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MERCY CORPS INTERNATIONAL – QUETTA

and

THE OFFICE OF THE AID REP, ISLAMABAD

REHABILITATION OF IRRIGATED
AGRICULTURE IN AFGHANISTAN'S
ARGHANDAB AND HELMAND VALLEY

REPORT ON PROJECT IDENTIFICATION
MISSION

by

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1. INTRODUCTION

1.1 Background

Mercy Corps International (MCI) is a US based Non-Government Organization (NGO) engaged in relief and development activities in various locations around the world including Afghanistan.

Current activities in Afghanistan include agricultural training and rehabilitation work and animal health care and the reconstruction of a major hydraulic structure on the Helmand River, namely the Darwishan Irrigation System intake works.

In respect to the latter activity, a site engineer has been resourced and recruited to MCI by UNDP-OPS, which is also providing the capital budget for the works. Even so, MCI sent for additional short term consultancy support from an irrigation specialist and USAID were approached as a possible source of finance to cover the resulting work. USAID's eventual agreement resulted in the engagement of an irrigations specialist rather than expend the consultancy entirely on the Darwishan intake works and extend the consultant's brief to include a survey of the rehabilitation required on the agriculture in portions of two river valleys in South East Afghanistan, ie. the areas around Kandahar and Panjwai and the Helmand river south and west of Lashkar Gah.

The following report comprises the results of the consultancy, although additional material has been prepared in the specific respect of the Darwishan intake works.

1.2 Terms of Reference

The consultant was required to:

- (i) become familiar with all aspects of MCI's irrigation repair programmes.**
- (ii) Meet with other O/AID/REP (eg. ARR, VITA, IRC) and UN organizations in irrigation repair programmes to get an overview of work being done and make comparisons with MCI programmes.**
- (iii) travel to the project sites in Kandahar and Helmand Provinces of Afghanistan for a first hand view of the project activities and site needs.**
- (iv) prepare a report outlining priority areas and specific sites for the groups in MCI in irrigation rehabilitation programmes, consistent with the projects of and implementation capability of MCI.**

- (v) provide specific technical recommendations for implementation of specific projects (eg. technical approach, time, labor and material estimates)
- (vi) make a brief visit to the Darwishan Diversion Repair Project for not more two days, check the progress of the project and make recommendations for appropriate changes to the work to improve the implementation.

1.3 Comments on the terms of Reference

In reading background documents prior to the formal briefing with AID-REP in Islamabad it became clear that two crucial issues had not been met by the Terms of Reference. First the increasing problems of salinity in many of the agricultural areas suggest that attention should be paid to drainage considerations. Second and related to the first, there was reason to suspect shortcomings in on-farm water management skills.

It was agreed at the formal briefing that the consultant should also look at these issues, but confining his attention to rehabilitation of existing drainage works; the possibility of installing new drains at field level and the needs for training in and facilitation of on-farm water management.

During the field visits it became clear that the nature of many of the interventions required were such that it would be very difficult and misleading to attempt to quantify the material and manpower inputs on the basis of rapid rural appraisal. This matter was discussed with MCI's Agriculture Programme Manager who agreed that, in such cases, quantitative descriptions identifying and justifying suitable technical approaches would suffice. Because of this it is stressed that this report presents the results of what must be seen as a project identification mission. Implementation of the various components should only proceed on the basis of site specific project preparation studies, which would be a normal next phase for any well thought out programme.

1.4 Timing of Mission

The mission took place during February and March, 1992 and proceeded very much according to plan.

It should be stressed at this juncture that the smooth running of the mission, especially as regards the cross-border component, was due to MCI's excellent connections and logistic capabilities within Afghanistan.

2. OVERVIEW OF LOCATIONS VISITED AND INTERVENTIONS IDENTIFIED

This chapter is intended to briefly introduce the reader to the two areas investigated by the consultant. It is divided into two main sections, the first dealing with agricultural areas being irrigated from the Arghandab river (though without necessarily being in the Arghandab valley itself) the second deals with the three large-scale irrigation schemes situated to the South and West of Lashkagar and abstracting water from the Helmand River. Identified problems and constraints are listed and briefly commented on. More detailed discussions of the problems and possible solutions are presented in the subsequent two chapters.

