which ultimately bring the loss of agriculture production and interrupts the timely supply of water. The unstable portions of the minor were periodically recorded and has been mentioned in the monitoring and evaluation report. So far, the observations that have been made are listed in Table 6.3. These weak portions have been developed due to overlooking the necessity for correcting maintenance.

6.2.5. Inspection Path (IP)

An inspection path is a most important component for irrigation canals, distributaries and minors in order to look after the system regularly. This helps to improve the conveyance efficiency of the system, avoid any kind of expected breaches, improve water distribution, and so on.

The Dhoro Naro Minor inspection path was observed during the walk-thru surveys and during daily observations on discharge and field calibration of outlet structures. The principal problems are from RD 00+000 to 08+981 and from 27+526 to 32+275.

Table 6.3. Weak portions of the banks of Dhoro Naro Minor.

Location (RD)	Weak Bank (Side)	Weak Bank Dimensions		
		Average Length (ft)	Average Width (ft)	Average Depth (ft)
02+000	Left Bank	10	5	1.5
02+300	"	20	5	1.5
02+600	"	500	5	2
"	Right bank	15	3	2
04+400	"	50	12	1.5
04+600	"	150	12	1.5
"	Left bank	15	5	1.5
04+800	"	20	5	1.5
05+000	"	10	5	1.5
"	Right bank	10	12	1.5
05+400	"	20	12	1.5
"	Left bank	20	5	1.5
05+600	"	100	5	1.5
"	Right bank	100	12	1.5
08+500	Left bank	5	5	1.5
06+200	"	12	5	1.5
06+400	"	6	5	1.5
06+600	"	15	5	1.5
06+800	"	15	5	1.5
07+400	"	200	5	1.5
08+800	Right bank	40	8	1.5
09+400	"	8	12	1.5
10+400	Left bank	200	5	1.5
11.000	"	30	5	1.5
"	Right bank	20	12	1.5
12+600	"	15	12	1.5
"	Left bank	20	5	1.5
14+600	Right bank	20	12	1.5
18+290	Left bank	30	5	1.5
18+490	"	15	5	1.5
"	Right bank	15	12	1.5
19+090 to 21+690	Left bank	1600	5	1.5
21+890	Right bank	20	12	1.5
22+090	"	5	12	1.5
22+690	"	5	12	1.5
"	Left bank	5	5	1.5
24+090	Right bank	15	12	1.5
25+290	"	10	12	2
26+290	"	100	12	1.5
"	Left bank	100	5	1.5
29+790	"	20	5	1.5
"	Right bank	15	12	1.5

7. DEFERRED MAINTENANCE PLAN

7.1. INVENTORY OF REQUIRED MAINTENANCE

From the diagnostic walk thru survey, different major and minor maintenance problems were observed. Mostly, problems were inter-related. Here is the inventory of those main problems which were observed as deferred maintenance problems.

1. Essential Structural Maintenance (ESM);
2. Sedimentation;
3. Vegetation;
4. Wider cross-sections;
5. Weak Banks;
6. Erosion; and
7. Lack of Inspection Path (IP).

7.2. MAINTENANCE COSTS FOR THE INVENTORY

In the interest of the project, as well as information for the water users, some approximate cost estimates for the inventory with regard to materials, equipment and labor will be made. These cost estimates have been calculated on the basis of field observations and through consultation with the farmers.

7.2.1. Material for Culverts

Out of 25 culverts on outlet structures, 20% of the culverts are damaged, 24% of the outlets had no culverts or were completely damaged, and the remaining 56% were partially damaged. The reasons for damaged culverts were observed in the field. The most common reason was that when Irrigation staff (Beldars) would insert a Dikka (an obstruction structure), they used bricks from the shoulder of the culvert.

Bridges over the Dhoro Naro Minor are used as a crossing road near villages. Their satisfaction in stability is very important. There are five bridges constructed over Dhoro Naro Minor at RD 7+700,8+880,11+000,22+076 and 27+526. These are all made of RCC; however, the shoulders are building using bricks, which are not in good condition.

Table 7.1. Showing percent of required material for each culvert.

Sr. No.	Outlet No.	Percent of Roof Damaged
01	3-R	30
02	4-R	100
03	4-L	100
04	4-BL	100
05	5-R	100
06	5-L	100
07	6-AR	100
08	6-L	100
09	7-L	100
10	11-Tail	50

Dimensions of existing roof of an outlet culvert.

Length = 4.670 meters.
Width = 1.600 meters.
Thickness = 0.155 meters.

Volume of concrete roof = 1.158 cu.m. = 40.867 cu.ft. = 41 cu.ft.
Volume of concrete for 8.80 culvert roofs = 8.8 x 41 = 360.8 cu.ft.

Cement:
Cement required for one cu.m. of concrete material = 7.0 bags.
Cement required for 10.19 cu.m. of concrete = 71.33 bags.
Note: One bag of cement contains 50 kg.

Sand:
Sand required for 1.00 cu.m. of concrete mixed material = 0.48 cu.m.
Sand required for 10.19 cu.m. of concrete mix = 4.89 cu.m.
= 172.6 cu.ft.

Gravel:
Gravel required for 1.00 cu.m. of concrete = 0.72 cu m.
Gravel required for 10.19 cu.m. of concrete mix = 7.337 cu.m.
= 258.90 cu.ft.

Iron:
Iron required for one culvert = 64 Kg.
Iron required for 8.80 culverts = 563.2 Kg.

Binding wires:
One culvert required of binding wires = 1.0 Kg.
8.80 culverts required binding wires = 8.80 Kg.
Total iron required = 563.2 + 8.80 = 572 Kg.

Labor:
Masons required one for 26.4 days, say 27 days.
Labor required two for 26.4 days, say 27 days.

Table 7.2. Sub-total of the concrete material for culverts

Type of Structure	Cement in Bags.	Sand in cu.ft.	Gravel in cu.ft.	Iron in Kg.
Culvert Roofs.	71.33	172.60	258.90	572.00

Table 7.3. Total material required for outlets and outlet culverts (Table 7.1 + Table 7.2).

Bricks in Nos.	Cement (Bags)	Sand (cu.ft)	Gravel (cu.ft)	Iron (Kg)	Mason (Days)	Labor (Days)
15200.0	108.33	387.15	258.90	572.00	41.6	83.2

Table 7.4. Showing total and sub-grand total cost for culverts.

MATERIAL.	Price Per Unit.	Price in Rs.
Bricks	Rs. 800/1000	12160
Cement	Rs. 180/Bag	18500
Sand	Rs. 500 /Cu.m.	1935
Gravel	Rs. 1000/Cu.m.	2589
Steel	Rs. 19/Kg.	10868
LABOR		
Mason	Rs. 200/day	8320
Labor	Rs. 100/day	8320
		Total: Rs. 62692

7.2.2. Sedimentation

For obtaining the actual depths of sediment deposition, a longitudinal and cross-section survey of the Dhoro Naro Minor was conducted. According to this survey, most of the silt was deposited from RD 00+000 to 11+000, which had an average depth of 3.0 ft, while from RD 20+700 to 27+600 the silt deposited had an average depth of only 0.5 ft. The results are shown in Table 7.5.

Table 7.5. Volume of sediment to be removed.

Location in RD.	Length in ft.	Width in ft.	Depth in ft.	Volume in cu.ft.
00+00 to 11+000	11000.0	15.33	3.0	505,890
20+700 to 27+600	6900.0	09.00	0.5	31,050
			Total Volume:	536,940

Through previous excavation June '96 experience, where 683698 cu.ft. soil volume was excavated in Rs. 40865 (Diesel cost Rs. 22869 + Operator Charges Rs. 18000). According to this, if diesel charges remain the same, then 536,940 cu.ft. of soil volume can be excavated for Rs. 32095.55, say Rs. 32,100.

7.2.3. Vegetation Removal

The right bank (inspection path) is 50% free from vegetation, while the remaining portion would be cleaned with a bulldozer and dressing during inspection path improvement. Whereas left bank is also 30% vegetative (JUNGLE). Vegetation cleaning experience was got in this annual water closure period January 97. A portion of 2+730 RDs was cleaned by ID field people through labor, for which they paid Rs. 2600. According to this, 30% vegetative length (i.e. 9+682 RDs) of the left bank of the minor can be removed at cost of Rs. 9221.425, say Rs. 9,300.

7.2.4. Wider Cross Sections

Wider cross-sections can be narrowed by placing tree offshoots from the bank sides of the minor. This process is locally called "jaak". A length of about 8987 ft needs to have the bank sides filled with tree offshoots. An average of 50 people can do this job for 1.0 RD in a day and 450 people can do this whole job in a day, at a cost of Rs. 36,000 (daily wage rate Rs.80/= per day per person).

7.2.5. Weak Banks

During the walk-thru survey, the weak bank locations were observed. These are listed in Table 7.6.

7.2.6. Soil Transportation

For the above calculated soil volume, 34544 cft would be required. This volume of soil is to be taken from about 7 to 8 Km away from the minor. The local soil carriage rate (with some concession in the case of larger volumes of work) is Rs. 150/ for carrying 130 cft of soil. Past experience shows that in loading, unloading and transporting, soil becomes loose; after compaction, its volume decreases to about 40%. According to this, the total volume of soil will be 34544 + 13817.6 (40 %) = 48361.6 cft, say 48,400 cft.

Total carriage cost of 48,400 cft at the rate of Rs. 150/ for carrying 130 cft, would be Rs. 55,846/=. A total length of 3601 ft of weak banks, after filling the soil, will be dressed in a day by 40 people. The daily wage rate is Rs. 80/day per person. Therefore, dressing costs for this work will be Rs. 3200.

Table 7.6. Location of weak banks and required volume of soil.

RD Number	Weak Bank Side.	Weak Bank Dimensions.			Volume Cft.
		Length in ft (Average)	Width in ft (Average)	Depth in ft (Average)	
02+000	Left bank	10	5	1.5	75
02+300	"	20	5	1.5	150
02+600	"	500	5	2	5000
"	Right bank	15	3	2	90
04+400	"	50	12	1.5	900
04+600	"	150	12	1.5	2700
"	Left bank	15	5	1.5	112.5
04+800	"	20	5	1.5	150
05+000	"	10	5	1.5	75
"	Right bank	10	12	1.5	180
05+400	"	20	12	1.5	360
"	Left bank	20	5	1.5	150
05+600	"	100	5	1.5	750
"	Right bank	100	12	1.5	1800
08+500	Left bank	5	5	1.5	37.5
06+200	"	12	5	1.5	90
06+400	"	6	5	1.5	45
06+600	"	15	5	1.5	112.5
06+800	"	15	5	1.5	112.5
07+400	"	200	5	1.5	1500
08+800	Right bank	40	8	1.5	480
09+400	"	8	12	1.5	144
10+400	Left bank	200	5	1.5	1500
11.000	"	30	5	1.5	225
"	Right bank	20	12	1.5	360
12+600	"	15	12	1.5	2700
"	Left bank	20	5	1.5	150
14+600	Right bank	20	12	1.5	360
18+290	Left bank	30	5	1.5	225
18+490	"	15	5	1.5	112.50
"	Right bank	15	12	1.5	270
19+090 to 21+690	Left bank	1600	5	1.5	12000
21+890	Right bank	20	12	1.5	360
22+090	"	5	12	1.5	90
22+690	"	5	12	1.5	90
"	Left bank	5	5	1.5	37.5
24+090	Right bank	15	12	1.5	270
25+290	"	10	12	2	240
26+290	"	100	12	1.5	1800
"	Left bank	100	5	1.5	750
29+790	"	20	5	1.5	150
"	Right bank	15	12	1.5	270
				Total	34544 cft..

7.2.7. Inspection Path (IP)

The physical condition of the banks along Dhoro Naro Minor are poor at so many portions. To improve the embankment conditions, a few farmers were consulted who had some experience to repair some portion of the banks adjacent to their lands, with the help of tractors and bulldozers. They said that 400 meters of length was leveled in one-and-a-half hours (90 minutes). At present, 15+885 RDs needs 50% filling of soil from adjacent lands and 50% leveling work. From the above experience, it can be said that an average of 20 hours for filling and 20 hours for leveling will be needed by bulldozer for 15+885 RDs. While the remaining 16+390 RDs require only a filling operation from the sides that will require another 20 hours of bulldozer time to complete the operation.

According to Agri. Engineering Department Govt. of Sindh, the rate of a working hour for a bulldozer is Rs. 693.40, say Rs. 695. According to this, the total cost of the bulldozer will be Rs. 41604.00.

7.2.8 Dressing of Inspection Path (IP)

After consultation with farmers, it was estimated that 4+750 RDs can be dressed with the help of two tractors and 40 laborers in a day after the bulldozer work. Locally, the tractor rate for one hour of work is Rs. 130 (with concession). According to this rate, 32+275 RDs of inspection path can be dressed with the help of tractors and labor at a cost of Rs. 35883.76 (Tractor cost Rs. 14136.028 + Labor cost Rs. 21747.736), say Rs. 36,000.

7.2.9. Summary of Cost

A summary of total cost is given in Table 7.7.

Table 7.7. Grand total of costs (labor, material and equipment).

Expenses Head	Allocation.				
	Labor	Material	Tractor	Bulldozer	Excavator
ESM	16640	46052	00.00		
Excavation.			00.00		32096
Vegetation.	9221		00.00		
Wider Section Improvement.	36000		00.00		
Weak Bank Improvement.	3200		55802		
IP.	21748		14137	41604	
Total:	86809	46052	63939	41604	32096
Grand Total:	Rs.276500				

After consultation with farmers, it was estimated that 4+750 RDs can be dressed with the help of two tractors and 40 laborers in a day after the bulldozer work. Locally, the tractor rate for one hour of work is Rs. 130 (with concession) and the daily wage rate is Rs. 80/ (with concession). According to this rate, 32+275 RDs of inspection path can be dressed with the help of tractors and labor at a cost of Rs. 36,000.

8. ACHIEVEMENTS

8.1. CATCH-UP MAINTENANCE PROGRAM JANUARY 1997

A walk-thru maintenance survey of the Dhoro Naro Minor was conducted in January 1997 with the water users federation. The main objective of this survey was to develop an understanding of the problems regarding maintenance of the minor and to inform the water users federation for the importance of its maintenance also to finalize the plan for KHATTI (de-silting) of the minor.

In this survey, WUF members, IIMI, Lahore and Hyderabad staff, along with the IIMI Nawabshah Field Station staff, took part. During the survey, water users were asked for suggestions on desilting of the minor. Their suggestions were discussed on the spot and final recommendations were made about how deep the minor should be desilted. Similarly, for wider sections, a lot of discussion took place. Finally, it decided by the water users that these sections be narrowed down by putting wooden pegs, locally called "jakk".

Following the walk-thru, the field staff conducted a survey on January 14, 15, 16, 1997 for estimating the volume of sediment (silt) deposition. Table 8.1 shows the amount of desilting required.

Table 8.1. Required depth of desilting (khatti).

Section	Silt Deposition
From Head of the Minor up to W/c 1-DL (RD 00+00 to 03+750)	1.00 ft to 0.75 ft.
From W/c 1-DL to W/c 2-R (RD 03+750 to 05+700)	0.75 ft
From W/c 2-R to W/c 3-R (RD 05+700 to 08+981)	0.75 ft to 0.25 ft.
From W/c 1-AL to W/c 2-L (RD 10+250 to 11+000)	0.5 ft.
From W/c 6-R to W/c 6-L (RD 22+076 to 27+526)	0.75 ft to 0.25 ft.
From W/c 7-R to W/c Tail (RD 29+500 to 32+275)	0.5 ft
Total Volume of Sediment Deposited	117,284 ft3

A General body meeting of the WUF for pre-planning of khatti was held on 19-01-1997 at Village Chaudhary Hameed near the watercourse 3-R bus stop. In the meeting, it was decided that khatti will be conducted by the farmers of each watercourse individually. IIMI field staff would facilitate and provide technical support. Therefore, the minor was divided into 25 equal sections by considering the total number of watercourse (there are 25 watercourses). Khatti was carried out from January 22 to 28,1997.

Before starting the desilting, the IIMI field staff fixed pegs every 400 meters of length along the minor, which indicated to the farmers how much depth of silt needed to be removed. This had been decided during the walk-thru survey.

8.2. DESILTING OF MINOR IN 1997

8.2.1. During Canal Closure (January 1997)

The general body meeting of the WUF decided that each water users association would be responsible to desilt 400 meters of minor length. The desiltation was carried out by using tractors, whereas the 400 meter portion designated for the WUA of 6-L was desilted using a bulldozer. The expenditures which was assessed for this desilting campaign are listed in Table 8.2. Photographs A, B, C, D, and E are showing some of the activities undertaken by the WUF with the assistance of IIMI.

Apart from WUF involvement in desilting the minor, the irrigation person (Daroga) also made efforts in desilting some head portion of the minor. He borrowed two tractors from the growers of Dhoro Naro Minor command area and gave them fuel charges of about Rs.400 each and desilted about 200 meters length and excavate 1 foot depth of silt. He also managed fuel charges from two growers. The desilting (khatti) of the minor was not carried out properly, therefore, landowners used their tenants for further improvement of that portion.

8.2.2. During June 1997

Due to the shortage of water in the minor tail, the WUF called a general body meeting. In the meeting it was decided that the WUF will seriously take up this matter and discuss with the Irrigation Department (ID), particularly the executive engineer. With the hard efforts by the water users federation, the executive engineer provided them a machine for desilting on payment of fuel charges. The federation and tail water users were extremely happy with this action of the executive engineer because this machine was allowed on a priority basis to the water users federation. That machine was working at some other places. The expenditure so far incurred was paid by the federation and tail water users. The expenses are listed in Table 7.3.

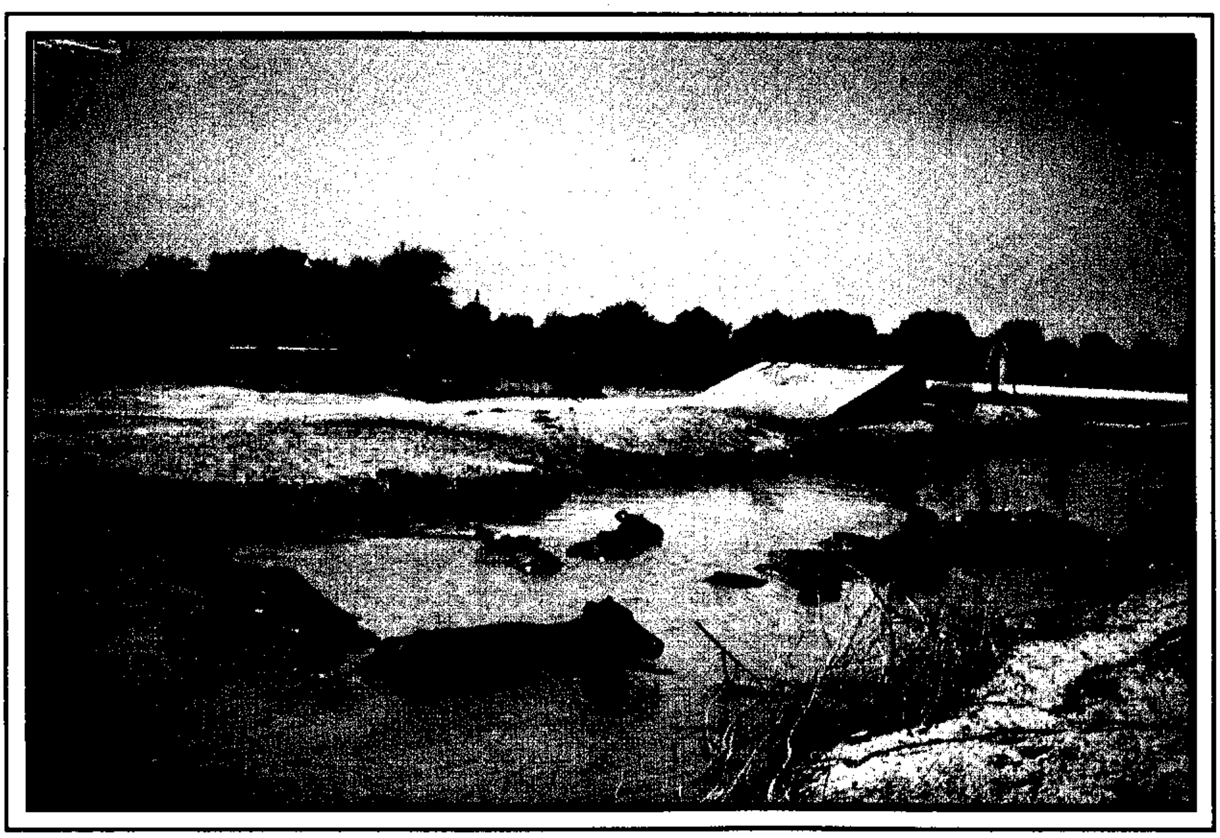
8.3. INSPECTION PATH

The inspection path of Dhoro Naro Minor was not being maintained, so that after desiltation of the minor, maintenance of the inspection path was of first priority. In this connection, the WUF wrote a letter to the Irrigation Department for improvement of the IP or to allow the WUF to maintain it collectively on their own. The irrigation Department gave permission to the WUF to do this. After that, on the request of the WUF, IIMI field staff prepared a cost estimate of Rs = 142,000, in consultation with the farmers. This estimate was approved by the Project Leader on a 50-50 cost sharing basis. Looking at the current need of that work, the WUF started development work along the inspection path on September 29, 1997, which is still in progress, but nearly complete. In the general body meeting, they decided to start work from the head of the minor and decided that the WUAs will provide labour and tractors for one day at a time. Photograph F showing the rehabilitated Inspection Path.

Table 8.2. Summary of expenditures assessed during deslting of Dhoro Naro Minor, Nawabshah.

Sr. No.	W/c No.	Date of work	Detail of work (Form & Hours)	Item Cost (Rs)	Total cost (Rs)
1	1-R		Not desilted because of non cooperation among water users on this w/c.	00	00
2	2-R		Not desilted because of non cooperation among water users on this w/c.	00	00
3	3-R		6 people worked 1 hour. one tractor worked 1 hour.	60 + 150	210
4	4-R	23-1-97	40 people for 4 hours and 1 tractor for 4 hours	1600+ 600	2200
5+6	5-R + 4-AL	29-1-97	WUAs of both w/c worked together 25 people for 4 hours. And 1 tractor for 4 hrs	1000 + 600	1600
7	6-R	2-2-97	17 people worked 4 hours 1 tractor for 15 minutes	680+ 40	720
8	6-AR	1-2-97	20 people for 3 hrs	600	600
9	7-R	28-1-97	22 people worked for 3 hrs	660	660
10	1-DL	29-1-97	17 people for 1 and 1/2 hrs 1 tractor for 1.5 hrs	255 + 225	480
11	1-L	29-1-97	19 people foe an 1 hour.	190	190
12	1-AL	30-1-97	14 people for 2 hrs 1 tractor for 2 hrs	280+ 300	580
13	1-BL	26-1-97	40 people for 6 hrs. 1 tractor for 6 hrs.	2400+ 1800	4200
14	1-CL	1-2-97.	20 people for 3 hrs.	600	600
15	2-L	31-1-97	4 people for 4 hrs 2 tractors for 4 hrs.	200+ 1200	1400
16+ 17	2-L+ 3-L	26-1-97	35 persons 4 hrs 1 tractor 4 hrs	1400+ 600	2000
18	4-L	27-1-97	22 persons 4 hrs 1 tractor 4 hrs	880+ 600	1480
19	4-BL	29-1-97	20 persons 4 hrs 1 tractor 1 hr 15 minutes	600+ 200	800
20	5-L	28-1-97	30 people for 3 hrs 1 tractor for 3 hrs	900+ 450	1350
21	6-L	26-1-97 27-1-97	Tractor (Bulldozer) engaged for 12 hrs and worked on: Inspection path + khatti of 400 meters 30 people for 2.5 hrs	3600+ 615	4215
22	7-L	26,28-1-97 and 2-2-97	54 people worked on different dates spent about 142 hrs.	1620	1620
23	9-L	27,28-1-97	20 people for 4 hrs.	800	800
24	10-L	27,28-1-97	14 people for 4 hrs.	560	560
25	11-L	26,27-1-97 2-2-97	31 people worked on different dates and spent about 96 hrs. 1 tractor for 1 hr.	960 + 150	1110
Grand total expenditure incurred on khatti (desilting) carried out by farmers.					27315

Photograph A. Condition of the channel before rehabilitation.



Photograph B. Animal bathing in the channel.

Photograph C. Farmers undertaking rehabilitation works.

Photograph D. Farmers using machinery for rehabilitation works.

Photograph E. Desilted channel.

Photograph F. Rehabilitated inspection path.

Table 8.3. Summary of expenditures incurred for desiltation by WUOs.

Month Desilted	R.D	Labour cost Rs.	Machinery Cost Rs.	Misc. Cost Rs.	Total Rs.
June 97	0 to 22	5,900	24,150	9,976*	40,027
July 97	22 to 32+275	2,500	20,250	800	23,550
GRAND TOTAL:					63,577

* Includes Rs 9,976 paid as special charges to the operators of excavation machine.

At this time, the development work of maintaining the inspection path is continuing and being supervised by WUF and IIMI staff.

Maintenance of the Inspection Path (IP) includes:

1- Removal of vegetation growth from berm and banks;
2- Dressing of silt on the top the IP;
3- Strengthening of weak portions of the embankment;
4- To make the cross-section narrower where it is too wide; and
5- To level the IP berm of the minor.

8.4. COST ESTIMATES FOR IMPROVEMENT OF EMBANKMENTS

Realizing the deteriorating situation of the Dhoro Naro embankments, the Water Users Federation held a general body meeting regarding this matter. In the meeting, it was decided that the embankments of the minor should be improved. For this problem, the federation asked the IIMI staff to prepare cost estimates for the work. As has been already agreed, a 50-50 cost sharing basis using the development funds would be the basis for meeting the costs. These funds were allocated to each of the pilot distributaries/minor for their rehabilitation.

For cost estimating and completion of the work, different ideas were included such as surveying by using an Engineers level, visual appraisal and farmers experience. The engineers level was used where benchmarks were installed and the banks could be surveyed. Whereas, at some places where an engineering level was not feasible to use because of dense vegetative growth, then the walk-thru survey information was used that had been conducted during January 1997.

In these cost estimates, the left bank is considered to be 5 ft in width and 2 ft in height from the maximum full supply level with the outer side slope being 1.5:1, while the right bank (inspection path) is considered to be 12 ft in width and 2 ft in height (above the maximum full supply level) with an outer side slope of 1.5:1.

8.4.1. Soil Volume Estimate

Table 8.4. Volume of soil needed for right bank of Dhoro Naro Minor from RD 06+959 to 22+076.

RD	FSL Elev.	Top of Bank Elev.	Proposed Bed Elev.	Cut/ Fill Depth (Col4-Col3)	Average Filling Depth For Sec.	Length of Section	Proposed Width	Volume
1	2	3	4	5	6	7	8	9
00+050	100.41	103.903	102.41	-1.49			12	
02+000	100.11	102.89	102.11	- 0.78			12	
05+700	99.42	101.70	101.42	- 0.28			12	
06+959	99.09	101.378	101.09	- 0.288			12	
					0.619	2028	12	15063.984
08+987	98.35	98.970	100.35	+ 1.38				
					1.426	1263	12	21612.456
10+250	98.28	98.808	100.28	+ 1.472				
					0.611	750	12	5499.00
11+000	97.94	99.79	99.94	+ 0.15				
					0.3595	1980	12	8541.72
12+980	97.55	98.980	99.55	+ 0.569				
					0.8795	680	12	7176.72
13+660	97.41	98.22	99.41	+ 1.19				
					1.5175	1286	12	23418.06
14+946	97.15	97.305	99.15	+ 1.845				
					1.805	3855	12	83499.3
18+801	96.38	96.615	98.38	+ 1.765				
					0.883	3275	12	34701.9
22+076	95.47	98.158	97.47	- 0.688			12	
24+526	95.30	97.815	97.30	- 0.515			12	
31+596	94.00	100.00	96.00	- 4.133			12	
32+275	93.90	98.97	95.90	- 3.07			12	
TOTAL							199513.14 cfs Say 200,000 cft.	

+ = Indicates the fill volume.
- = Indicates the cut volume.
ELEV. = Elevation.
SEC. = Section.
FSL = Full Supply Level.

Next >>

Table 8.5. Volume of soil needed for outer slope for right bank from RD 6+959 to 22+076.

1	Average field elevation	93.8085
2	Average bank elevation	98.377
3	Difference of 1 & 2	4.569
4	Side Slope	1.5 : 1
5	Area	17.13375
6	Length	15117
7	Volume of soil	259010 cft. Say 260,000 cft.

Table 8.6. Volume of soil needed for left bank of Dhoro Naro Minor from RD 5+700 to 27+526.

RD	FSL Elev.	Top of bank Elev.	Proposed bed Elev.	Cut fill depth (Col4 - Col3)	Average filling depth for sec.	Length of section	Proposed width	Volume
1	2	3	4	5	6	7	8	9
00+050	100.41	103.903	102.41	- 0.102			5	
02+000	100.11	102.89	102.11	- 0.26			5	
05+700	99.42	101.70	101.42	- 0.843				
					0.356	1259	5	2180.5
06+959	99.09	101.378	101.09	+ 0.712				
					1.1585	2028	5	11747.19
08+987	98.35	98.745	100.35	+ 1.605				
					1.4185	1263	5	8957.827
10+250	98.28	99.048	100.28	+ 1.232				
					1.21075	750	5	4540.313
11+000	97.94	99.79	99.94	+ 1.189				
					0.60475	1980	5	5987.025
12+980	97.55	98.980	99.55	+ 0.02				
					1.105	680	5	3757.00
13+660	97.41	98.22	99.41	- 2.19				
					0.215	1286	5	1382.45
14+946	97.15	97.305	99.15	+ 0.43				
					1.415	3855	5	27274.125
18+801	96.38	96.615	98.38	+ 2.4				
					1.55	3275	5	25381.25
22+076	95.47	98.158	97.47	+ 0.7				
					0.45	2094	5	4711.5
24+526	95.30	97.815	97.30	+ 0.2				
					0.1	3356	5	1678.00
31+596	94.00	100.00	96.00	- 3.488			5	
32+275	93.90	98.97	95.90	-3.26			5	
Total					97597.18 cft. Say 100,000 cft.			

Table 8.7. Volume of soil needed for outer slope for left bank from RD 5+700 to 27+526.

1	Average field elevation	93.060
2	Average bank elevation	98.492
3	Difference of 1 & 2	5.432
4	Side Slope	1.5 : 1
5	Area	21.728
6	Length	21826
7	Volume of soil	474235.328 cft. Say 475,000 cft.

Table 8.8. Volume of soil needed for filling different specific weak portions of embankments observed during walk-thru survey.

RD	Weak Bank Side	Weak Bank Dimension, ft			Volume (cft)
		Average Length	Average Width	Average Depth	
2+000	Left Bank	10	5	1.5	75
2+300	"	20	5	1.5	150
2+600	"	500	5	2	5000
"	Right bank	15	3	2	90
4+400	"	50	12	1.5	900
4+600	"	150	12	1.5	2700
"	Left bank	15	5	1.5	112.5
4+800	"	20	5	1.5	150
5+000	"	10	5	1.5	75.
"	Right bank	10	12	1.5	180
5+400	"	20	12	1.5	360
"	Left bank	20	5	1.5	150
5+600	"	100	5	1.5	750
"	Right bank	100	12	1.5	1800
8+500	Left bank	5	5	1.5	37.5
6+200	"	12	5	1.5	90
6+400	"	6	5	1.5	45
6+600	"	15	5	1.5	112.5
6+800	"	15	5	1.5	112.5
7+400	"	200	5	1.5	1500
8+800	Right bank	40	8	1.5	480
9+400	"	8	12	1.5	144
10+400	Left bank	200	5	1.5	1500
11.000	"	30	5	1.5	225
"	Right bank	20	12	1.5	360
12+600	"	15	12	1.5	2700
"	Left bank	20	5	1.5	150
14+600	Right bank	20	12	1.5	360
18+290	Left bank	30	5	1.5	225

Table 8.8 (Complete)

RD	Weak Bank Side	Weak Bank Dimension, ft			Volume (cft)
		Average Length	Average Width	Average Depth	
18+490	"	15	5	1.5	112.5
"	Right bank	15	12	1.5	270
19+090 to 21+690	Left bank	1600	5	1.5	12000
21+890	Right bank	20	12	1.5	360
22+090	"	5	12	1.5	90
22+690	"	5	12	1.5	90
"	Left bank	5	5	1.5	37.5
24+090	Right bank	15	12	1.5	270
25+290	"	10	12	2	240
26+290	"	100	12	1.5	1800
"	Left bank	100	5	1.5	750
29+790	"	20	5	1.5	150
"	Right bank	15	12	1.5	270
Total volume of soil required			34,544 cft, say 35,000 cft.		

Table 8.9. Volume of soil required for eroded outer side slopes.

S.No.	Variables	Right Bank.	Left Bank.
1	Average field elevation.	93.578 ft.	93.4006 ft.
2	Average bank elevation.	99.69 ft.	99.54 ft.
3	Difference of Row 1 & Row 2	6.102 ft.	6.14 ft.
4	Side Slope	1.5 : 1	1.5 : 1
5	Area.	27.459 ft2	27.63 ft2
6	Length.	17158 ft.	10449 ft.
7	Volume.	471141.522 cft.	288705.87 cft, Say 290,000 cft.

Table 8.10. Summary of total volume of soil required to improve the banks of the Dhoro Naro Minor.

Table No.	Soil Volume
Table 8.4	200,000 cft.
Table 8.5	260,000 cft.
Table 8.6	100,000 cft.
Table 8.7	475,000 cft.
Table 8.8	35,000 cft.
Table 8.9	290,000 cft.
TOTAL:-	1,360,000 cft

8.4.2 Soil Transportation

For the above estimated soil volume about 35,000 cft would be carried out from about 7 to 8 Km distance from the minor. The local soil carriage rate is Rs. 150/ for carrying 130 cft of soil. Due to loading, unloading and transporting the soil becomes loose; therefore, the volume is reduced about 40 % due to compaction. Because of this, the total volume required to be transported will be 35,000 + 14,000 (40 %) = 49,000 cft.

Total carriage cost of 49,000 cft at the rate of Rs. 150/ for carrying 130 cft, would be Rs. 56550.

On the other hand, following are the Government rates for soil carriage per 100 cft.

Mileage	Cost in Rupees
1st Mile	114.10
2nd Mile	21.60
3rd Mile	16.60
4th Mile	14.55
5th Mile	12.60
6th Mile	11.25
7th Mile	10.15

8.4.3 Bulldozer Costs

In the last minor cleaning operation, a portion of 400 meters in length was cleaned by Watercourse 6-L growers with the help of a bulldozer. During that period, it was observed that it takes one-and-half hours (90 minutes) in leveling the very irregular inspection path. While in this work, 15+885 RDs needs 50% filling of soil from adjacent lands before the cotton sowing season and 50% leveling work. From the above said experience, it can be said that on the average 20 hours for leveling and 20 hours for soil filling is needed for 15+885 RDs out of 32+275 total RDs. While the remaining 16+390 RDs requires only a filling operation from the sides, that will be equal to the above filling hours (i.e. 20 hours).

Overall, 60 working hours of a bulldozer would be needed to complete this operation. According to the Agriculture Engineering Department, Govt of Sindh, the rate of a working hour for a bulldozer is Rs. 693.40. According to this, the total cost of bulldozer work will be: 60 * 693.40 = 41,604.

8.4.4 Dressing Costs

After consultation with the farmers, it was estimated that 4+750 RDs can be dressed with the help of two tractors and 40 laborers in a day after the bulldozer work. Locally, the tractor rate for one hour of work is Rs. 130 (with concession) and the daily wage rate is Rs. 80 (with concession).

Following the above rates, the dressing of 32+275 RDs (inspection path) with tractor and laborers can cost Rs. 35884 (tractor charges Rs.14136 and labor charges Rs. 21748) say Rs. 36,000.

8.4.5. Vegetation (Jungle) Removing Costs

As the right bank (inspection path) is 50% free from vegetation, while remaining portion would be cleaned with bulldozer and dressing operation.

Where as left bank is also 30% vegetative (JUNGLE). Vegetation cleaning experience was got in last annual water closure period January, 97. A portion of 2+730 RDs was cleaned by ID field people through labor, for which they paid Rs. 2600/. According to this 30% vegetative length (i.e. 9+682 RDs) of left bank of the minor can be removed at the cost of Rs. 9221.425/.

8.4.6. Total Estimated Cost

Expenses	Cost in Rs.
Bulldozer Work.	41600
Tractor Work.	14100
Labor Work.	21750
Soil Carriage.	55800
Vegetation Removal.	92200
TOTAL :-	142450
SAY:-	143000

8.5. COSST FOR STRUCTURES

8.5.1. Cost Estimate of a Room (16 Ft * 14 Ft), for Water Users Federation Office Near the Head of Dhoro Naro Minor.

Material Estimate

Room Length	4.8780 m = 16 ft.
Room Width	4.2683 m = 14 ft.
Room Height	3.3536 m = 3 ft.
Room Area	20.820 m^2 = 224 ft^2
No. of Door	1
Door Height	2.058 m
Door Width	1.015 m
Door Area	2.0887 m^2
No. of Window	3
Window Height	1.169 m
Window Width	0.889 m
Window Area	1.039 m

Total area of three Windows	3.117 m^2
Total area of three Windows and one Door	5.2058 m^2
Total Length of walls	19.2126 m.
Height of wall	3.3536 m.
Thickness of wall	0.23 m.
Volume of wall	20.8272 cu.m.
Total length of base wall	19.2126 m.
Depth of base wall	0.9416 m.
Thickness of base wall	0.33 m.
Volume of base wall	5.7987 cu.m.

Volume of bed:

(a) Bed foundation volume	4.2683 * 4.878 * 0.1524 = 3.17 cu.m.
(b) Bed topping volume	4.2683 * 4.878 * 0.0762 = 1.5869 cu.m.

Volume of concrete for foundation	19.2126 * 0.20325 * 0.4573 = 1.7858 cu.m.
Volume of Mortar for three Window Shade	0.889 * 0.4573 * 0.10163 = 1.7858 cu.m.
Volume of mortar for Door Shade	1.015 * 0.4573 * 0.10163 = 0.04717 cu.m.
Volume of Plaster for wall	0.01 * 19.2126 * 3.3536 = 1.2886 cu.m.
Volume of Door & window Sides	17.479 * 0.1524 * 0.01 = 0.0266 cu.m.
Volume of Mortar for wall	0.02 * 20.8272 = 4.790 cu.m.
Volume of Mortar for base wall	0.262 * 58987 = 1.5193 cu.m.

Total volume of Plaster & Mortar	9.3825 cu.m.
Total volume of concrete	4.95969

Material For Wall & Foundation Wall

Bricks	26.6259 * 500 = 13312.95 + 10% = 14644.245 No.
Cement	7.2 * 9.3825 = 67.554 bags.
Hill Sand	35.315 * 9.3825 = 331.343 + 10% (Wastage) = 364.477 cft.

Concrete Material For Bed And Foundation

Cement	6 * 4.95969 = 29.758 bags.
Hill Sand	35.315 * 0.42 * 4.95969
=	73.564 + 10% (Wastage) = 80.92 cft.
Crush Gravel	35.315 * 0.78 * 4.95969 = 136.618 cft.

Material For Ceiling

Bricks	32 * 13 = 416 + 10% (Wastage) = 457.6 No.
Iron	
(a) No. of Girder	3
Length of girder	15 ft.
Total Length of three girders	45 ft.

(b) No. of Tears	13
Length of a tear	17 ft.
Total length of 13 tears	221 ft.

Total Material

Bricks for wall	14644.245 Nos.
Bricks for ceiling	457.60 Nos.
Cement	67.554 + 29.75 = 97.304 bags.
Hill Sand	364.477 + 80.92 = 445.397 cft.
Crush Gravel	36.168 cft.
Iron	
(a) Girders	45 ft.
(b) Tears	221 ft.
(c) Iron Bar	35.297 Kg.
(d) Iron grill for three window	60 Kg.

Cost

Bricks (Wall)	=	14.644245 Nos. * 1000	=	Rs. 14644.245/=
Bricks (Ceiling)	=	457.60 Nos. * 4.00	=	Rs. 1830.4/=
Cement	=	97.304 Bags * 180	=	Rs. 17514.72/=
Hill Sand	=	4.4539 cft * 450	=	Rs. 2004.287/=
Crush Gravel	=	1.3617 cft * 1000	=	Rs. 1361.68/=
Iron				
(a) Girders	=	45 ft * 80	=	Rs. 3600/=
(b) Tears	=	221 ft * 22	=	Rs. 4862/=
(c) Iron Bar	=	35.297 Kg. * 19.70	=	Rs. 695.351/=
(d) Iron Grill	=	60 Kg. * 19.70	=	Rs. 1182/=
Door	=	1 No. * 2500	=	Rs. 2500/=
Windows	=	3 Nos. * 2000	=	Rs. 6000/=
Color				
(a) Distemper	=	3 Liters * 250	=	Rs. 750/=
(b) Oil paint	=	1.5 Liters * 450	=	Rs. 675/=
Labor cost	=	224 ft2 * 40	=	Rs. 8960/=
Total Cost	=	Rs. 66389.10/=		
Say	=	Rs. 66400		

8.5.2. Cost Estimate for a Bridge Roof at Dhoro Naro Minor @ R.D. 25+956

This bridge is located at RD 25+956 at Dhoro Naro Minor for crossing people and agriculture products. The pillars of this bridge were already constructed by landowner Mr. Muhassin Shah, but the roof is uncomplete. This estimate is prepared on the request of WUA of watercourse 6-AR.

Dimensions of the Roof

Length	5.36 m =17.581 ft.
Width	3.14 m = 10.299 ft.
Thickness	0.275 = 0.9 ft.
Volume of concrete roof	4.628 Cu.m

Material Estimate

Cement required for one Cu.m	7 Bags
Cement required for 4.628 Cu.m	32.398 Bags
Including 5% wastage	34 Bags
Hill Sand required for one cu.m	0.48 Cu.m
Hill Sand required for 4.628 Cu.m	2.22 Cu.m
Including 5% wastage	2.33 Cu.m
Gravel required for one Cu.m	72 Cu.m
Gravel required for 4.628 Cu.m	3.332 Cu.m
Including 5% wastage	3.498 Cu.m
Iron needed in one culvert	64 Kg
This bridge is four times more than culvert	
Seiron required for this bridge	256 Kg
Material For Bridge Wing Walls	
Length	3.14 m
Width	0.329 m
Height	609 m
Volume of wall	0.629 Cu.m
Bricks needed	618 Nos.
Including 5% wastage	650 Nos.
Morter required for one brick	0.0004 Cu.m
Morter required for 650 bricks	0.26 Cu.m
Cement required for one Cu.m Mortor	7.2 Bags
Cement required for 0.26 Cu.m mortor	1.87 Bags
Including 5% wastage	2 Bags
Hill Sand required for one Cu.m mortor	1.00 Cu.m
Hill Sand required for 0.26 Cu.m mortor	0.26 Cu.m
Including 5% wastage	0.273 Cu.m

Labor :

Meson required one per day for 4 days

Labor required 3 per day for 4 days

Total Material & Labor

Bricks	Cement	H.Sand	Gravel	Iron	Mason	Labor
650 Nos.	36 Bags	2.603 Cu.m	3.498 Cu.m	256	4	12

Cost Estimate

Material	Cost per unit	Price Rs.
Bricks	Rs.800/1000 bricks	520/=
Cement	Rs.200/ 1 Bag	7200/=
H. Sand	Rs.500/1 Cu.m	1302/=
Gravel	Rs.1000/1 Cu.m	3498/=
Iron	Rs.20/1 Kg	5180/=
Mason	Rs.300/ day	1200/=
Laborer	Rs.100/day	1200/=
GRAND TOTAL:		20100/=

8.5.3. Cost Estimate for Five Culverts at Outlets of 3-R,4-R,5-R,6-AR & 10-L of Dhoro Naro Minor

1. Culvert Roof Dimensions

Dimensions of existing roof of an Outlet Culvert

Length	4.670 meters
Width	1.600 meters
Breadth	0.155 meters

Material for Roof:

Total volume of concrete roof	1.158 cu.m. = 40.867 cu.ft.
Volume of concrete of 5 culvert roofs	5.79 cu.m.

Cement:

Cement required for one cu.m. of concrete material	7.0 bags.
Cement required for 5.79 cu.m. of concrete	40.53 bags.

Note: One bag of cement contains 50 Kg.

Sand:

Sand required for 1.00 cu.m. of concrete mixed material	0.48 cu.m.
Sand required for 5.79 cu.m. of concrete mix	2.779 cu.m.

Gravel:

Gravel required for 1.00 cu.m. of concrete	0.72 cu m.
Gravel required for 5.79 cu.m. of concrete mix	4.17 cu.m.

Iron:

Iron required for one culvert	64 Kg.
Iron required for 5 culverts	320 Kg.

Binding wires:

One culvert required of binding wires	1.0 Kg.
5 culverts required binding wires	5 Kg.
Total iron required	320 + 5 = 325 Kg.

Labor:
Masons required one for 10 days.
Labor required three for 10 days.

2. Culvert Wing Wall Dimensions

Length	1.6 m
Width	0.385 m
Depth	0.65 m

Material for walls:

Volume of a wall	0.4004 Cu.m
Volume of 10 walls	4.004 Cu.m

Bricks:

Bricks needed for one wall	151.14 Nos.
Bricks needed for 10 walls	151.14 *10 = 1511.4
5 % wastage	75.57 + 1511.4 = 1587 Nos.

Mortar:

Mortor required for one brick	0.0004 Cu.m
Mortar required for 1587 bricks	0.635 Cu.m

Cement:

Cement required for 0.635 Cu.m mortar	7.2*0.635 = 4.57 Bags
5% wastage	0.228 + 4.57 = 4.79 = 5 Bags

Hill Sand:

Hill Sand required for 0.635 Cu.m mortar	0.635 Cu.m
5% wastage	0.0317 + 0.6348 Cu.m = 0.666 Cu.m

Labor:
One mason for five days.
Two laborer for five days.

Total of the concrete and necessary material for culverts.

Type of structure	Cement in bags.	Sand in cu.ft.	Gravel in cu.ft.	Iron in Kg	Meson	Labor
Culvert Roofs.	45.53	3.45	4.17	325	15	35

Cost Estimate

Material	Cost per Unit Rs.	Total Cost Rs.
Bricks	Rs.800/1000 bricks	1269.6
Cement	Rs.200/ 1 Bag	9106
H. Sand	Rs.500/1 Cu.m	1725
Gravel	Rs.1000/1 Cu.m	4170
Iron	Rs.20/1 Kg	6500
Mason	Rs.300/ day	4500
Laborer	Rs.100/day	3000
Grand Total		3027.6 Say 30300

8.5.4. Cost and Material Estimates for a Buffalo Wallow Near RD 11+000

This is the cost and material estimates for buffalo wallow that will be constructed near RD 11+000 of Dhoro Naro Minor, Nawabshah. This will facilitate the farmers of village Chaudhary Abdul Hameed and save the minor from damage, due to buffalo free bathing in the minor. Construction will be made on a cost sharing basis among WUA of Watercourse 1-AL and the development fund of the project. Water will be provided from Watercourse 1-AL during the irrigation turn of Mr. Ahsan Ali (President of WUA and Finance Secretary of WUF).

Dimensions of Buffalo Wallow

Length	15.24 m
Width	15.24 m
Height	1.067 m
Thickness of wall	0.23 m
Gate way	3.049 m

According to farmers decision to make estimate more economical, the bed of wallow should be brick's made with good bed compaction.

Material:

Bricks:

Bricks for wall	8360 Nos.
Bricks for bed	10000 Nos.
Total Bricks	18360 Nos.

Mortar:

Mortar required for 18360 bricks — 18360*.0004 = 7.344 Cu.m

Cement:

Cement required for 7.344 cu.m mortar — 7.2*7.344 = 52.87 Bags + 5% wastage
= 2.64+52.87 = 55.514 Say 56 bags.

Hill Sand:

Hill Sand required for 7.344 cu.m mortar — 7.344 cu.m+ 5% wastage
= 0.367+7.344 7.71 cu.m

Labor:
One meson for 23 days.
Three labor for 23 days.

Concrete Bed for Gate Way

Dimensions	
Length	3.049 m
Width	1.524 m
Thickness	0.16 m
Volume of concrete bed for gate way	0.743 cu.m

Material:
Cement:
Cement required — 7*0.743 = 5.2+ 5% wastage
= 0.26+5.2= 5.46 =6 bags.

Hill Sand:
Hill Sand required — 0.743 cu.m 5% wastage = 0.037+0.743 = 0.78 cu.m

Gravel:
Gravel needed — 0.72*0.743 = 0.534 cu.m
+ 55 wastage = 0.0267+0.534 = 0.56 cu.m

Labor:
One meson for one day.
Three labor for one day.

Total Material and Cost

Material	Quantity	Cost per unit	Total Cost in Rs.
Bricks	18360 Nos.	Rs.800/1000 bricks	14688/=
Cement	62 bags.	Rs.200/1 bag	12400/=
H. Sand	8.49 cu.m	Rs.500/1 cu.m	4245/=
Gravel	0.56 cu.m	Rs.1000/1 cu.m	560/=
Meson	24	Rs.300/day	7200/=
Labor	72	Rs.100/day	7200/=
Grand Total:			46293/= Say 46300

9. CONCLUSIONS AND RECOMMENDATIONS

From the foregoing study, the following conclusions have been drawn.

1. The tampering of outlets and lack of essential structural maintenance and deferred maintenance would lead to the problem of inequity in water distribution. Therefore, the solution of this problem could be achieved by the help of joint efforts of water users; i,e Water Users; (i.e., WUF + WUF).

2. Desilting (Khatti) of the minor during the closure period (January) every year, as well as during heavy silt deposition could be carried out effectively by the combined efforts of the water users, if they are united.

3. Deferred maintenance, like the inspection path, unstable portions of the non-inspection path, wider cross-sections of the minor, and vegetative growth removal have not been conducted since about 8-10 years (farmers information). After the formation of the water users federation, they realized the need for maintenance of the minor.

4. The project development funds for the minor which were allocated in January 1997, has been used by the WUF for the development of the minor. These funds were used on a 50-50 cost-sharing basis. The development works were identified by the water users association of each watercourse, as well as the water users federation in the general body meeting. The water users federation prioritized the work. The IIMI field team prepared the cost estimation for each piece of work. The work was carried out under the supervision of the water users federation and the IIMI field team. By involving the beneficiaries, the cost for the work could be minimized and the quality of the work could be improved. The practical suggestions of the farmers and local people helped very much in better management of the work.

5. Looking into the problem of animals bathing in the minor and creating sedimentation problems in the minor, the water users opted for the alternative of constructing a buffalo wallow on a watercourse. This has been constructed for a total cost of Rs. 45,000.

6. The improvement of the inspection path and stabilization of weak portions of the non-inspection path was done. The total estimated cost for the whole work was Rs. 143,000. This work was carried out and completed for a cost of Rs.??/. This has again proved that the involvement of the beneficiaries would further minimize the expenditures. These estimations were thoroughly discussed with the water users and experienced farmers.

7. The other works have been done on watercourse culverts for improving transportation in the command area.

10. REFERENCES

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ANNEXURES
FIELD NOTES
AND SKETCHES

ANNEX A. OPERATIONS CONTROL MAINTENANCE SURVEY OF DHORO NARO MINOR.

RD 91.4
GAJRAH BRANCH

1. HEAD REGULATOR

1.1 Gate of Head Regulator

The head regulator for the Dhoro Naro Minor (Fig A1) has one cast iron gate which is manually operated, and in good condition. The size of gate measured during the inspection is given below.

Width of gate	=	3.985 ft
Height of gate	=	5.547 ft
Height of frame	=	10.08 ft.

1.2 Crest

The crest of the head regulator is in good condition.

1.3 Wing Walls

Wing walls are constructed to streamline the flow. They are in good condition.

1.4 Shoulders

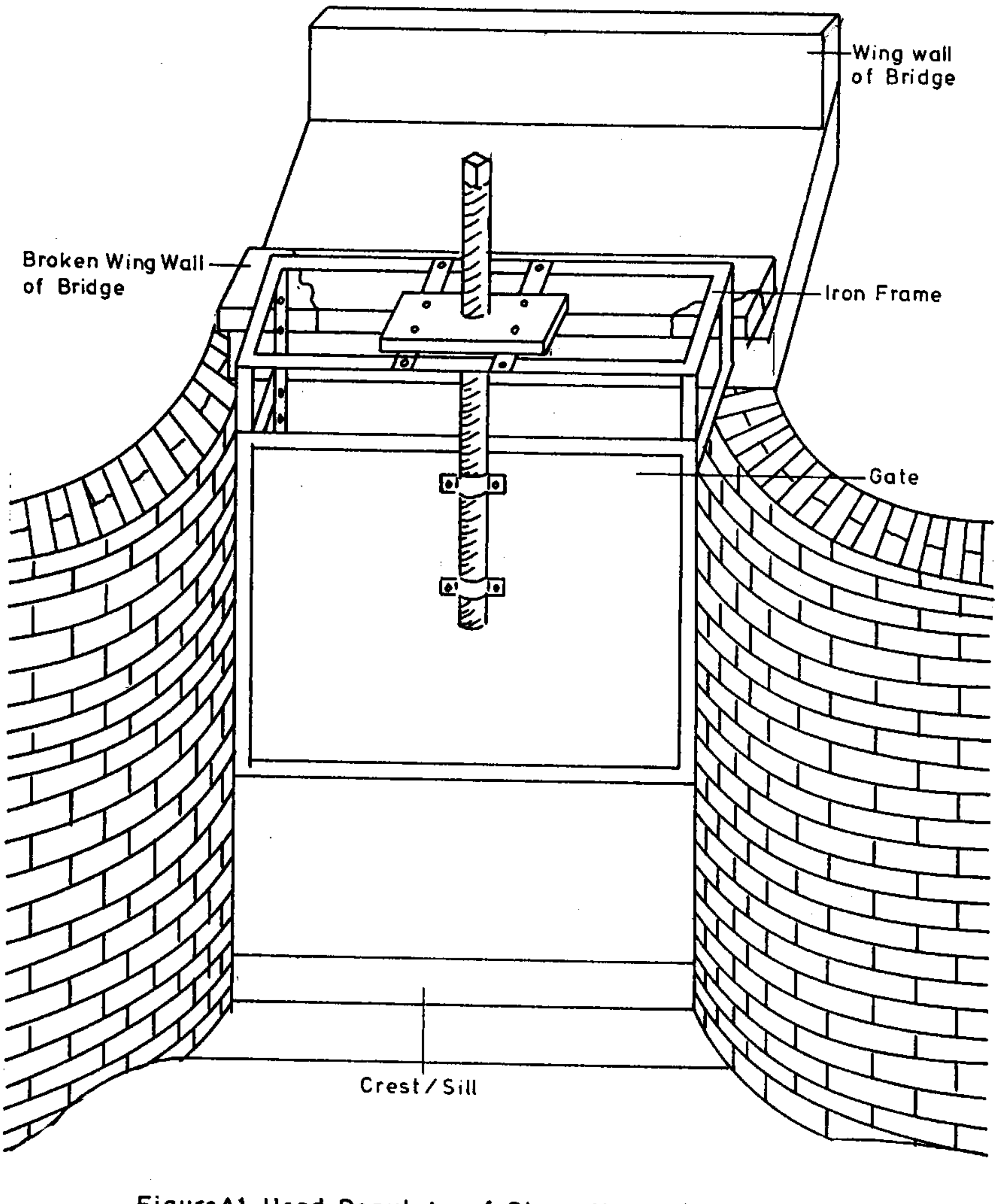
The shoulders of culvert (Head regulator) are in poor condition.

1.5 Upstream and Downstream of Head Regulator

The heavy amount of sediment deposition just upstream of the head regulator was observed. There is no silt deposition at the downstream of the head regulator mainly because of free flow conditions at the head regulator. However, about 100 ft. downstream of the head regulator, sediment deposition had taken place.

Causes: Due to lack of proper maintenance silt deposited at upstream. Shoulders are damaged. Gate opening fluctuations are main cause of silt deposition at downstream of head regulator at about 100 ft. length.

Remedy: Shoulders may be repaired with minimum cost. Regulator may be operated at full supply level to control sediment deposition.



FigureA1. Head Regulator of Dhoro Naro Minor.

2. OUTLET STRUCTURES (MOGHAS)

RD 2+000 Outlet 1-R

Situation: The throat and crest of outlet structure was damaged/tampered. The outlet culvert was also damaged. The upstream wing walls do not serve their purpose because they are damaged (Figure A2).

Causes: Tampering of crest and throat has been done for drawing more water.

Remedy: Outlet structure may be remodeled on the existing discharge and may not be disturbed in the future. It's repair may need about 500 bricks, cast iron frame and 3-4 bags of cement with hill sand.

RD 3 + 750 Outlet 1-DL

Situation: This outlet was tampered. Its crest was damaged and lowered to about 0.4 ft. below the crest level, where the iron frame was placed. There are no wing walls. (Figure A3).

Causes: The lack of proper check and balance has developed this situation. An other major reason is to draw more water. Although the water is available in the system but artificial stoppage of water by inserting dikkas is the normal practice by the concerned department.

Remedy: Outlet throat and crest level may be remodeled according to available supply and reliability in supply should be assured.

RD 5+700 Outlet 2-R

Situation: The throat of outlet was irregular and crest was tampered by lowering it down. The outlet has free flow. Wing walls at upstream and downstream were damaged and need repairs (Figure A4).

Causes: Tampering of throat and crest is to draw more water. The influential landowners mostly do this practice.

Remedy: Check and balance should be strictly observed. Reshaping of outlet throat and proper crest elevation should be made on the basis of available supply. Water Users Federation may be activated to stop this practice. This would be possible only when water users and concerned department will have close coordination and O&M responsibility of distributary may be shifted from ID to WUF.

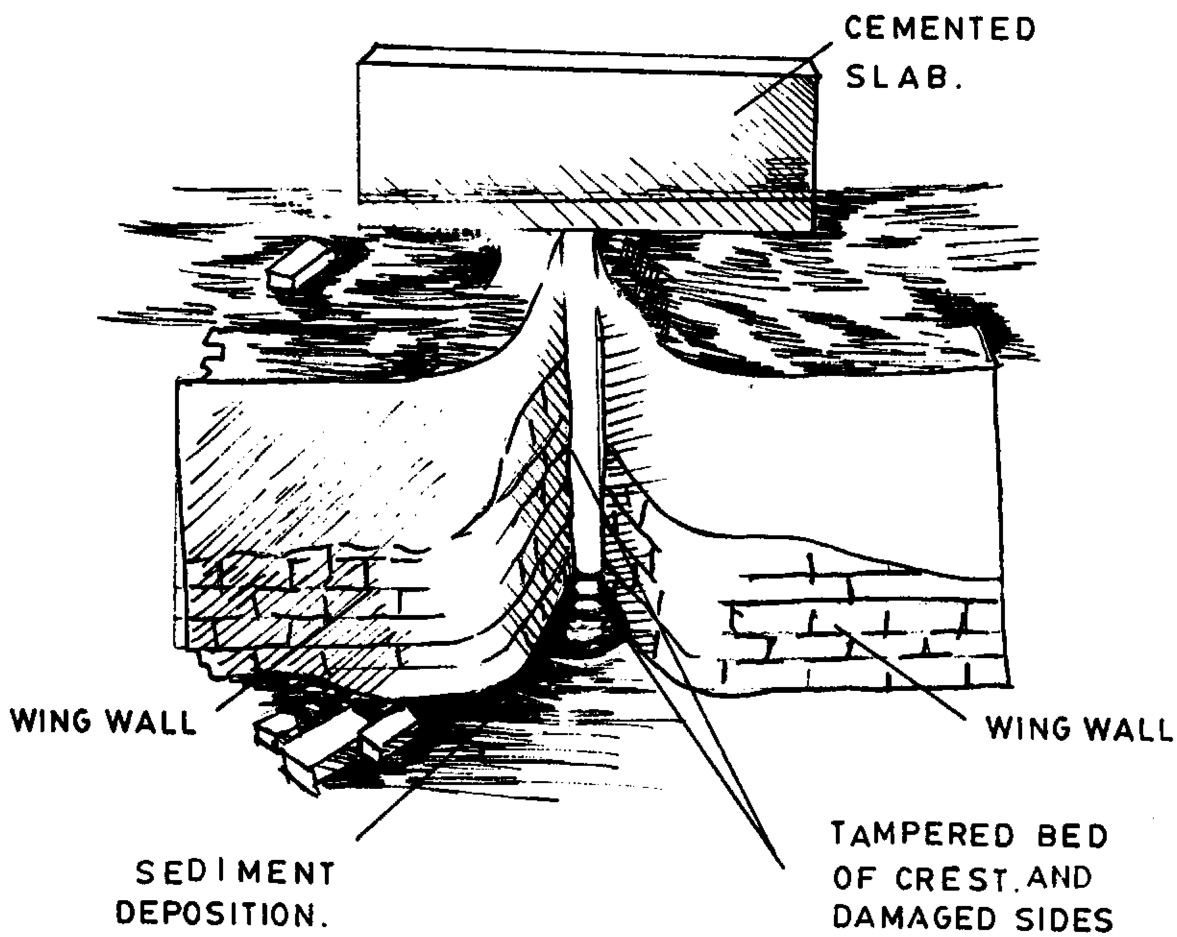


Figure A2. Outlet 1R Dhoro Naro Minor.

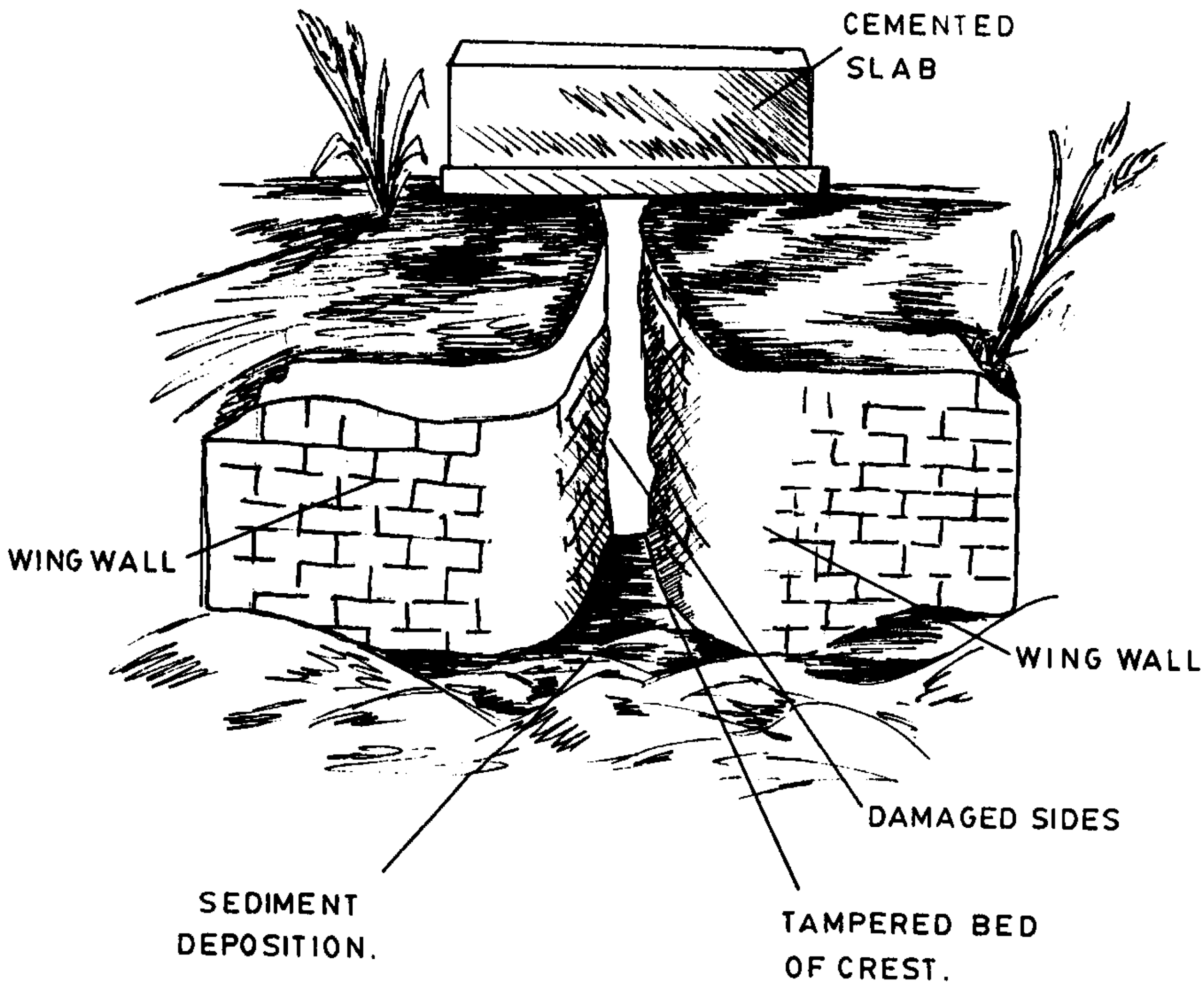


Figure A3. Outlet 1DL Dhoro Naro Minor.

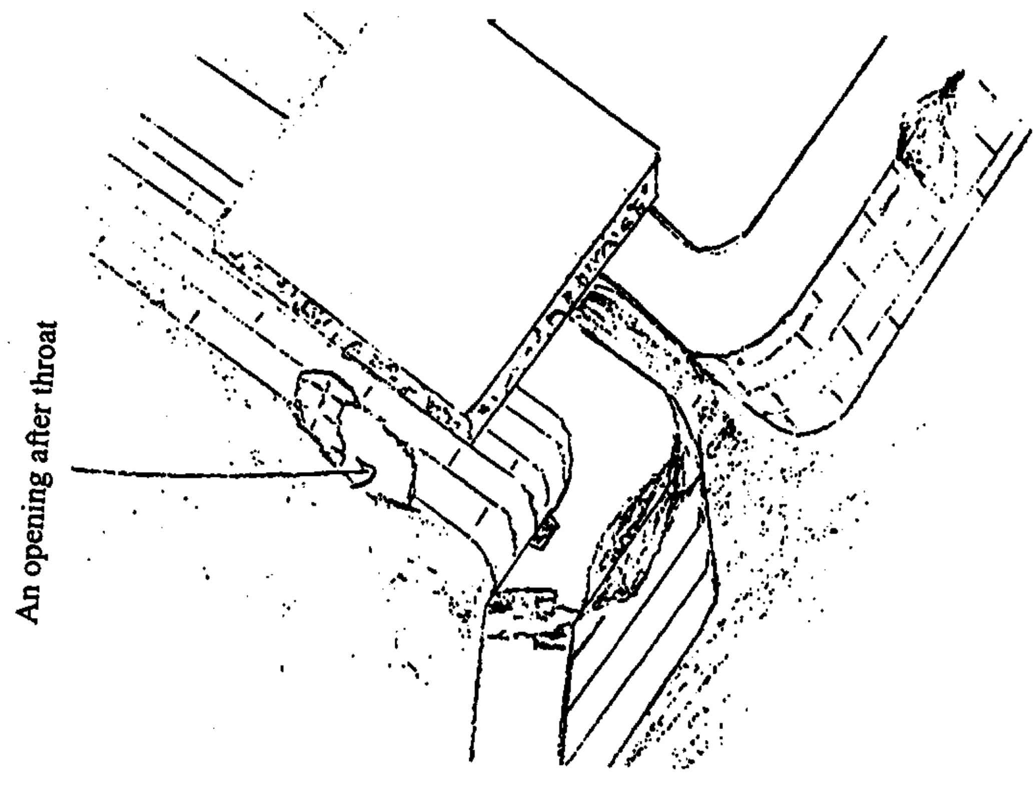


Figure A4. Outlet 2R Dhoro Naro Minor.

RD 8+981 Outlet 1-L

Situation: The outlet throat was found tampered and its width (tampered width) was about 0.197 ft. On the left side wall there was a hole of about 0.92 ft. wide and 1.3 ft in height (See Figure A5). The upstream wing walls of outlet were broken from top.

Causes: The tampering is done to draw more water. Due to lack of maintenance, the condition of the outlet looks poor.

Remedy: ID personnel should constantly petrol the system. Through the WUF the sanctions may be put over the person who may be found if wrong doing/wrong practices.

RD 8+981 Outlet 3-R

Situation: The outlet throat and crest was badly damaged. The crest was almost looking below the bed elevation of parent channel. The wing wall culvert (roof & Shoulders) were also damaged. A hole from left side was made for drawing extra quantity of water through it (Figure A6).

Causes: There are almost the same causes as in previous outlet cases.

Remedy: Outlet should be remodeled on the basis of available supply. Most important is that the reliable supply should be guaranteed. There should be a check and balance system.

RD 10+250 Outlet 1-AL

Almost same conditions were observed as in the case of previous outlet 3-R (Figure A7).

RD 11+000 Outlet 1-BL, 1-CL, 2-L

Situation: At this RD three outlets are offtaking from the channel. Outlet 1-BL was flowing submerged. The wing walls were almost disappeared (Figure A8). Crest of the outlet was damaged.

Outlet 1-CL was also flowing submerged. Throat was tampered (Figure A9).

The crest and throat of outlet 2-L were damaged and tampered. The wing walls of outlet were also damaged seriously (Figure A10).

Causes: Tampering and damaging of the outlet was done to draw more water.

Remedy: Repairs may be done by ordinary masonry work. But these should be first remodeled on the basis of available water supply and then should be repaired accordingly. After repair the check and balance system should be strictly followed. Otherwise all the exercise will be useless.

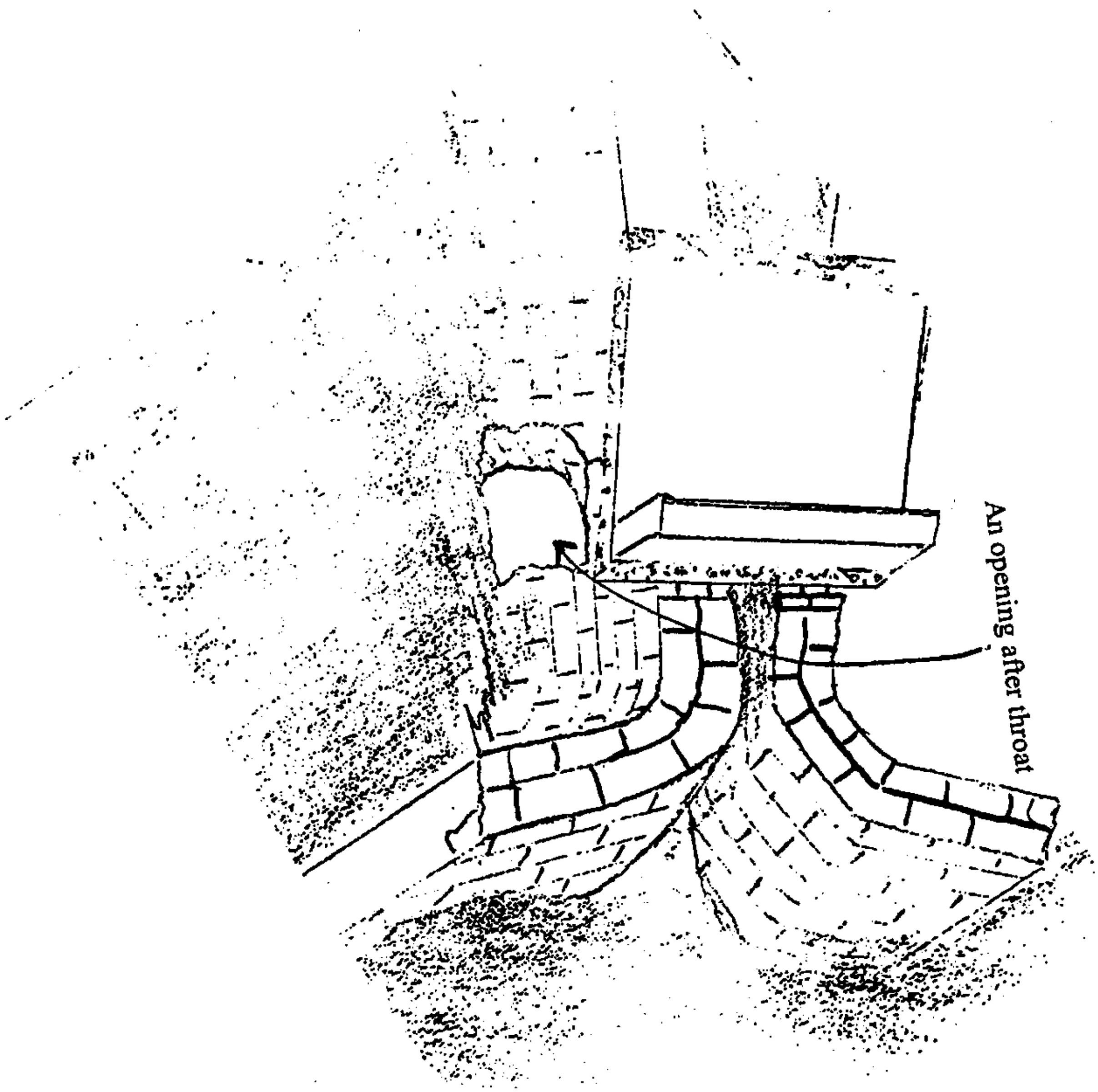


Figure A5. Outlet 1L Dhoro Naro Minor.

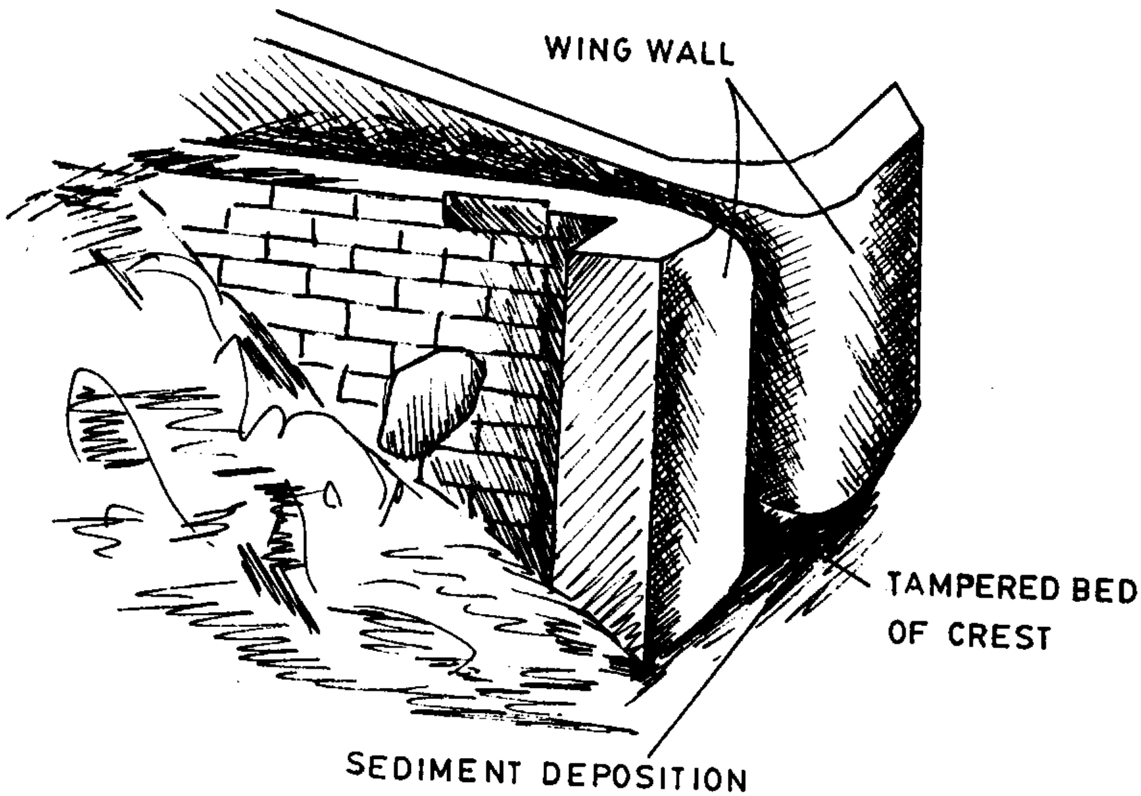


Figure A6. Outlet 3R Dhoro Naro Minor.

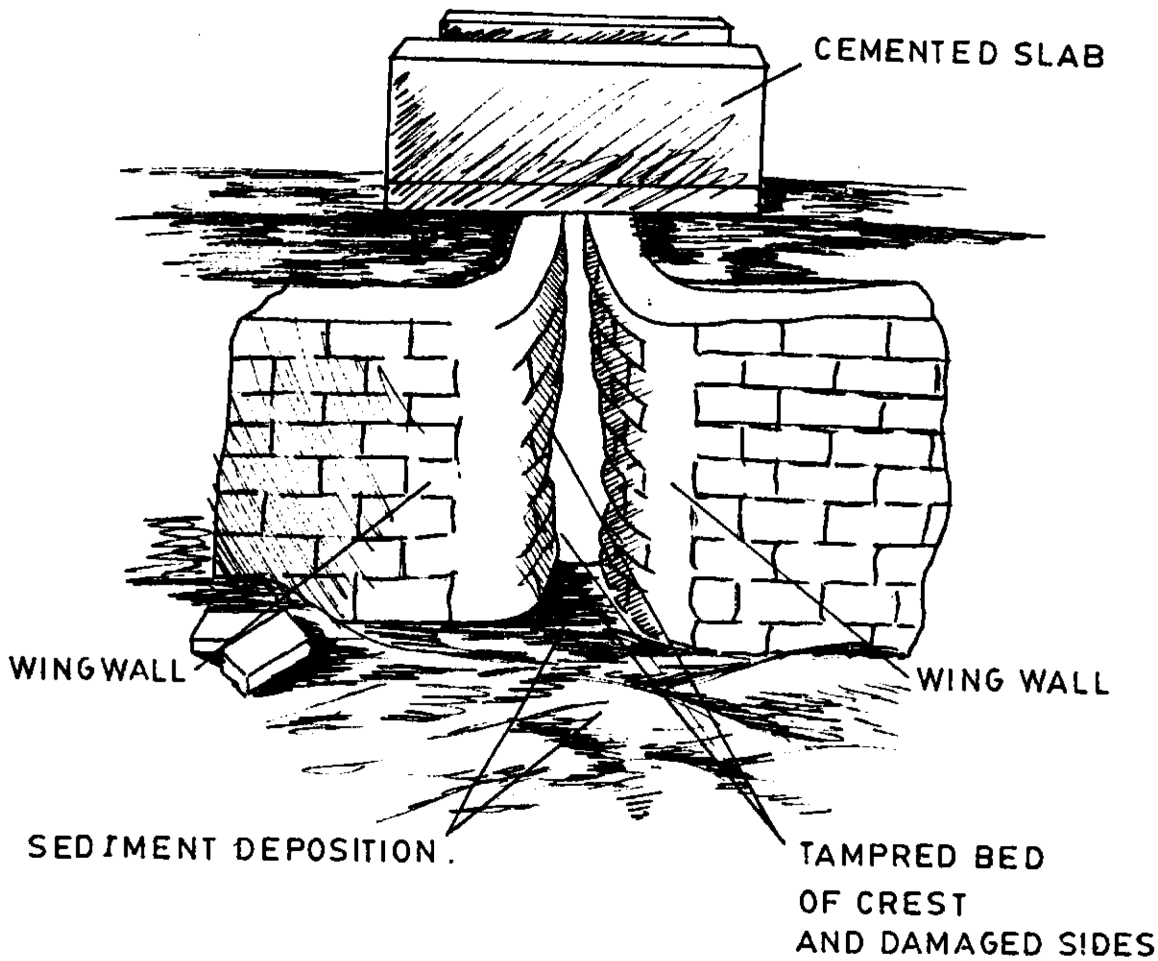


Figure A7. Outlet 1AL Dhoro Naro Minor.

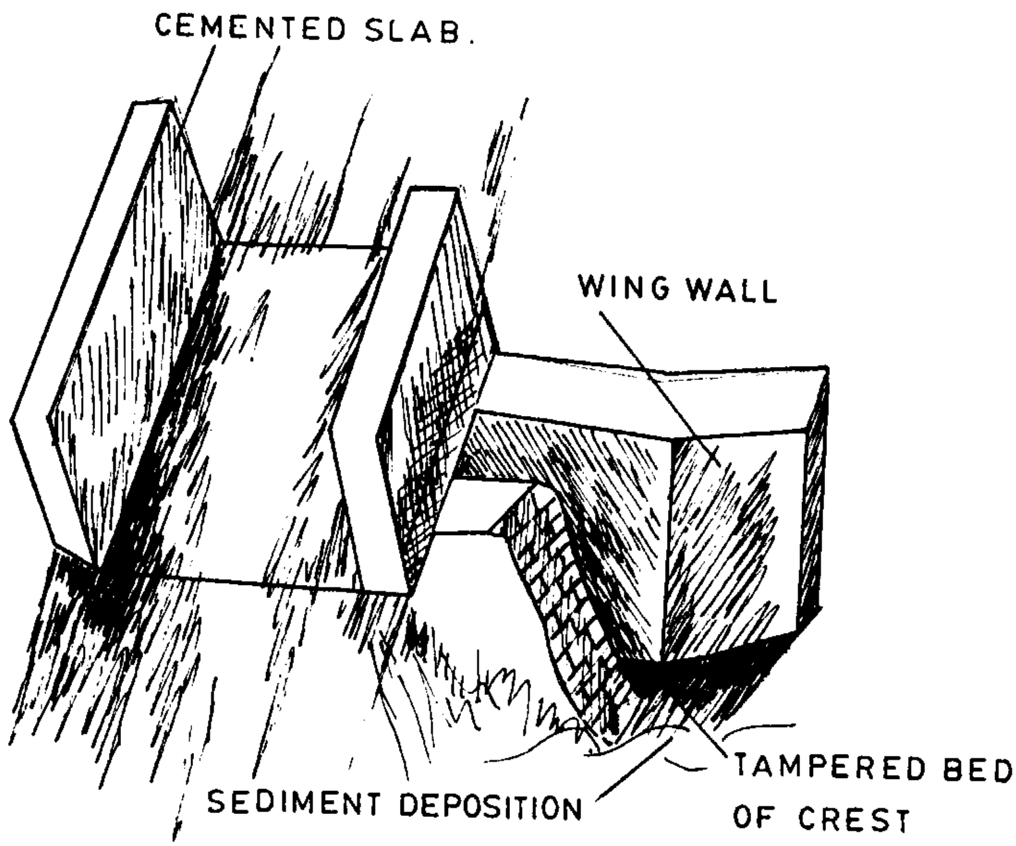


Figure A8. Outlet 1BL Dhoro Naro Minor.

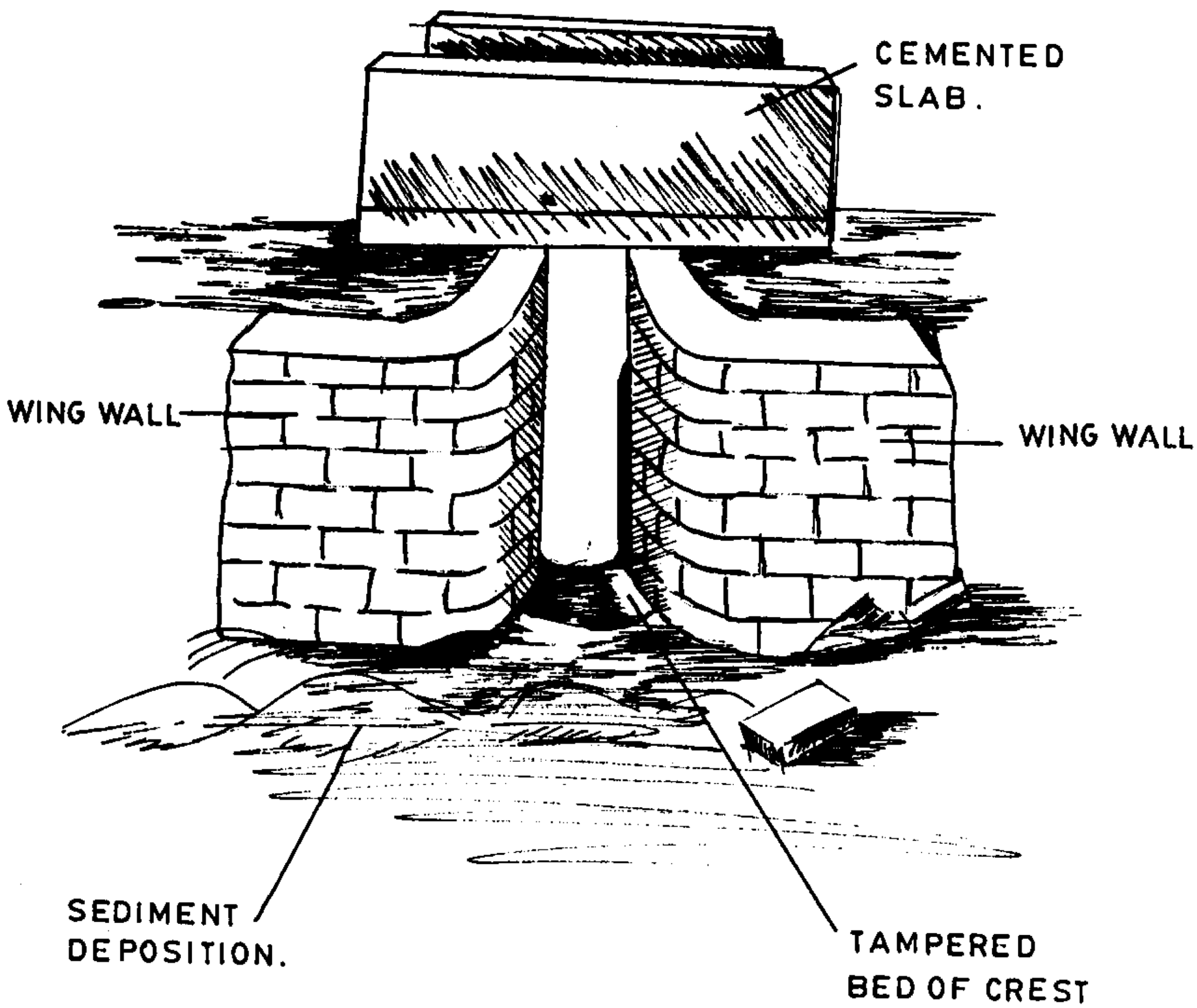


Figure A9. Outlet 10L Dhoro Naro Minor.

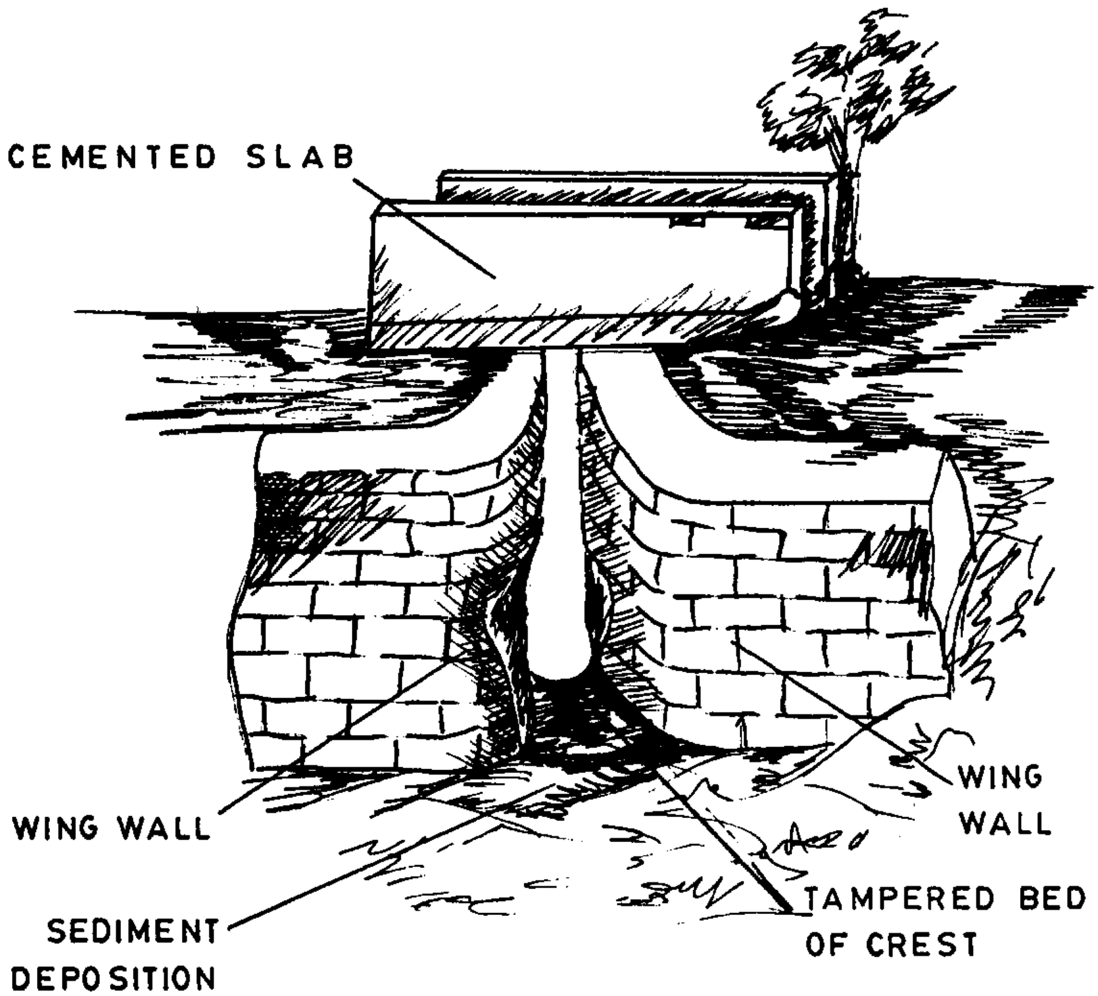


Figure A10. Outlet 2L Dhoro Naro Minor.

RD 12+960 Outlet 2-AL, 4-R

Situation: These two outlets are located at RD 12+960 and 12+980, respectively. The outlet 2-AL was badly damaged. Functioning throat width was averagely 0.5 ft. Water was entering from three sides (i.e., left side, right side and from outlet itself) (Figure A11, A12). The throat and crest of outlet 4-R were damaged. A hole from the bottom of crest of outlet was also observed during survey. The roof of the culvert was absent.

Causes: Tampering is generally done to get more water. Due to lack of maintenance, the condition of outlet structures was poor.

Remedy: Outlets may be remodeled. The reliable supply may be assured and check and balance may be strictly followed. The WUF should be involved in operation and maintenance of the channel. Close coordination between ID and water users federation may be made.

RD 13+660 Outlet 3-L

Situation: The throat width and crest of the outlet was tampered. Roof and shoulders of culvert were badly damaged. Crest level was below the existing bed level and more sediment was observed in the watercourse (Figure A13).

Causes: Because of lowering the crest level, sediment was observed in the watercourse. For drawing more water crest and throat of outlet was tampered and damaged.

Remedy: To stop the excess entry of sediment into the watercourse, the crest level should be fixed at designed level. The cast iron frame should be designed and fixed on the available supply rate with close coordination of WUF/Water Users. The experience of the water users should be utilized. Proper operation and maintenance should be made by involving the water, users.

RD 14+946 Outlet 4-L
15+276 Outlet 4-BL
18+801 Outlet 5-R
18+942 Outlet 4-AL

Situation: The condition of these four outlets was almost same. The crest and throat of all the outlets were tampered and damaged. The roof of culverts was badly damaged. (See Figures A14-, A15, A16, A17). Also, more silt entry was observed in the watercourses.

Causes: Tampering was made to get more water and to cultivate more land. Due to lowering of crest level more silt goes into watercourse. Lack of maintenance and supervision of concerned department has led to the poor condition of structure of outlets.

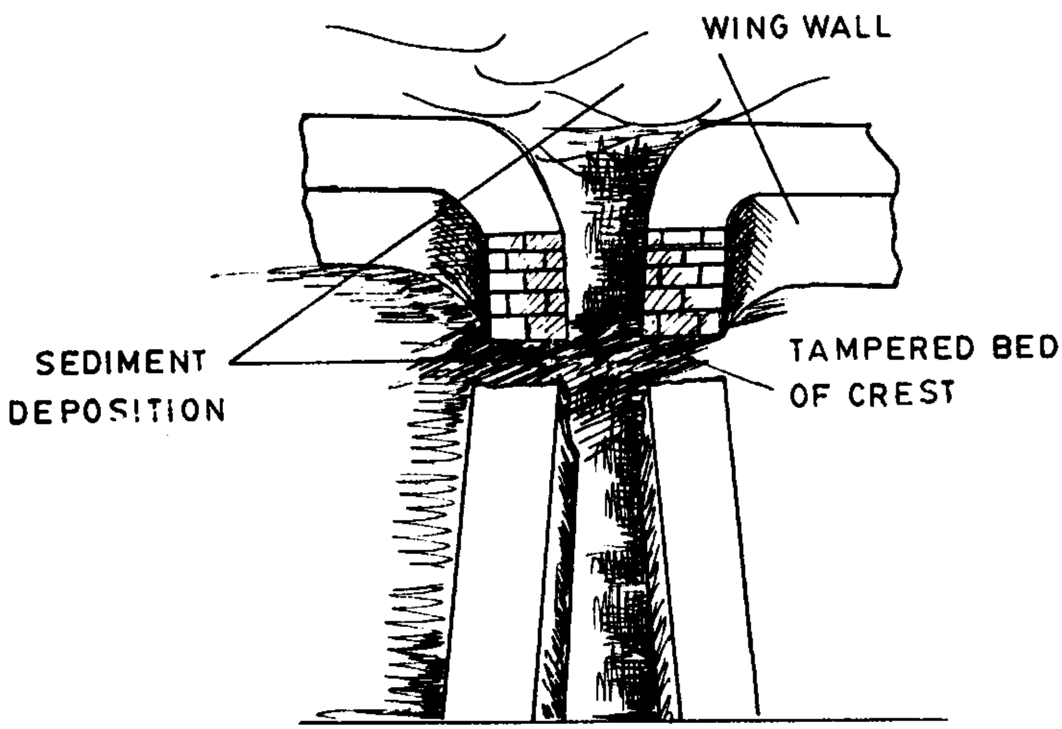


Figure A11. Outlet 2AL Dhoro Naro Minor.

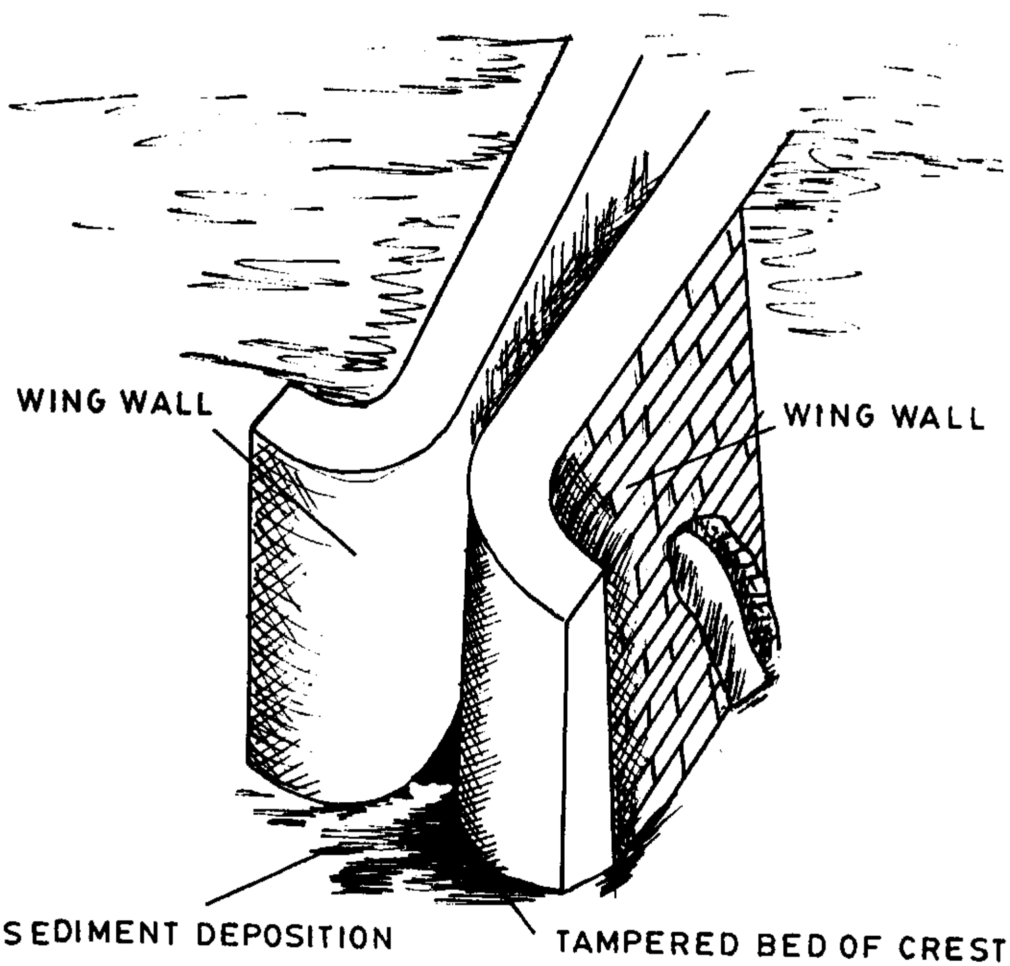


Figure A12. Outlet 4R Dhoro Naro Minor.

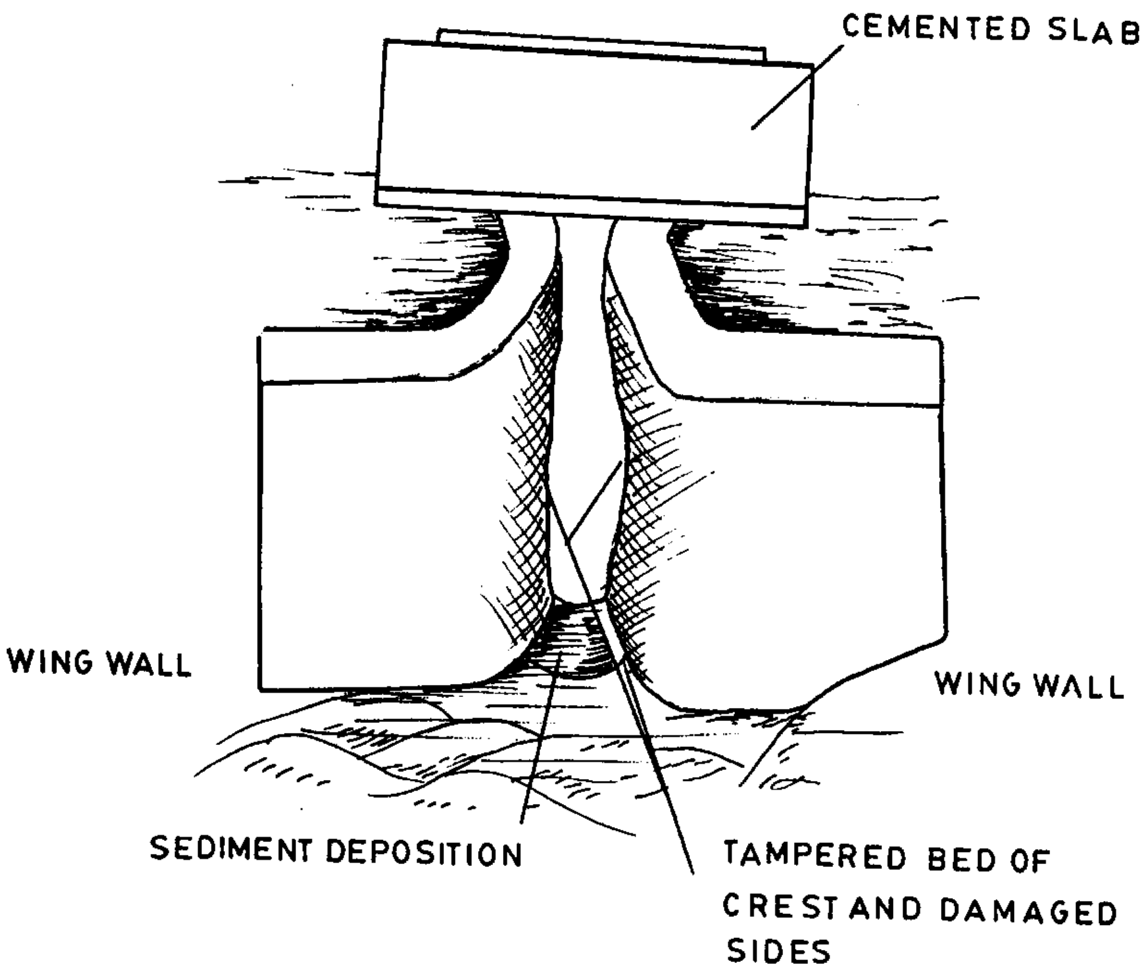


Figure A13. Outlet 3L Dhoro Naro Minor.

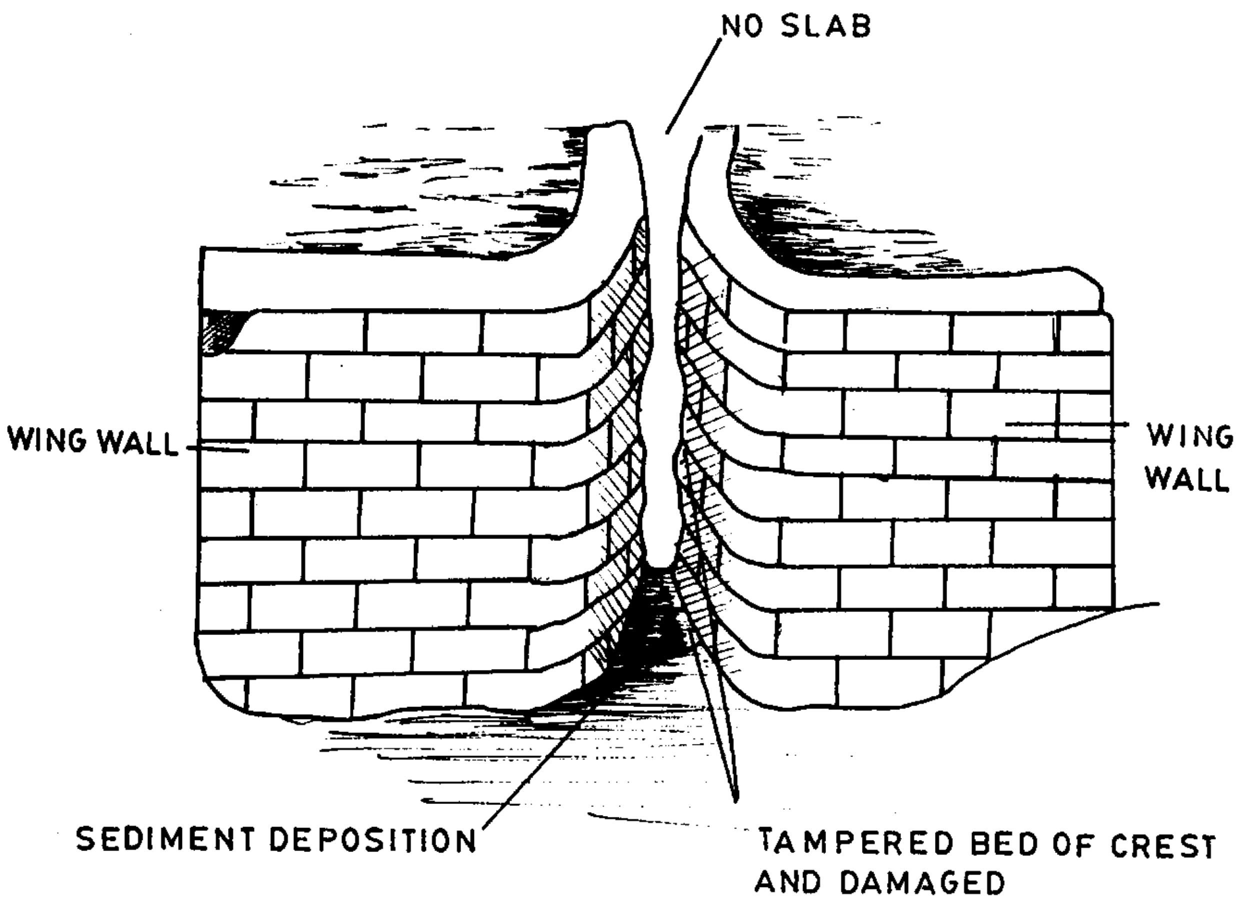


Figure A14. Outlet 4L Dhoro Naro Minor.

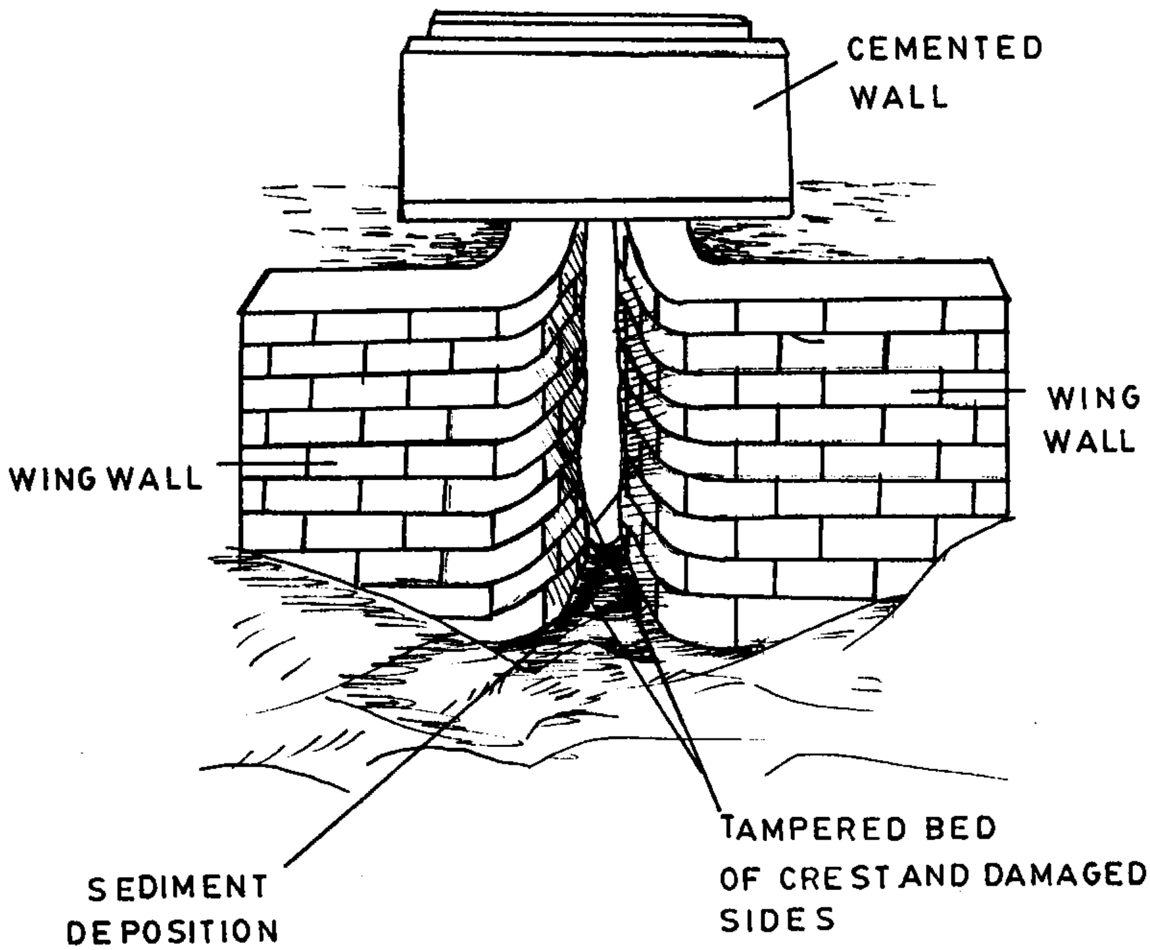


Figure A15. Outlet 4BL Dhoro Naro Minor.

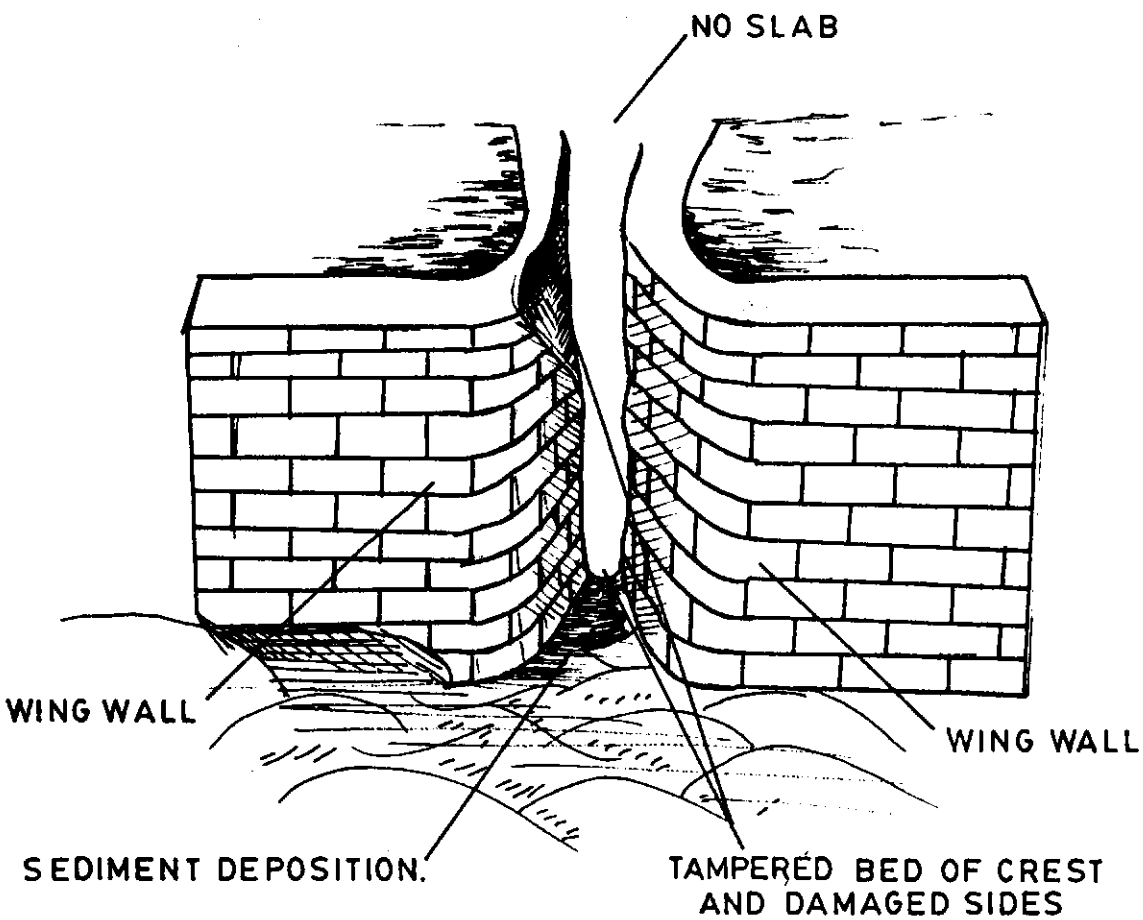


Figure A16. Outlet 5R Dhoro Naro Minor.

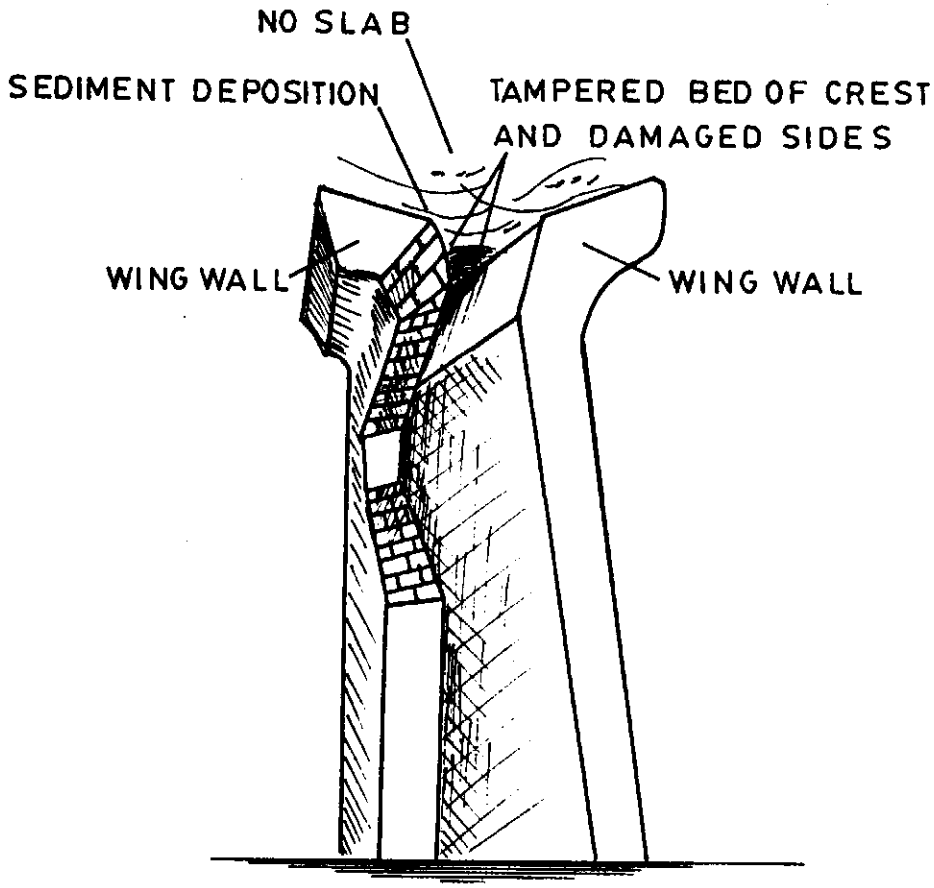


Figure A17. Outlet 4AL Dhoro Naro Minor.

Remedy: The outlets should be remodeled on the available supply of water (i.e., crest level, B and Y). After remodeling and restructuring, the beneficiaries may be made bound to maintain them properly. ID should inspect the system regularly. The coordination between water users and ID should be strengthened so that proper O&M may be made which would help to manage the system properly.

RD 22+076 Outlet 6-R

Situation: Outlet throat was deshaped by damaging its sides. The crest level of the outlet was tampered. Observation also showed that the bed level of the watercourse was looking higher then the crest level. Inspite of this, the crest level was lowered. Silt deposition was observed on the watercourse some four feet downstream of the outlet. The roof of the culvert was disappeared (Figure A18).

Causes: Tampering was made only to get more water. Due to lack of proper maintenance and supervision of the concerned department, the culvert roof has disappeared and the other small problems like damaged wing wall etc. has been happened.

Remedy: Outlet structure should be remodeled on the basis of available water. The solution will be sustainable when the beneficiaries will be involved. Check and balance should be strictly followed. Proper distribution of water from head to tail should be made as well as reliable supply at head regulator should be strictly followed.

RD 24+170 Outlet 5-L
24+386 Outlet6-AR
24+526 Outlet 6-L
29+500 Outlet 7-R
31+596 Outlet 7-L
31+795 Outlet 9-L

Situation: These six outlets are offtaking at different RDs of the minor as mentioned above. The physical conditions of all the outlets were almost same. The throat and crest were tampered and damaged. Upstream of these outlets some artificial obstructions were also seen which were used to raise water level so that more water could go to these outlets. The upstream wing walls of the outlets were badly damaged. (Figures A19, A20, A21, A22, A23, A24).

Causes: Because lack of proper check and balance, these situations were developed. The purpose of tampering was to get more water. This tampering mostly occurs due to two reasons: (1) due to shortage as well as excess water and (2) due to influential people.

Remedy: Outlet should be remodeled on the existing supply of water. The distribution of water should be equal from head to tail of the minor. The "equity" should be defined by the water users so that sustainable remedy may be achieved. Check and balance should be strictly followed (Figures A25, A26).

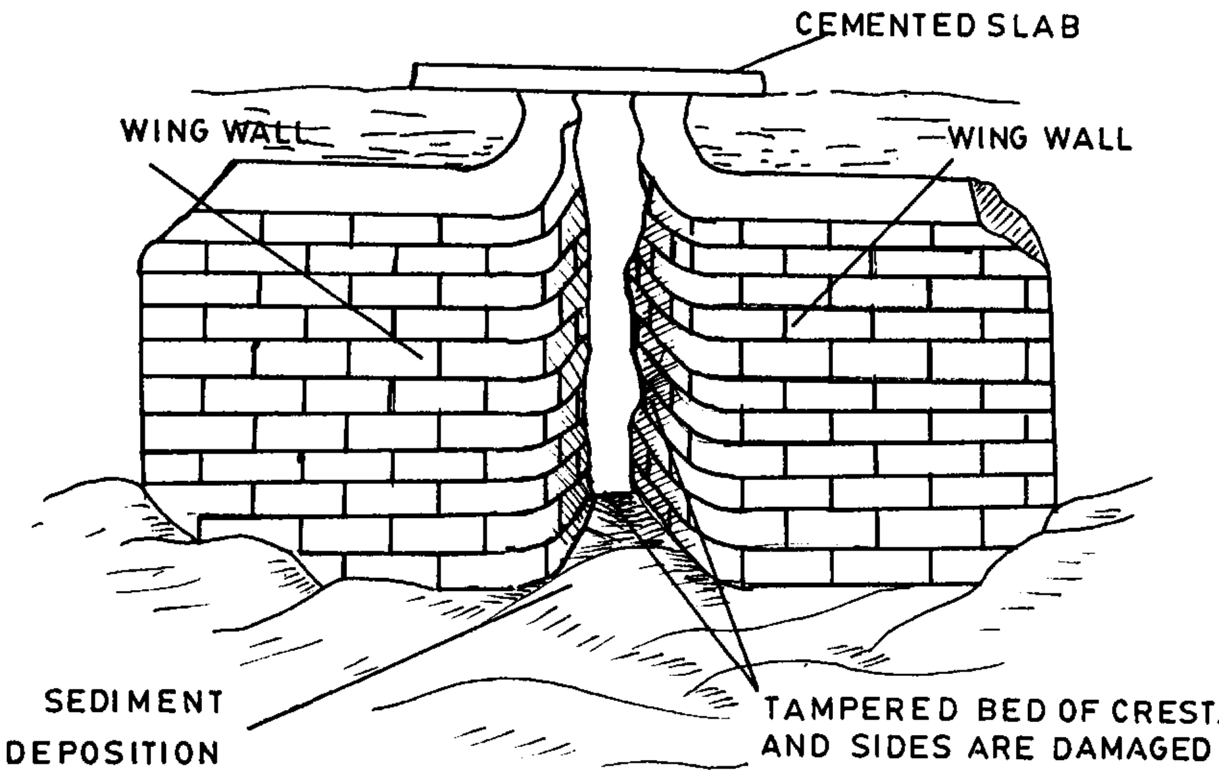


Figure A18. Outlet 6R Dhoro Naro Minor.

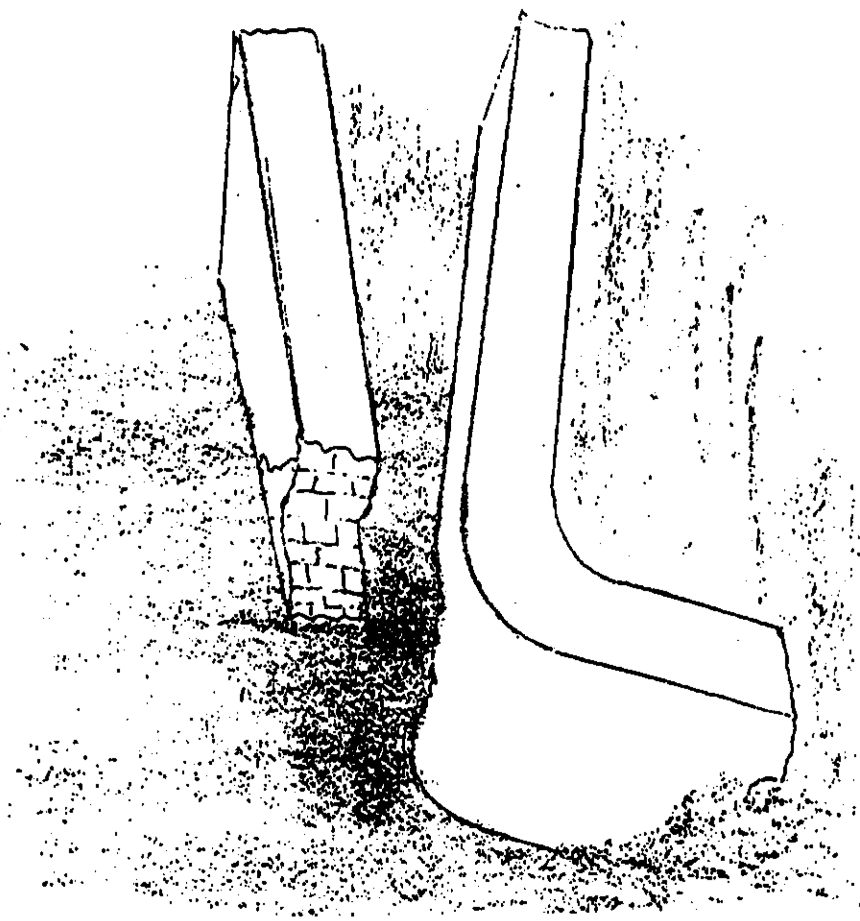


Figure A19. Outlet 5L Dhoro Naro Minor.

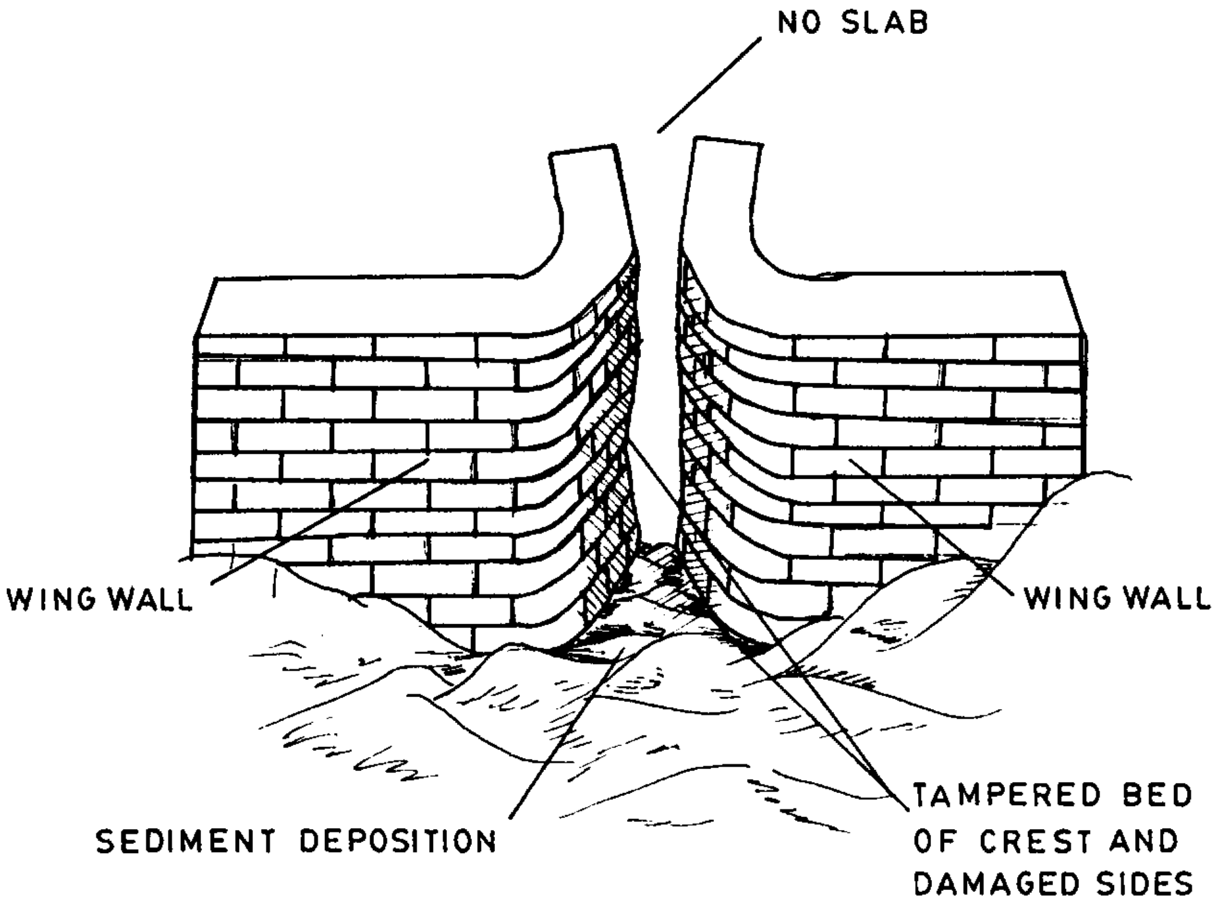


Figure A20. Outlet 6AR Dhoro Naro Minor.

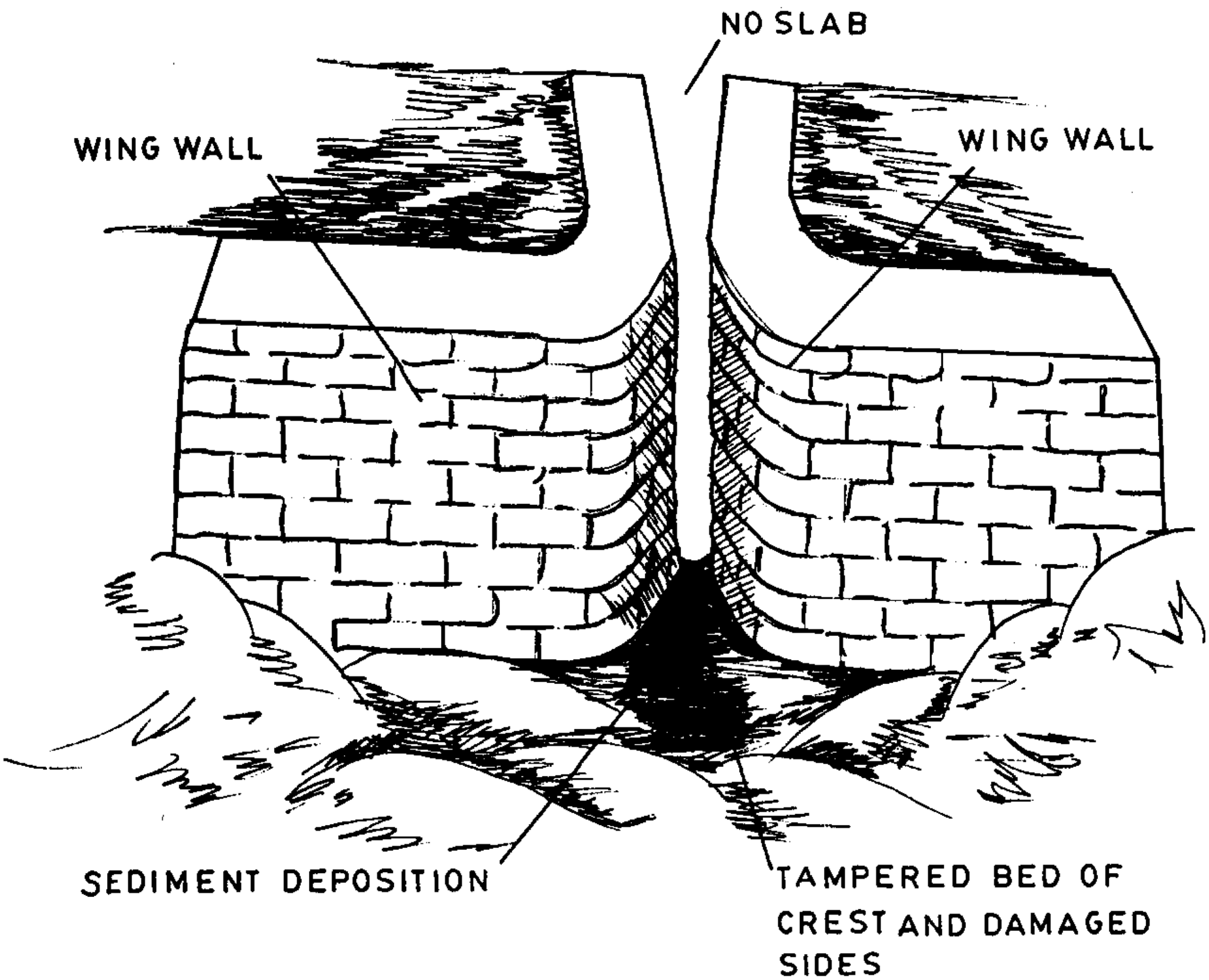


Figure A21. Outlet 6L Dhoro Naro Minor.

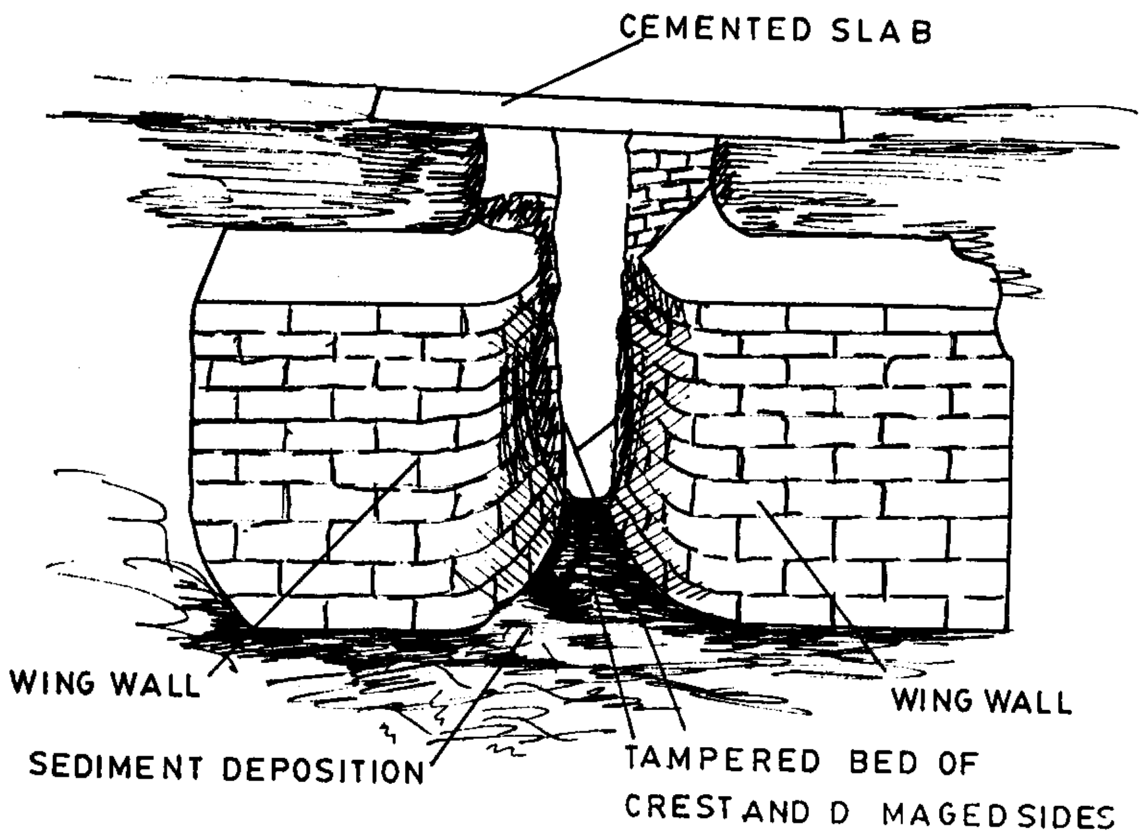


Figure A22. Outlet 7R Dhoro Naro Minor.

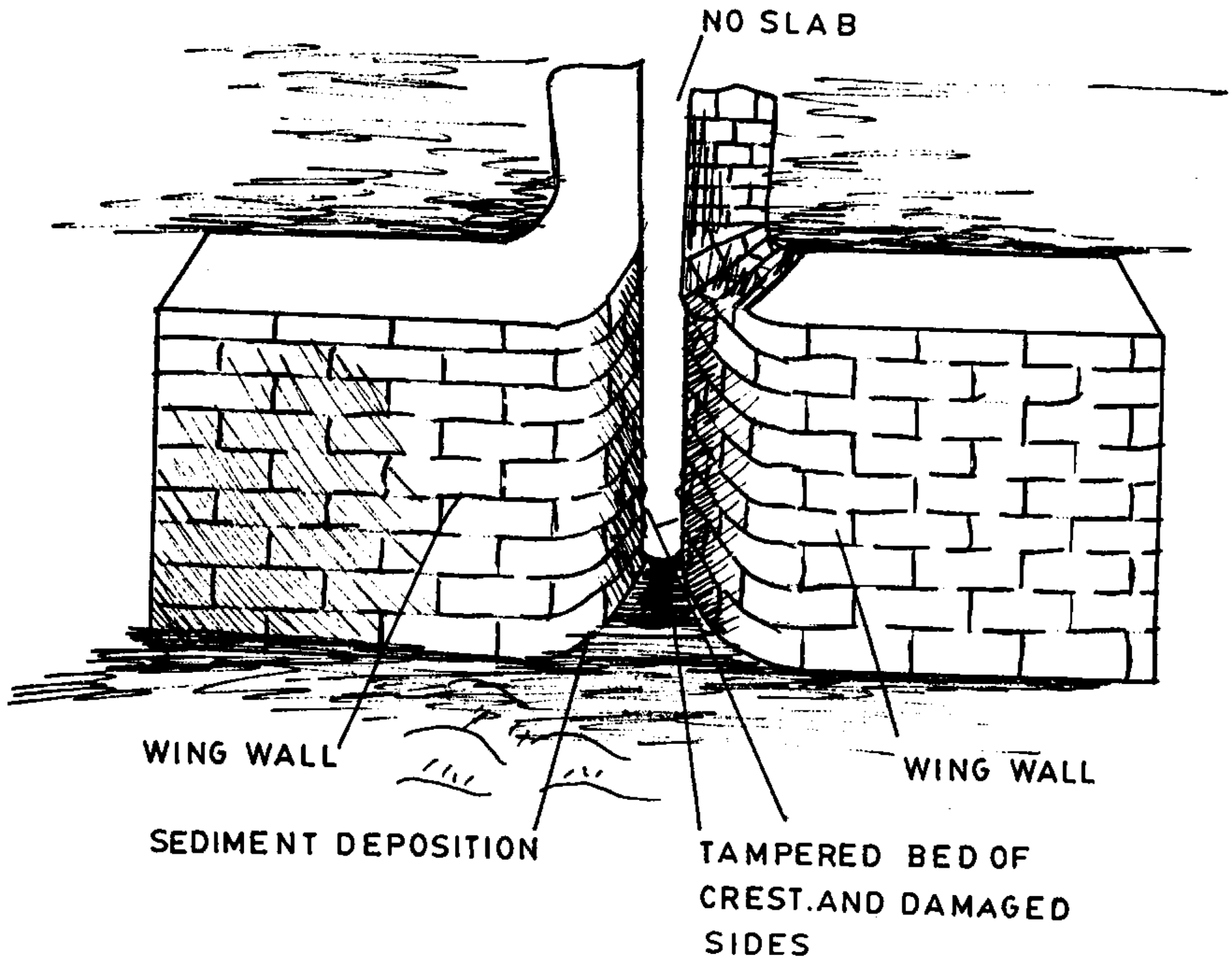


Figure A23. Outlet 7L Dhoro Naro Minor.

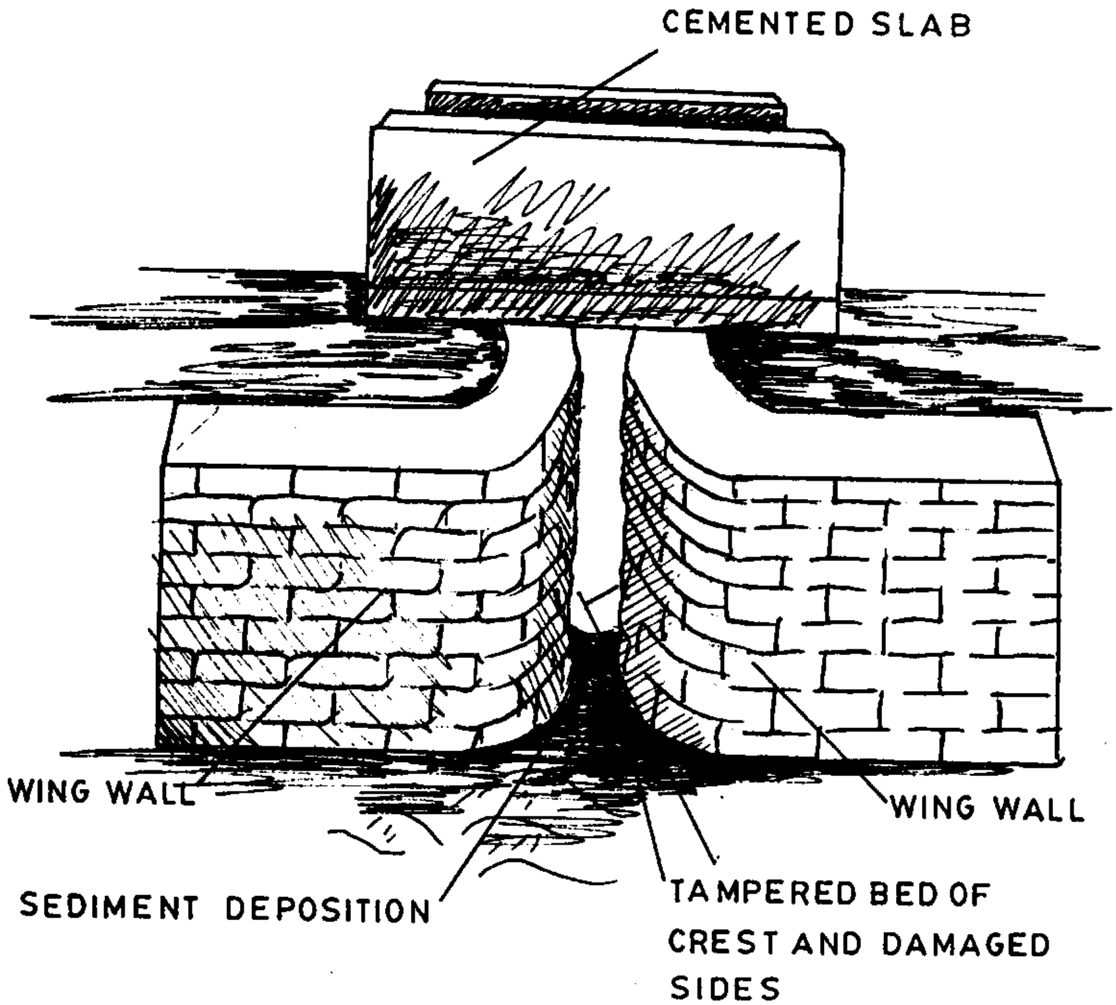


Figure A24. Outlet 9L Dhoro Naro Minor.

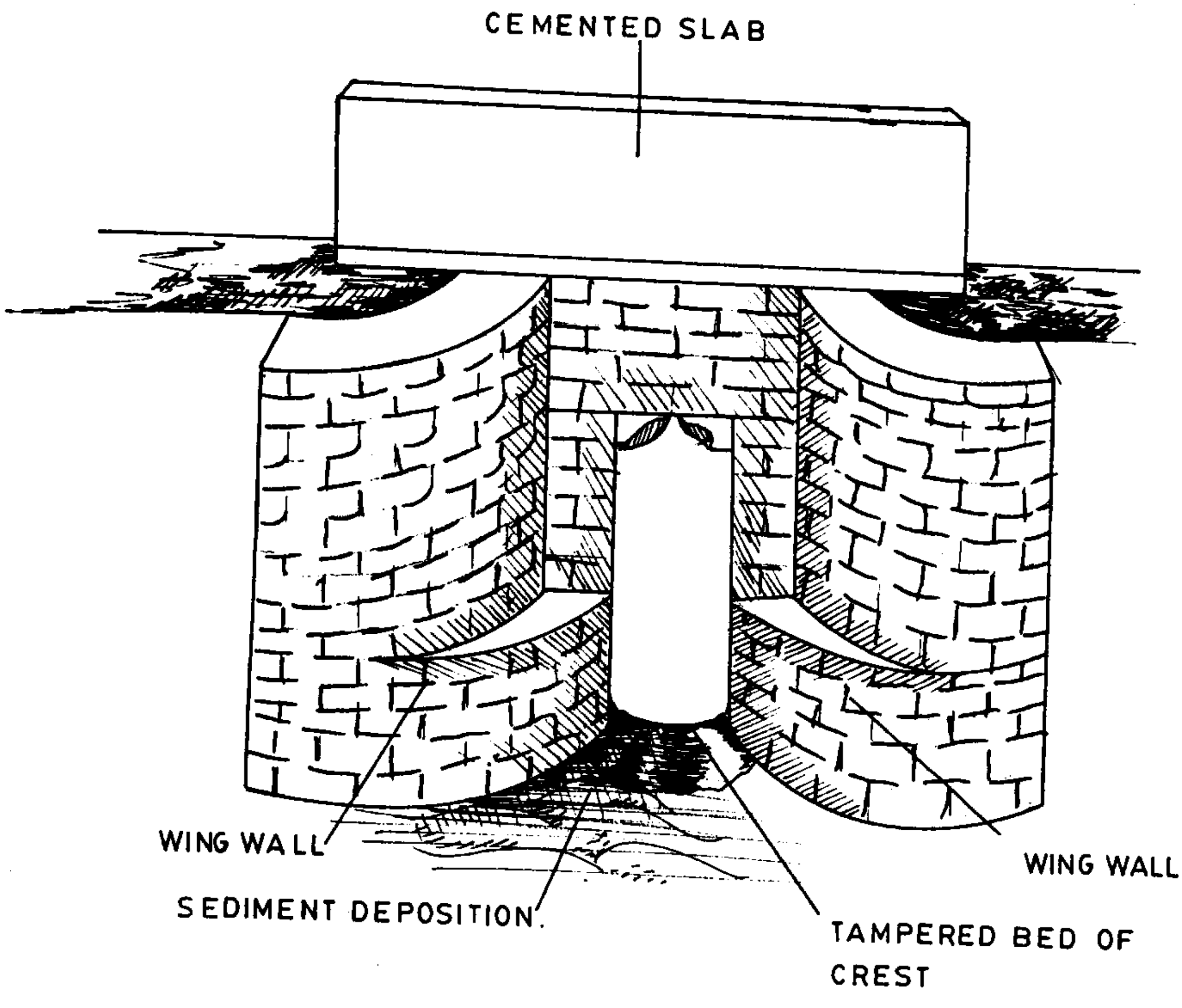


Figure A25. Outlet 10L Dhoro Naro Minor.

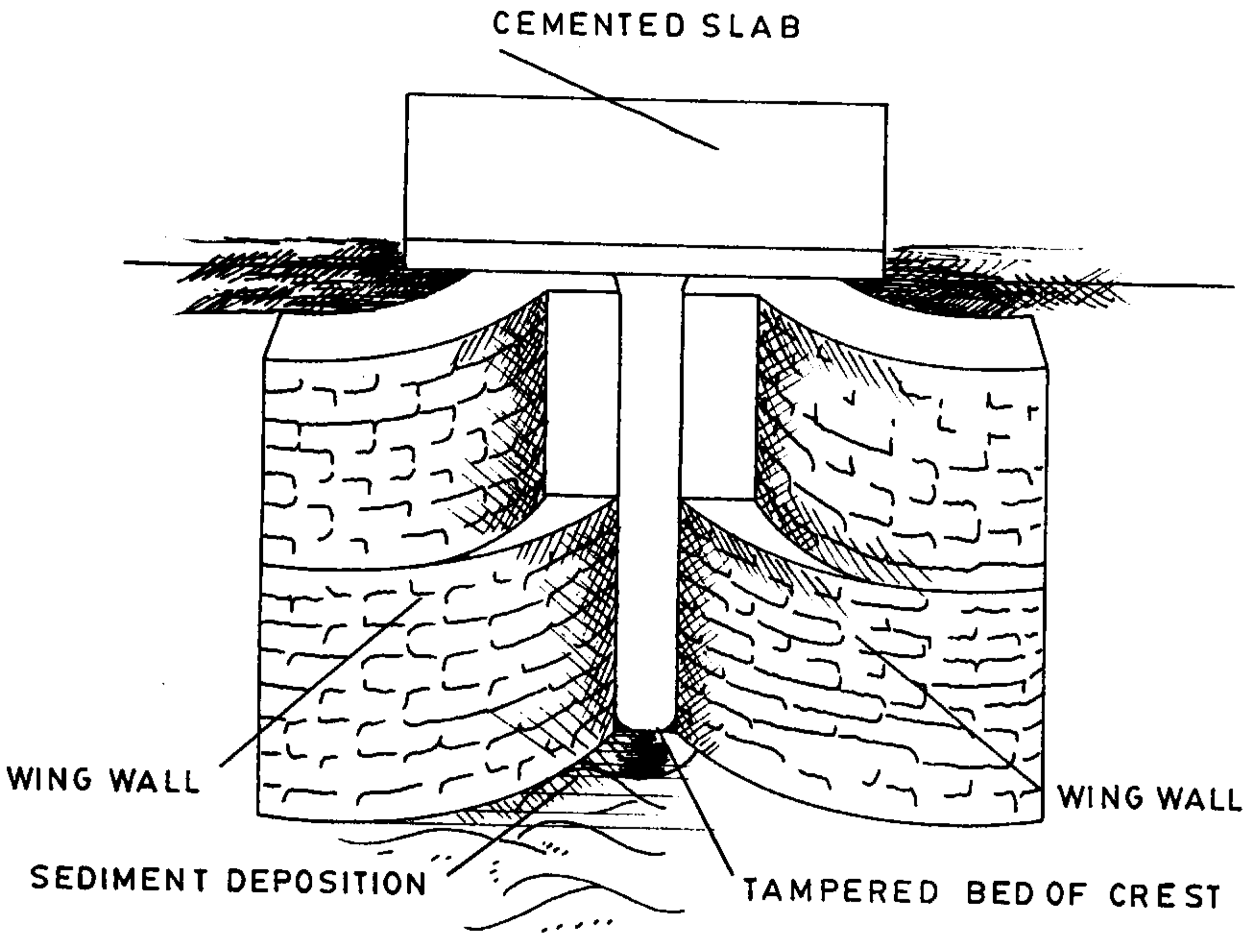


Figure 26. Outlet 11L Dhoro Naro Minor.

RD 32+275 Outlet 10-L, 11-Tail

Situation: These two outlets are offtaking from tail of the minor. The condition of throat and crest were almost in good condition. Although the culvert shoulders were partly damaged.

Causes: These two outlets were in good condition because these are at tail. Tail always suffers due to shortage of water, hence no tampering has taken place.

BRIDGES

RD 07+700 A concrete bridge (No.1) is located for crossing the Village Mahmood Jamali link road (Fig. A-27). Bridge roof was observed 4.5 ft above the existing bed level of the minor. Sediment deposition about 1.0 ft was observed over the concrete bed. The banks for about 120 ft at the upstream side were observed weak.

08+880 The 2nd concrete bridge crosses the minor at this RD (Fig. A-28). The height between bed and inner side of the culvert roof was observed about 4.5 ft. Both sides of minor for about 120 ft downstream of culvert were weak and section was wide because of animal bathing.

11+000 The 3rd bridge is located at this RD. Downstream from the bridge, about 45 ft left bank was observed weak. Left wing wall of the bridge was 100 % and right wing wall was 90 % damaged (Fig. A-29). Sediment deposition was observed near the culvert. This happened due to wider section.

22+076 The 4th concrete bridge was located upstream of outlet 6-R of the minor for crossing Village Ali Jan link road (A-30).

27+526 The 5th bridge is located at this RD of the minor. This bridge is called Chisel abad link road bridge. The sketch of bridge is shown in Figure A-31.

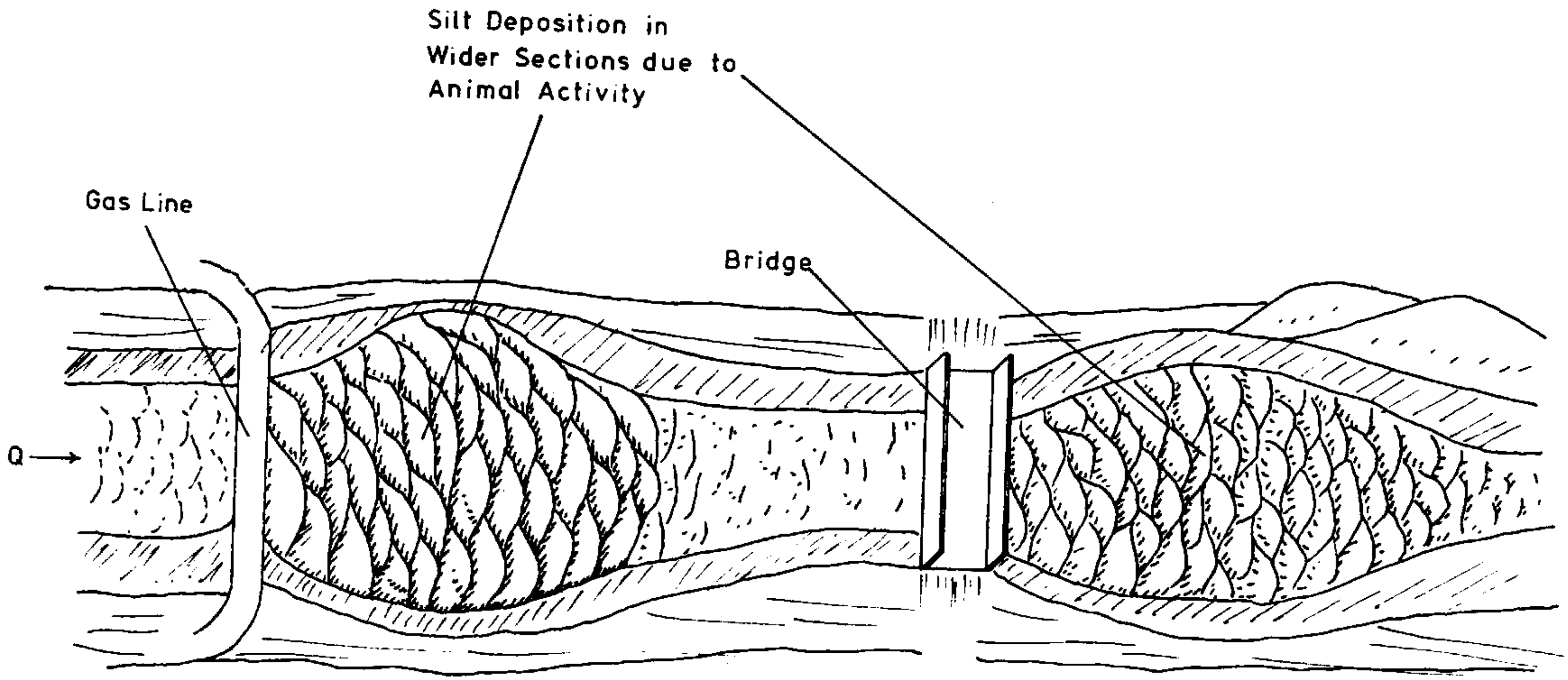


Figure A27. Dhoro Naro Minor from RD 7+200 to 7+600, two sections of 180 ft. and 120 ft. in length observed wear due to animal bathings near Mahmood Jamali link road bridge and Soi Gas crossing line.

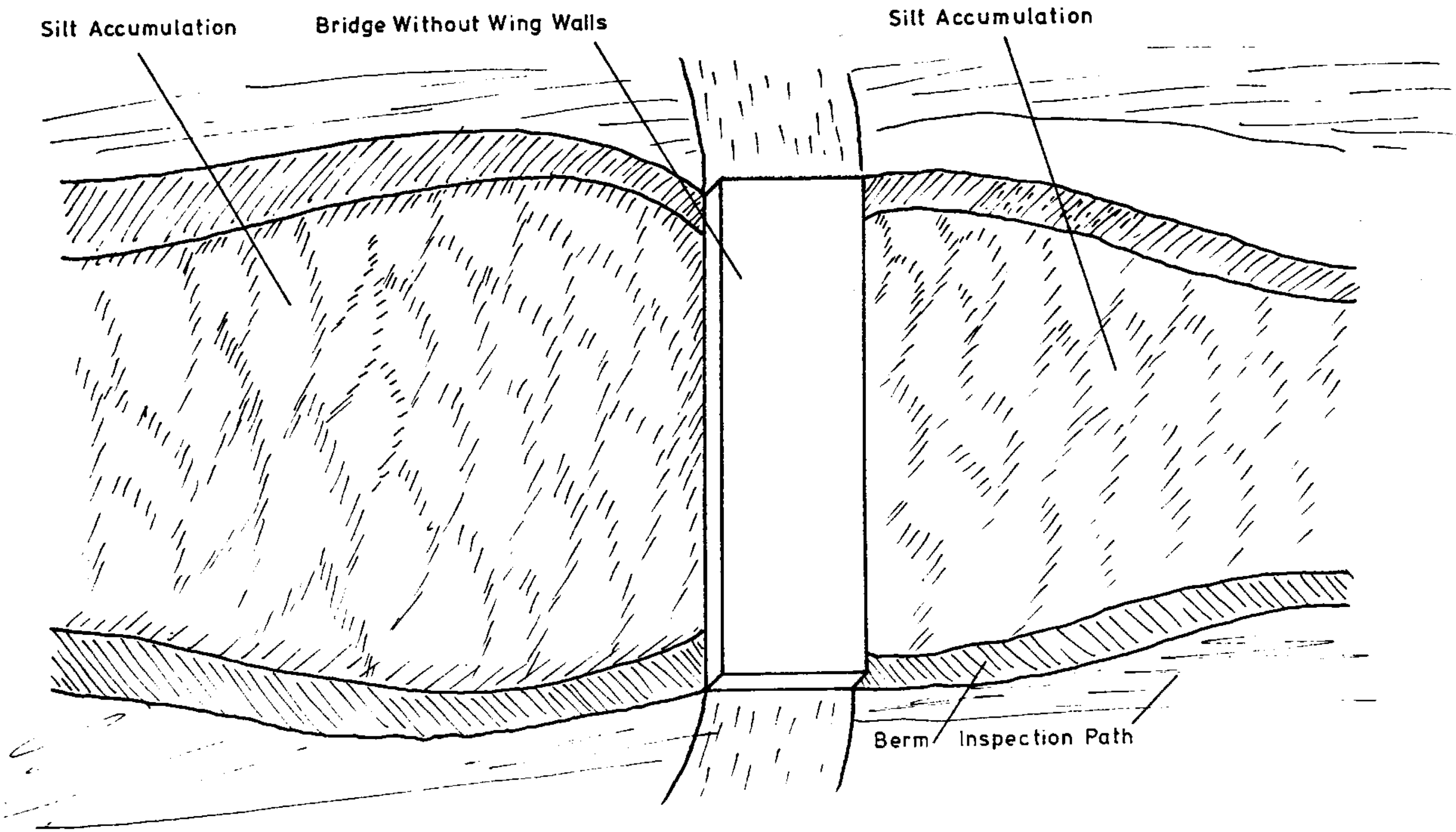


Figure A28. A bridge without wing walls at 8+971 RD of Dhoro Naro Minor.

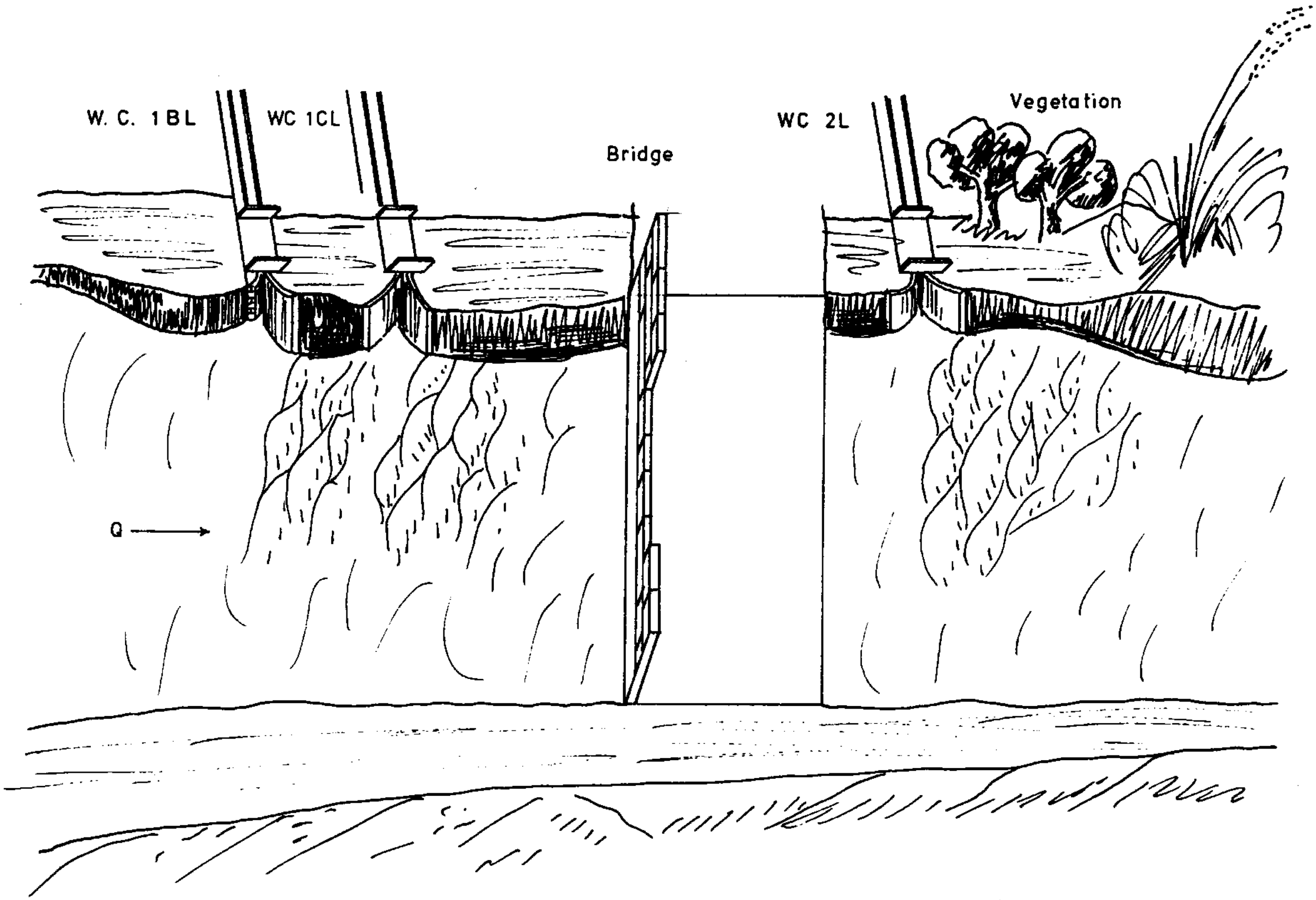


Figure A29. Bridge at RD 11+000 along with water courses 1BL, 1CL and 2L Dhoro Naro Minor.

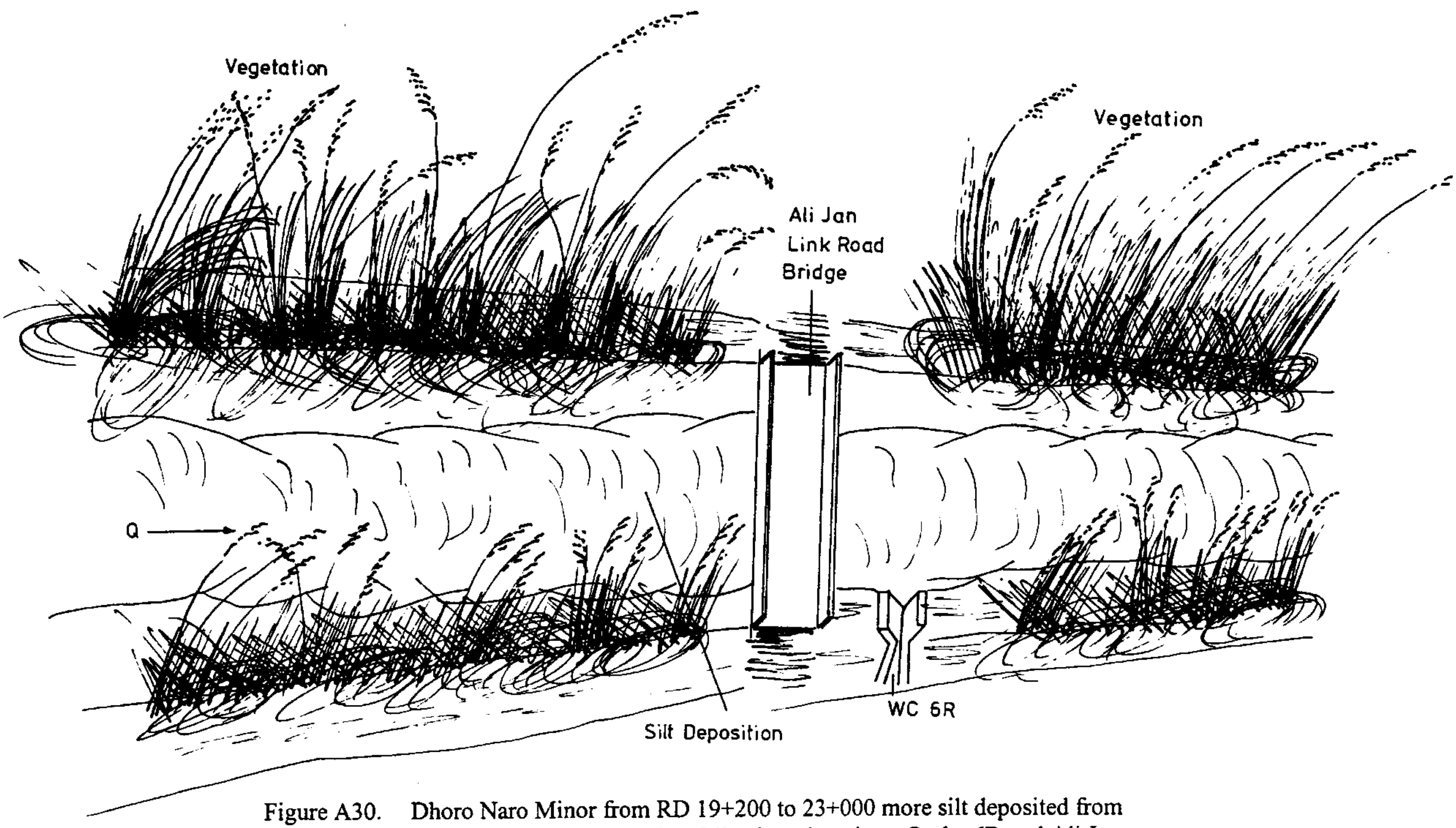


Figure A30. Dhoro Naro Minor from RD 19+200 to 23+000 more silt deposited from bank sides due to vegetation fallen into the minor. Outlet 6R and Ali Jan link road bridge situated in this section.

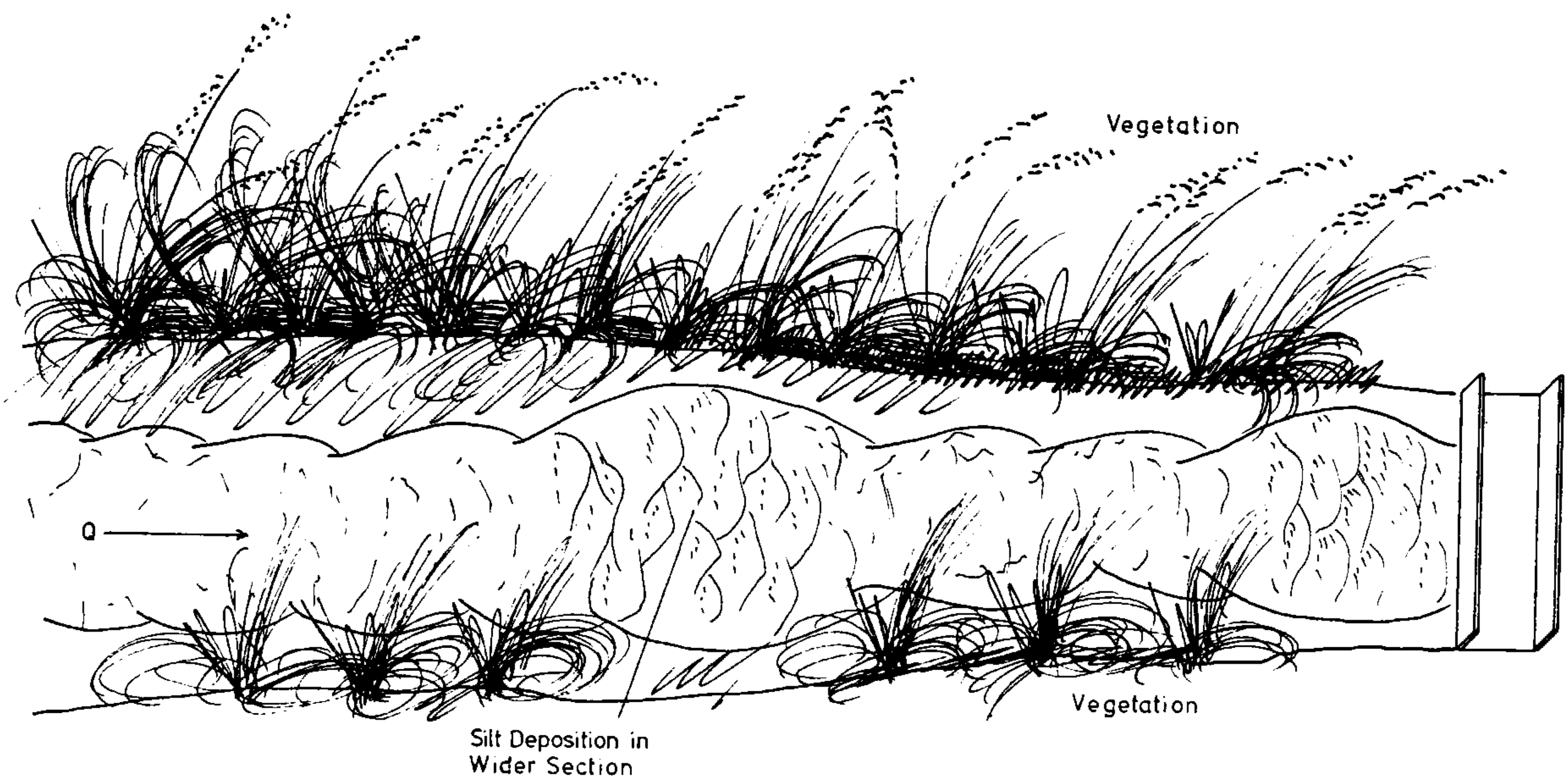


Figure A31. Dhoro Naro Minor from RD 24+400 to 27+526, two sections observed wider with more silt deposition at the end chiselabad link bridge observed.

ANNEX B. DIAGNOSTIC WALK-THRU MAINTENANCE SURVEY OF DHORO NARO MINOR.

Following is the detail of location wise maintenance needs observed during Walk Thru Maintenance Survey.

RD 00+000 to 00+400: This section observed averagely about 23 ft. wide. The silt deposition was observed as 1.0 ft and 3.0 ft. with reference to sill elevation and zero gauge elevation, respectively. At the end of section right bank was eroded for about 30ft. in length. There was no berm on both sides. Bank sides were provided stone pitching to control the scouring (Fig. B-1).

RD 00+400 to 00+700: In this section three depressions of 50 to 100 feet in length averagely 3 ft deep and 3 ft wide from left bank side were observed because of some offshoots and vegetation growth from right bank side (Fig. B-2). More silt deposition on right side was observed due to depression at right side and vegetative growth. Section was averagely about 19 ft wide. There was about 2 ft silt deposition.

RD 00+700 to 02+100: Section was 21 ft wide. No vegetation was observed. Excavated silt was dumped on both banks of the minor. In this section 30 ft length of right bank and 17 ft. length on left bank were eroded. Therefore, banks were looking weak. A heavy and thick wooden block was placed on the minor for crossing as pony track (Wooden Bridge shown in Fig.B-3). This block touches the water supply level, due to which a depression was created just after it (29 ft length and 2 ft deep). This wooden bridge was also serving as head up of water level at its upstream side which of course helps to the outlets which offtak from its upstream side.

RD 2+100 to 02+800: In this section 180 ft portion was observed weak from both banks, due to erosion, animal crossing and bathing. Section was 25.5 ft wide (Fig. B-4). No vegetation was observed. Inspection Path (IP) was in fatigue condition. Heavy silt deposition was observed due to wider section and animal bathing.

RD 04+600 to 07+400: In this section right bank observed weak at three different points of 50 and 40 ft in length. Also the same condition was observed on the left bank of the minor. Left bank was weak at three different points of 50, 70 and 10 ft in length. At these weak point, sections of the minor was observed wider of about 19 ft. Due to wider sections more silt was deposited in those sections. The main reason was the free bathing and crossing the animals. In this section there was no vegetation. Inspection path (IP) was not maintained properly.(Fig. B-5). Another reason of more sediment deposition was the re-entry of silt from the banks which was thrown over the banks during desilting of the minor.

RD 07+200 to 07+600: At this location a bridge is constructed to cross the Mahmood Jamali link road, at a height of 4.5 ft.from the bed of the channel. Both banks just downstream and upstream of the bridge in the length of about 120 ft were weak and scoured due to animal bathing and crossing (Fig. B-6). Hence more silt deposition in these sections was observed.

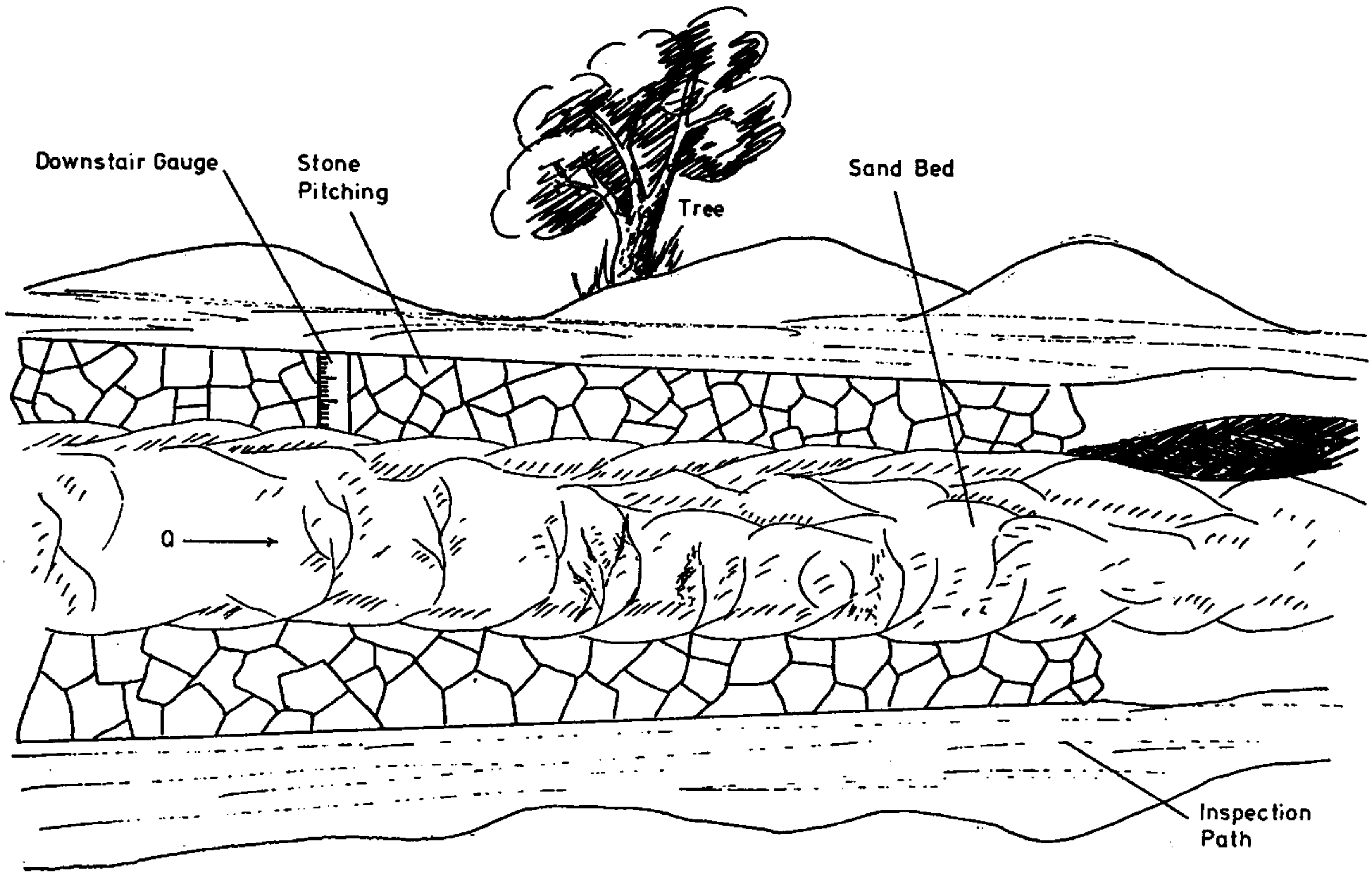


Figure B1. Sketch of Dhoro Naro Minor from RDs 0·0 to 0·4.

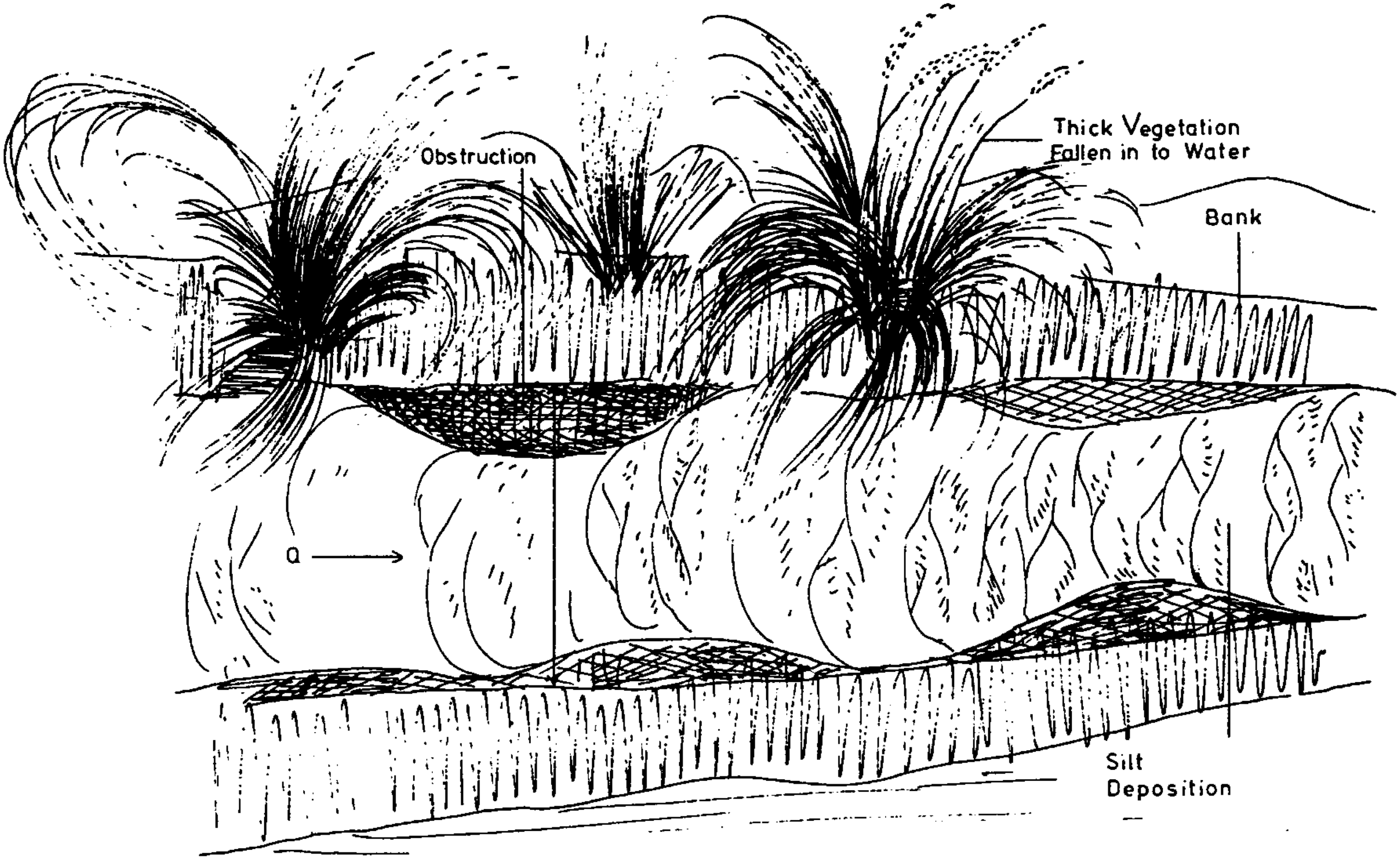


Figure B2. Sketch of Dhoro Naro Minor from RDs 0.4 to 0.7.

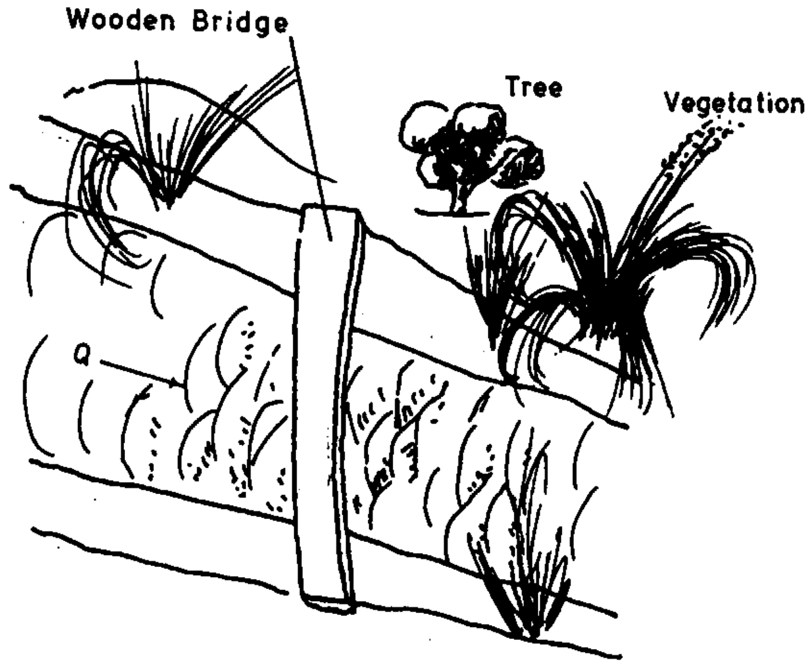


Figure B3. Sketch of Dhoro Naro Minor from RDs 0·7 to 2·1.

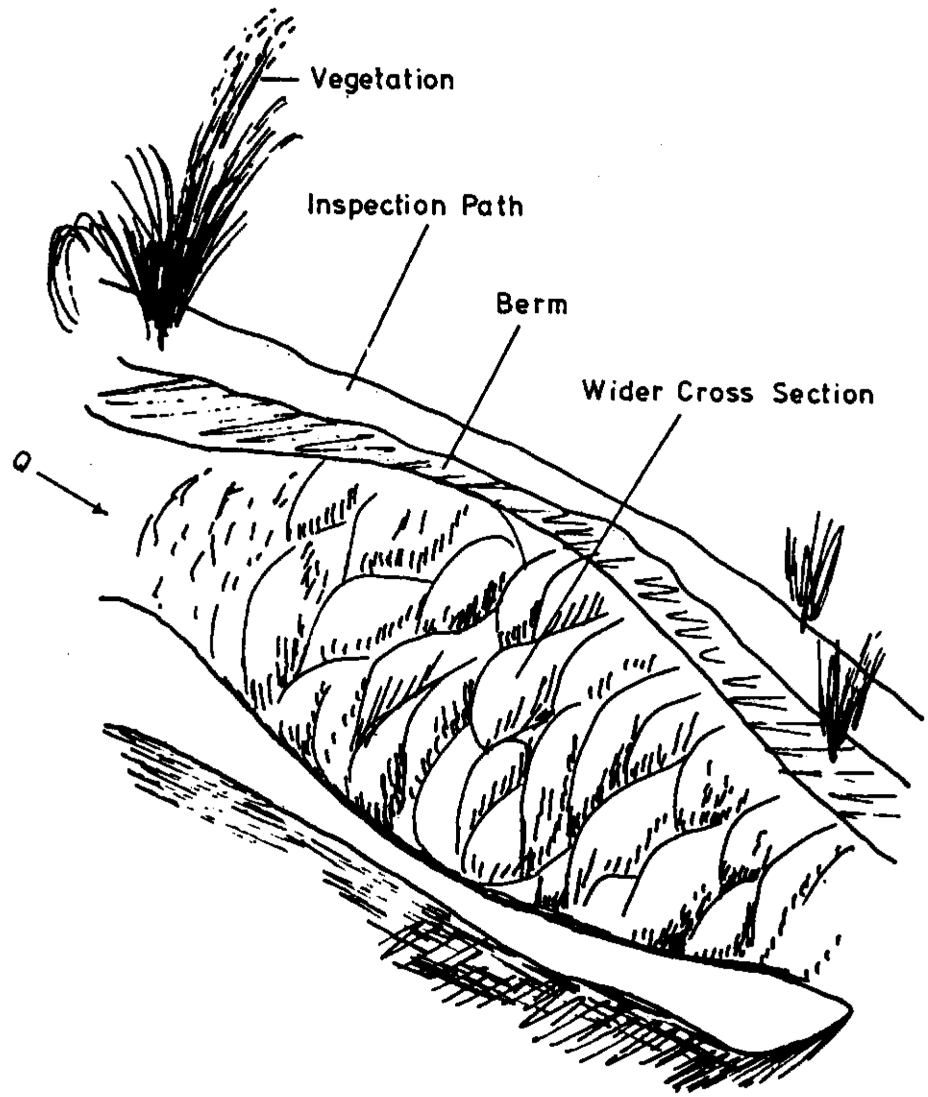


Figure B 4. Sketch of Dhoro Naro Minor from RDs 2·1 to 2·8.

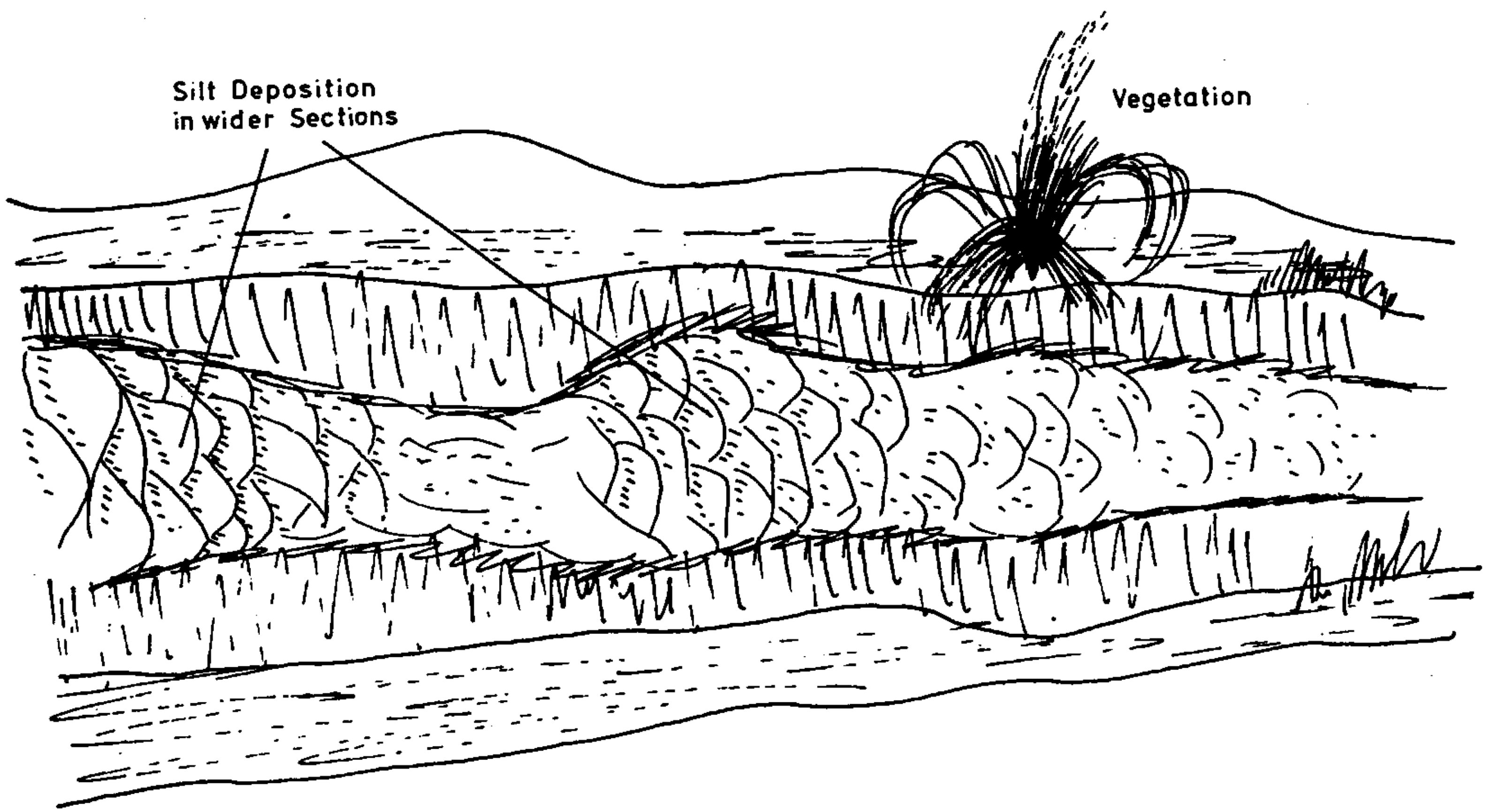


Figure B 5. Sketch of Dhoro Naro Minor from RDs 4.6 to 7.4.

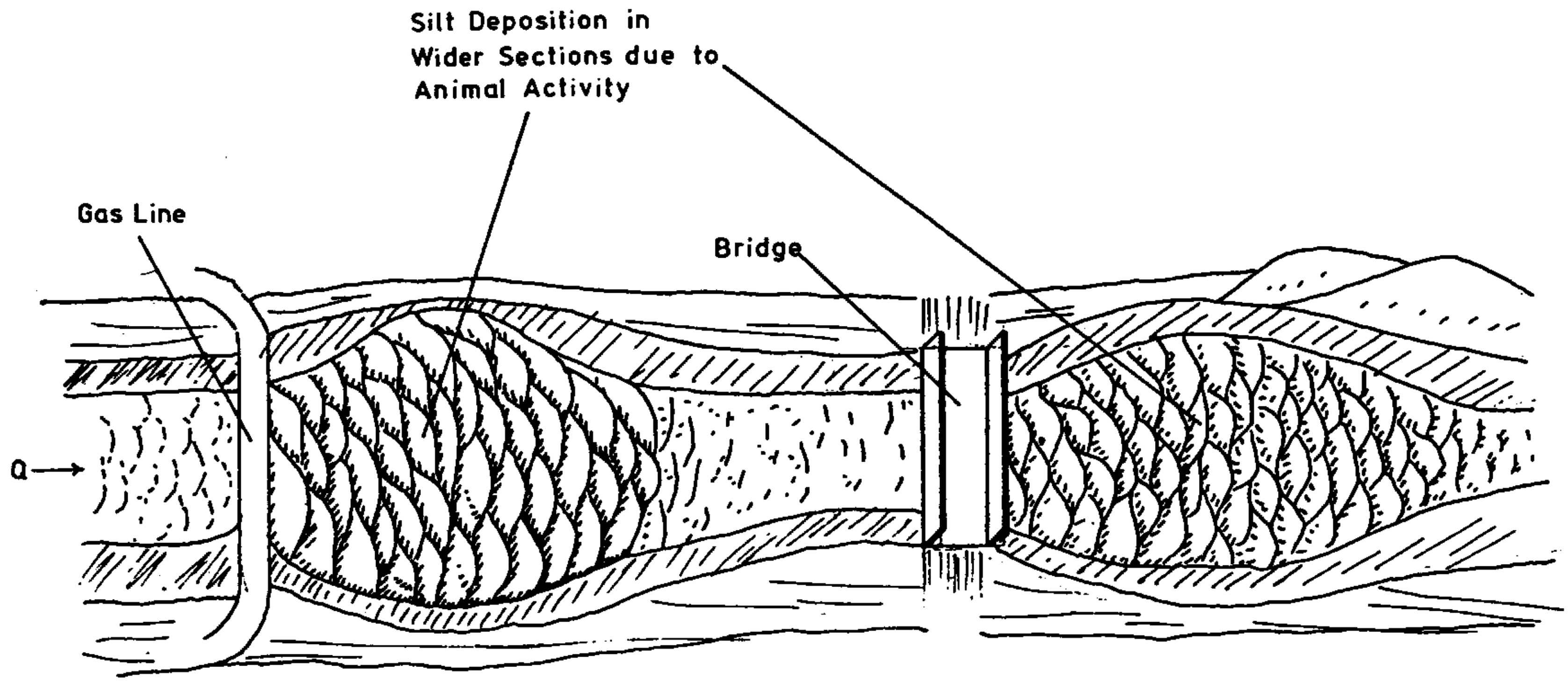


Figure B 6. Sketch of Dhoro Naro Minor from RDs 7.2 to 7.6.

08+880 At this location 2nd concrete bridge was constructed to cross the Sher Mohamman Jamali Katcha link road at the height of 4.5 ft. Both banks just up and downstream of the bridge in the length of 130 ft were weak and eroded due to animal bathing and crossing (shown in Fig. B-7). More silt was deposited in these sections due to wider section. IP was not maintained.

RD 09+400 to10+400: This section was averagely 12.5 ft wide. Inner bank sides were rectangular and mostly in good condition. Silt accumulation was comparatively less than up stream sections as discussed earlier. Both banks were stable. Previous excavated silt was thrown over the top of left bank, which became the cause of re-entry of silt into the minor. Maximum dense and tall vegetation was observed in about ¾ of length of the section, which was interfering the flow at several places (Fig. B-8).

RD 11+000: At this location a 3rd bridge is situated. The one wing wall of the bridge was completely disappeared while the 2nd was 90% damaged, as shown in Fig. B-9. At the up and downstream of this bridge both sections of the minor were found wider due to animal bathing. Due to wider sections the more silt was deposited, which became the cause of flow controlling section. In this section outlets 1-BL, 1-CL and 2-L are situated. At the upper section of this portion the left bank was weak. Previous excavated silt was dumped on the both banks at some places. No vegetative growth was observed in this section.

RD 12+980 to17+200: Inspection Path (IP) was not maintained properly. Left bank was full with vegetation on the top of banks (above frenetic line). While right bank was only 300 ft vegetative (Fig. B-10). But vegetation growth was affecting the flow streamlines. Width of section was about 12 ft. Previous excavated silt was dumped on both banks of the minor which became the cause of siltation by re-entering into the minor due to animal free grazing and wind blowing. The sediment deposition was observed about 1.0 ft. in depth.

RD 19+000: In this portion both the banks were possessing thick vegetative growth. About 10% of vegetation was falling into the minor which was disturbing the flow streamlines. The depression of 20 feet long and 1.5 feet deep and 4 feet wide was observed which was artificially created for increasing water head at up stream for outlet 4-AL. Also in this section, 70 feet long, 2 feet deep and 2 feet wide soil belt dumped artificially to restrict the flow (Fig. B-11).

RD 19+200 to 23+000: One and half portion of both banks of the section was covered with vegetative growth (Fig. B-12). It was above the freatic line but was fallen in to the minor flowing section, due to which silt deposition was observed. The section width was observed 9.5 ft. banks were in good condition while the inspection path was in very bad condition and was not possible to drive over it. This section has outlet 6-R and a bridge for crossing the Ali Jan link road.

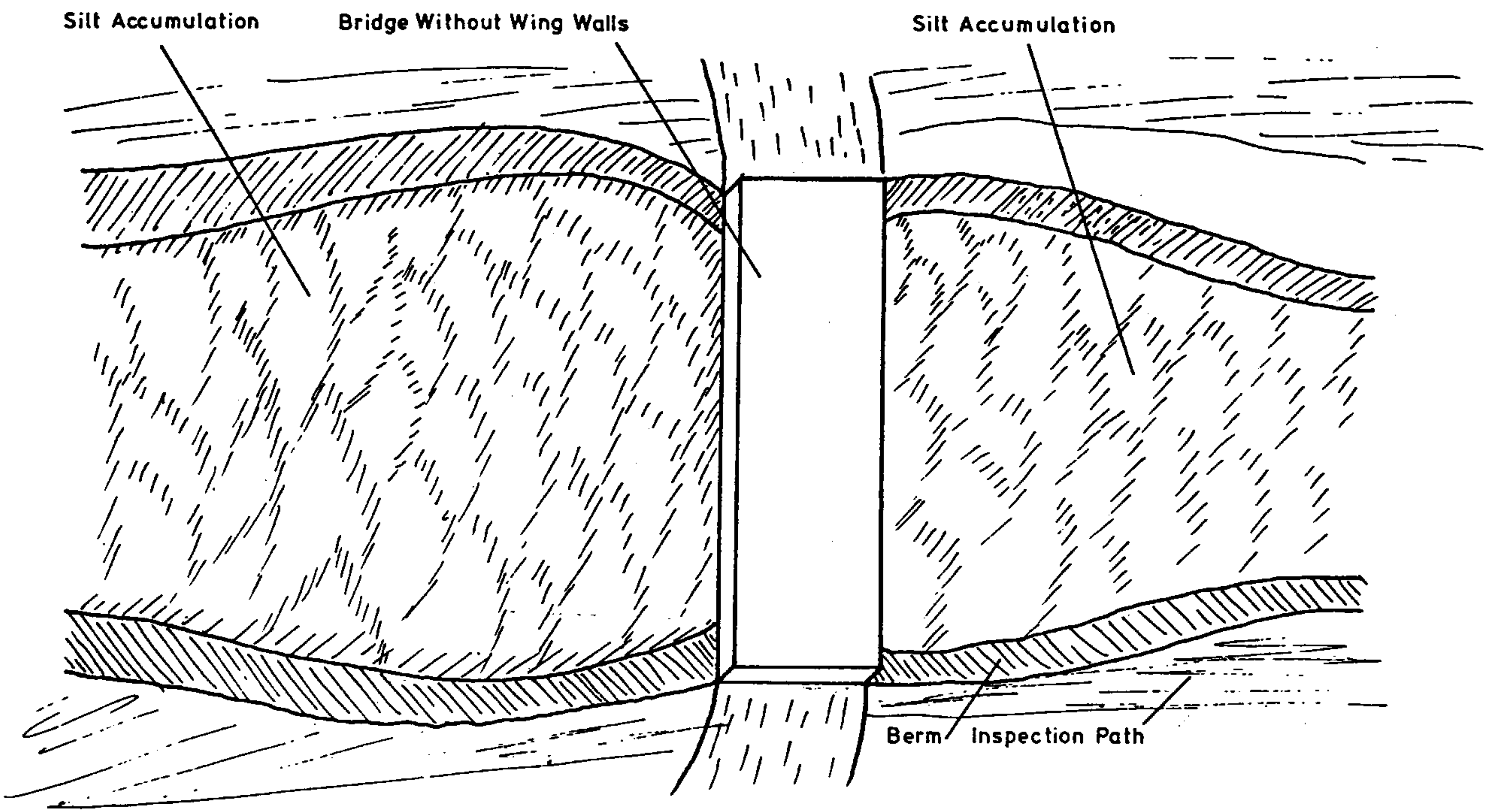


Figure B7. Sketch of Dhoro Naro Minor at RD 8.971.

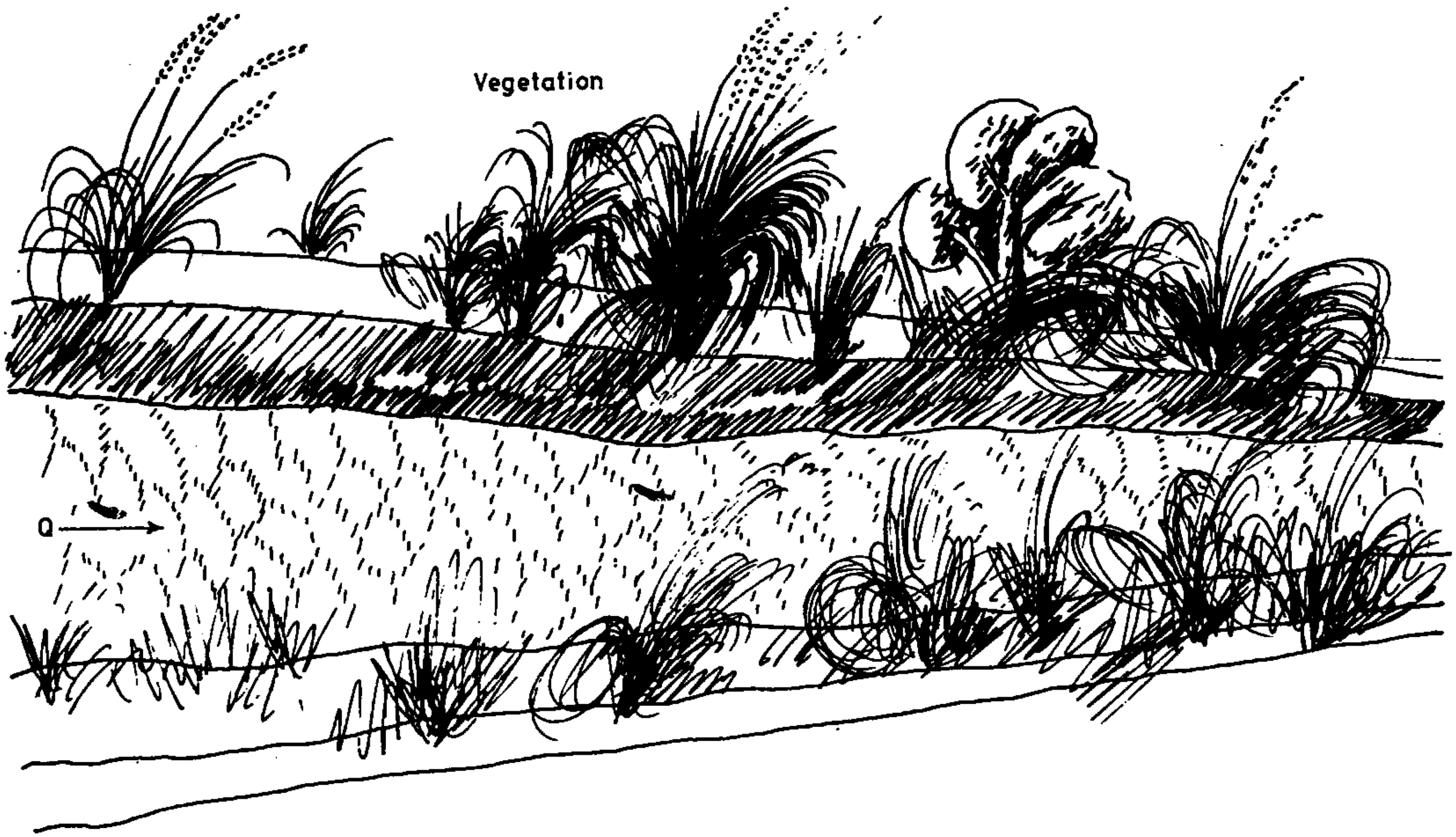


Figure B8. Sketch of 'Dhoro Naro Minor Showing Vegetation Growth from RDs 9.4 to 10.4.

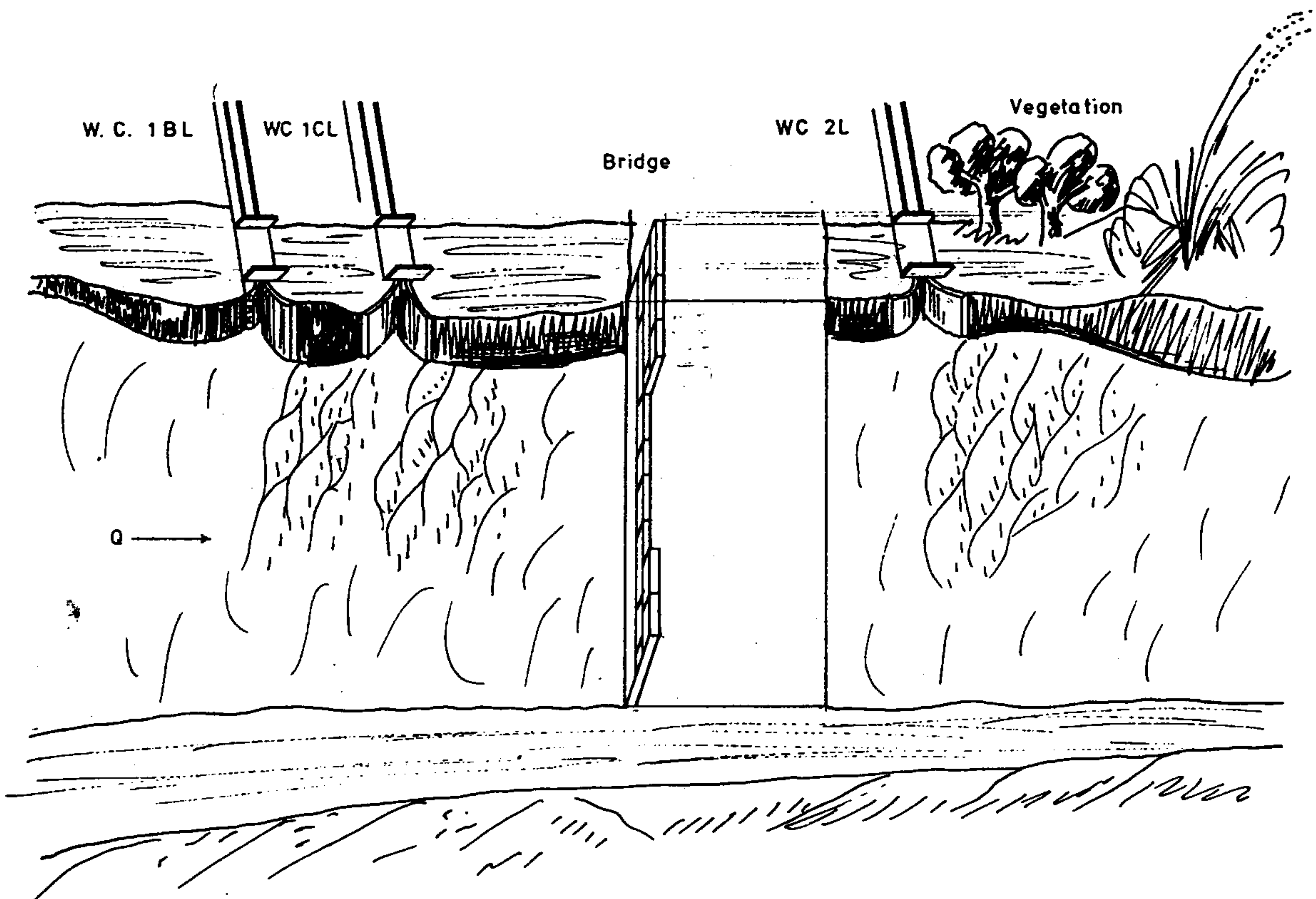


Figure B9. Sketch of Dhoro Naro Minor, Showing a Bridge at RD 11·0 alongwith Watercourses 1BL, 1CL and 2L and Vegetation Growth.

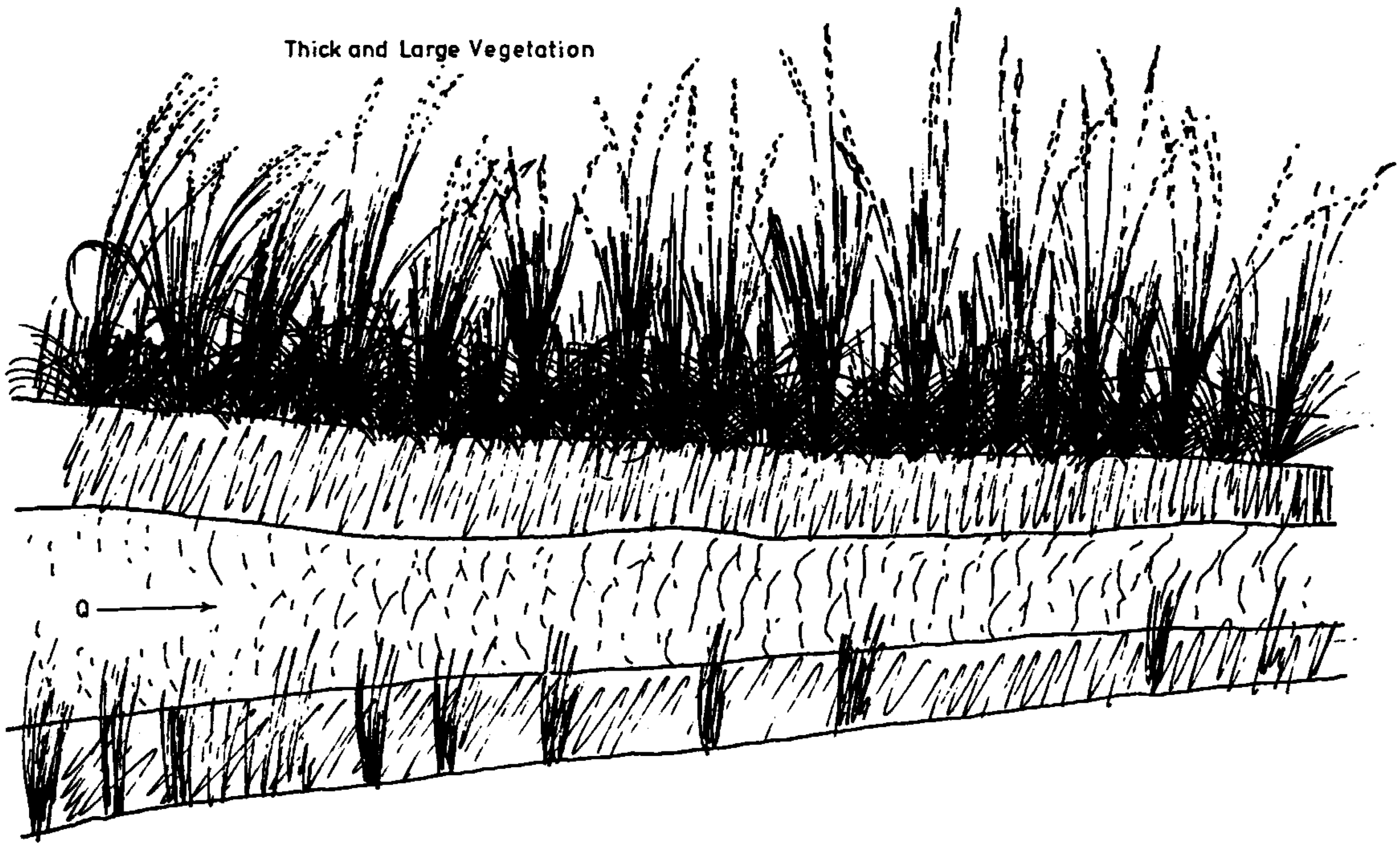


Figure B 10. Sketch of Dhoro Naro Minor from RDs 12.98 to 17.2.

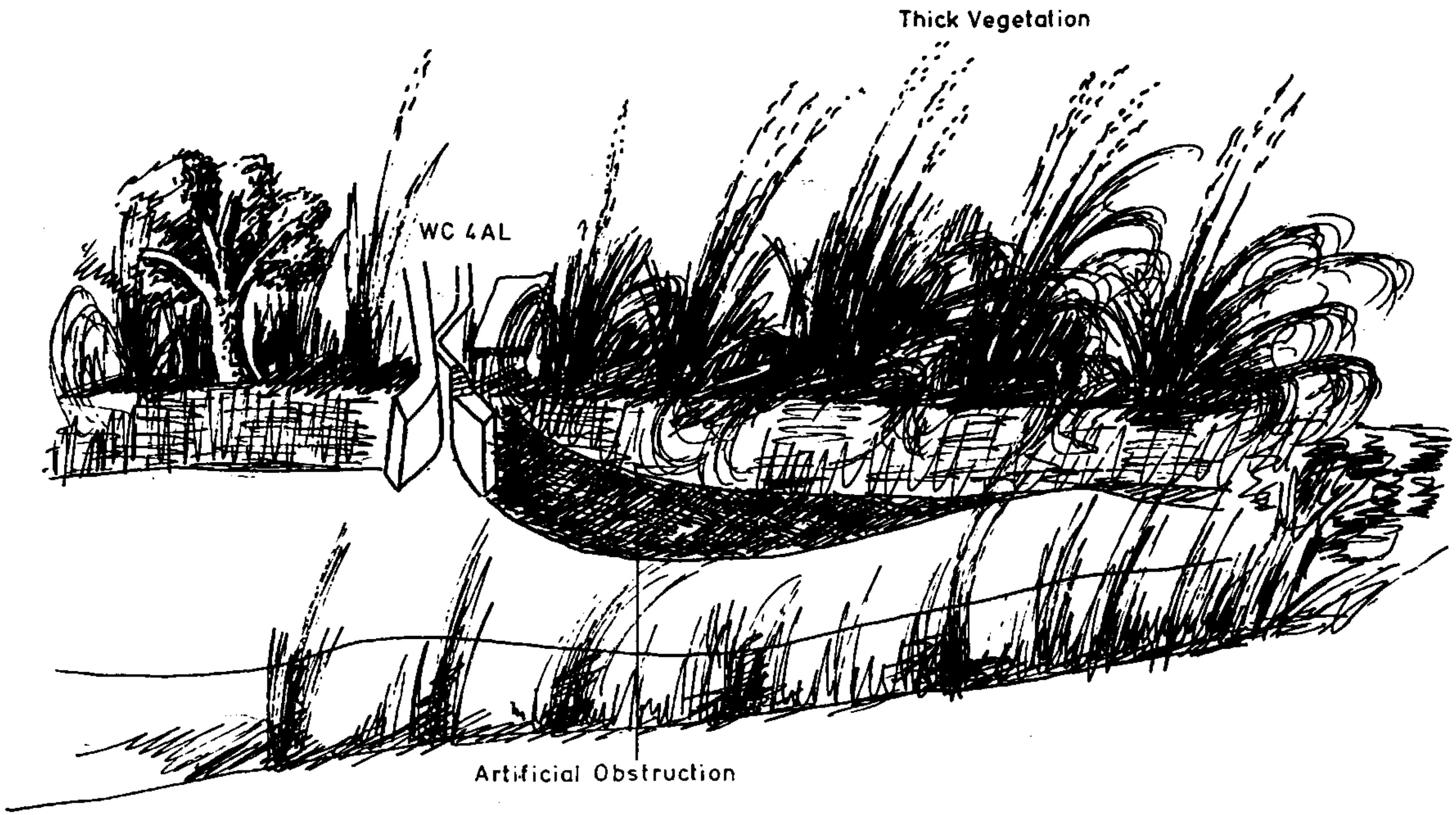
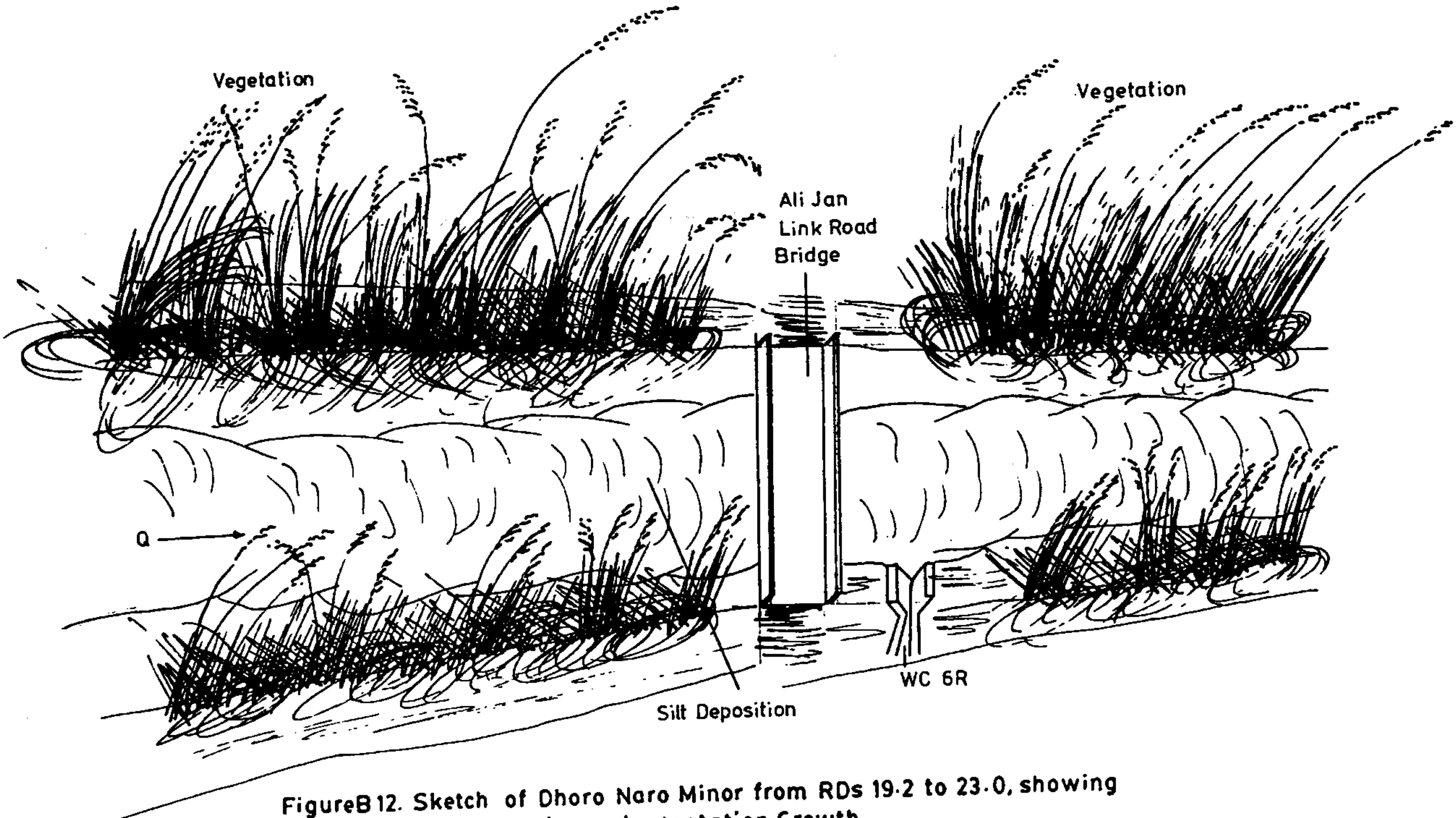


Figure B 11. Sketch of Dhoro Naro Minor at RD 19·0, showing a section of artificial obstruction near watercourse 4 AL.



FigureB12. Sketch of Dhoro Naro Minor from RDs 19.2 to 23.0, showing silt deposition and vegetation Growth.

RD 23+000 to 24+300: Both banks were covered with vegetative growth above the freatic line that was affecting the flowing section of the minor and caused silt deposition. Both banks were stable. Section width was observed 9.5 ft. At this section artificial hurdles like wooden pieces, tree steams, stone blocks and mud were dumped for getting more water (Fig. B-13).

RD 24+400 to 27+526: In this portion of the minor an un-effective and moderate vegetation growth was observed. The cross-section at the end portion was wider because of animal bathing while remaining portion was almost straight and has a proper alignment. Due to wider section some sediment deposition was observed. At the end of this section a bridge is situated for the Chisel abad link road as shown in Fig. B-14.

27+526 to 32+275: In this portion left bank was full with vegetative growth. Vegetation was falling in to the minor at some places due to which silt was deposited over there. The left bank was possessing very less vegetation. IP was not maintained properly. Section width was averagely 5.5 ft. In this portion outlets 6-L, 7-R, 7-L, 9-L, 10-L and 11-T are offtaking, as shown in Fig B-15.

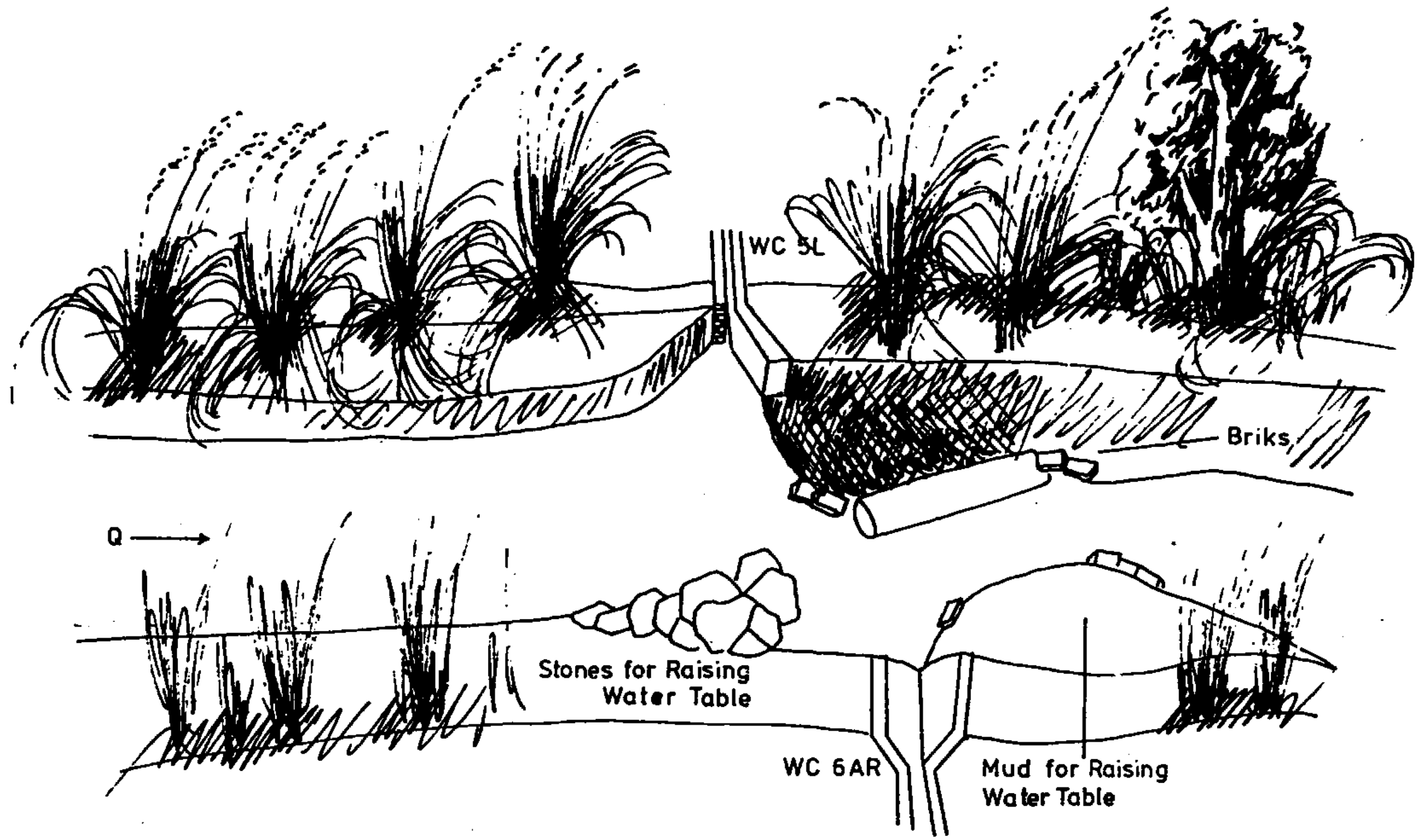


Figure B13. Sketch of Dhoro Naro Minor Showing stones, bricks, tree steam and mud which are artificially dumped for getting more water near outlets 5L, 6AR at RD 24.17.

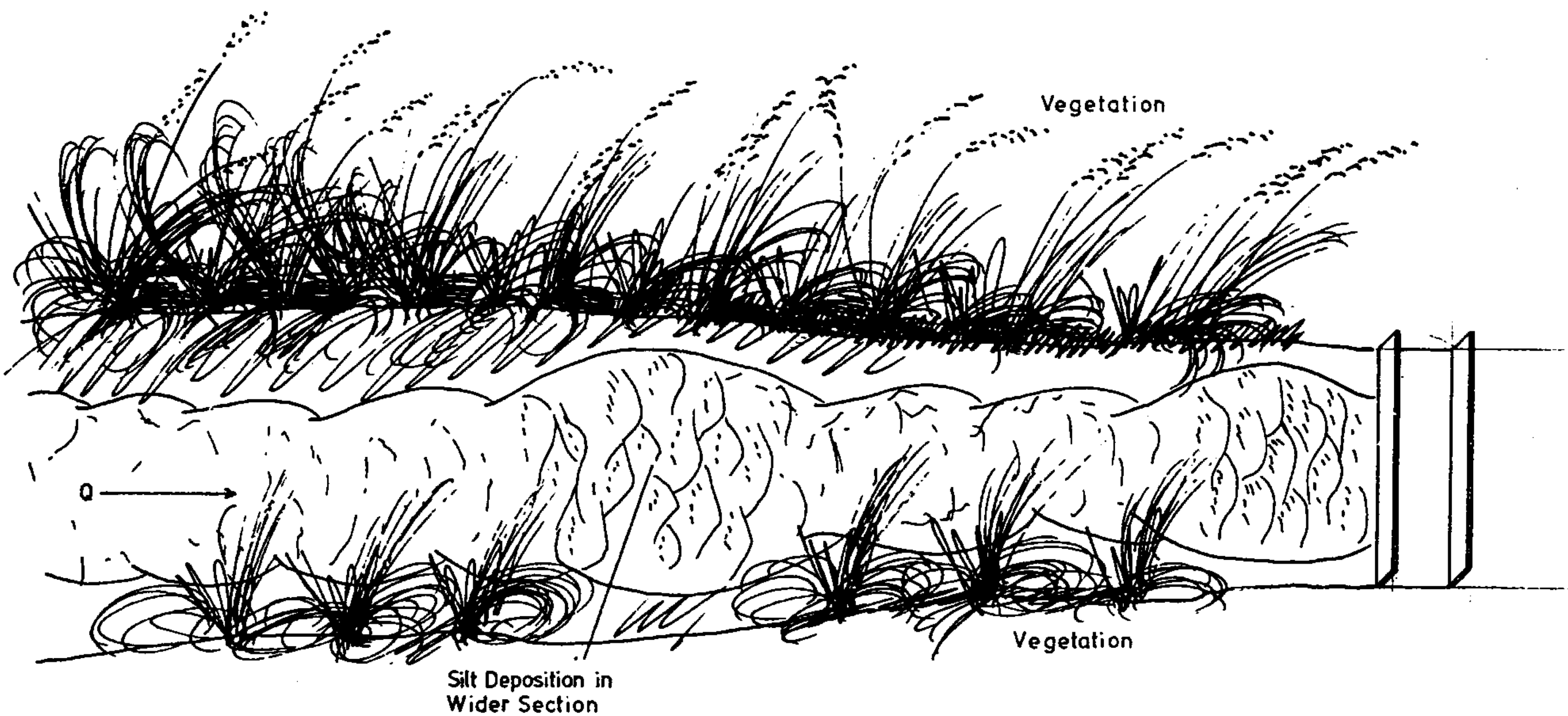


Figure B14. Sketch of Dhoro Naro Minor from RDs 24.4 to 27.526, showing vegetation growth and silt accumulation in wider sections.

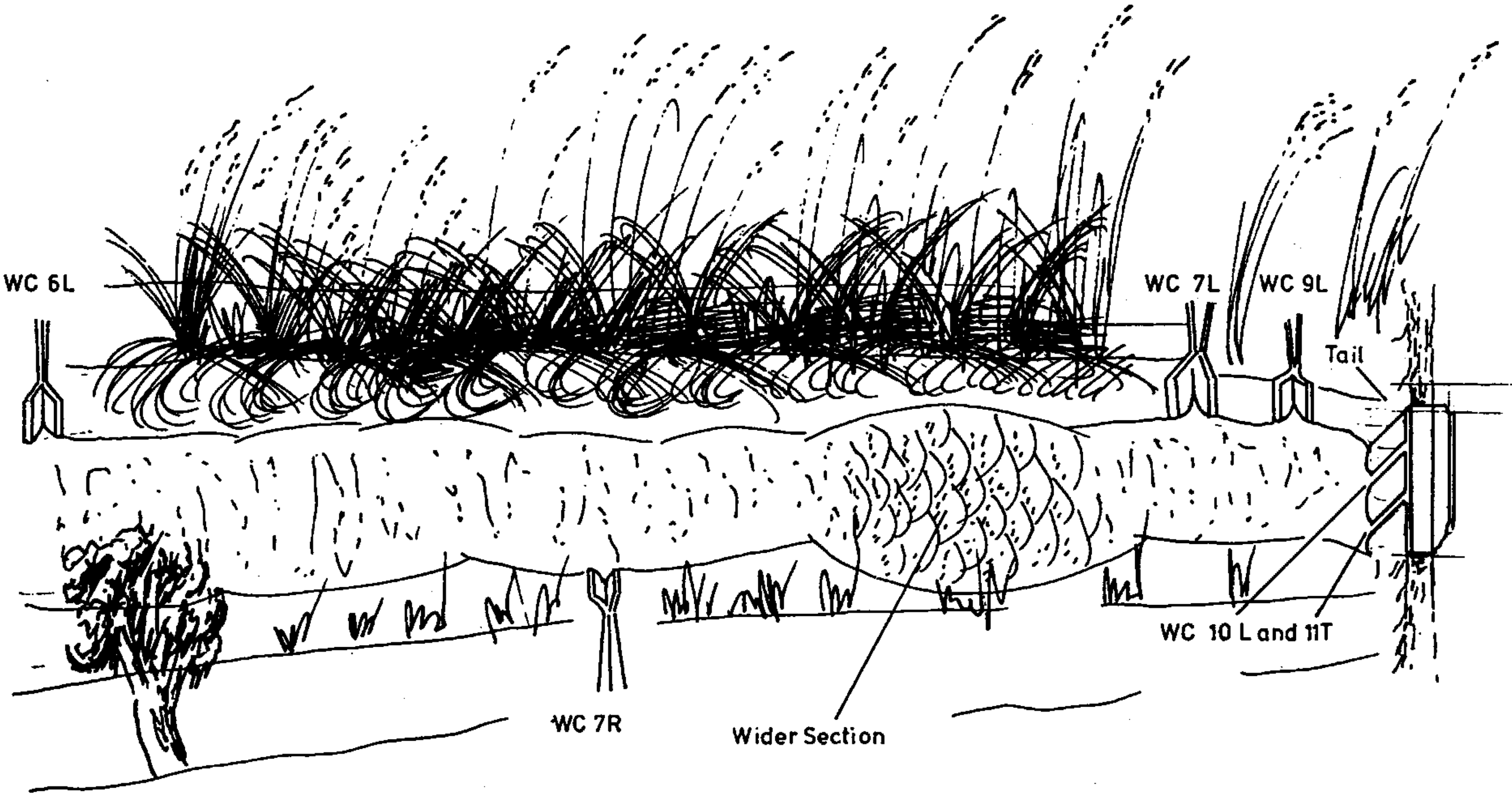


Figure 15 B. Sketch of Dhoro Naro Minor from RDs 27·526 to 32·275.

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