Before proceeding with this and subsequent chapters; however the reader's attention is drawn to an album of photographs which illustrate many of the issues and problems identified (numbers on the back of the photographs correspond to numbers given in the text).

2.1 Arghandab Area

2.1.1 General

The area visited during the mission is delineated on Figure 2.1. It is roughly triangular in shape and is bounded to the North West by the right bank of the Arghandab river which flows approximately from North East to South West and to the South by the Dor river. The confluence of the two rivers forms the apex of the triangle which then stretches some 45 km to the East.

Four basic agro-ecological zones are involved:

- (1) The area is interspersed with barren mountains, many of which have scree deposits at their feet (see photograph 2). These mountains tend to run parallel to the Arghandab river and together comprise a series of ridges;
- (2) Lying between the Arghandab and Dor rivers, are extensive flat plains of deep loose silty-sands sloping gently from North to South (see photographs 33 and 66). These plains have been almost entirely cultivated with wheat and raisins (see photographs 3 and 69) predominating, although some *a'falla* was observed along with some general grazing areas (see photograph 62);
- (3) Seasonable swamps are encountered immediately to the South and West of Panjwai (see photographs 63 and 64);
- (4) On the immediate right bank of the Arghandab is a strip pedologically and economically similar to those in zone 2 above, but instead of being flat the land tends to undulate gently. This strip varies in width and slopes up moderately from the river until loose generally gravelly soils covered with coarse, seasonal pasture are reached (see photograph 4). The interface between the two soils can be regarded as the boundary of the area of interest.

The Arghandab river is flowing through essentially mature landscape (see photograph 5) and is still incising its course with minimal meandering along most of the section in question. All alluvial deposits are very large grain (see photograph 46) which indicates that the river is fairly young in relation to its environs - although by the time that it passes Panjwai significant meanders are beginning to form. The Dor on the other hand exhibits a strong meandering tendency not adequately indicated by the figure.

During the course of the Russian occupation of Afghanistan the area was the scene of prolonged and intense military activity. Examples of destroyed military hardware is everywhere in evidence, but more telling are the myriad bomb and shell craters which pepper the landscape along with the almost total destruction of buildings.

As result of the military activity and the associated de-population of the area there is an urgent need for rehabilitation on a broad front. The efforts of the slowly returning refugees will not be enough without adequate resourcing and technical assistance.

Already however, elements of the infrastructure are slowly being restored. New or reconstructed homesteads are much in evidence as are rehabilitated vineyards and raisin drying sheds. The bazaars are bustling once more with normal peacetime economic activities. This is of course encouraging but does not address the pressing issues affecting agricultural production in this once prosperous area.

There are two overriding problems:

- (1) The irrigation systems, which are essential for reliable agricultural production are inoperative due to (i) war damage, (ii) looting of essential equipment, and (iii) general dilapidation due to the total lack of maintenance activities during the Russian occupation and subsequent inter-factional fighting. In addition to these problems, which have their origins in recent history, there are occasional examples of problems with more fundamental causes;
- (2) The area has become highly salinated (see photographs 51, 52 and 71) due to poor drainage and high water tables. Attempts by the returning refugees have been frustrated by a lack of technical knowledge and equipment.

In general it is possible to conclude that the area has by no means reached the point of no return, but much has to be done, particularly in the irrigation and drainage sectors. The level of reconstruction activity already in progress would suggest that any donor/agency involvement would be more than matched in effort by returnee farmers. The remainder of this section therefore introduces the various interventions that were identified by the consultant during the short time available.

2.1.2 Location 1 Figure 2.1 - Harambance Drainage Area

Refugees are returning slowly to their homes but are finding the rehabilitation of their bomb cratered fields very arduous. The problems are greatly exacerbated by very high water tables and resulting salinity.

2.1.3 Location 2 Figure 2.1 - Gurgan Aqueduct

The Gurgan aqueduct used to convey water over the Tarnak river. The aqueduct has been completely destroyed by high river flows and inappropriate construction technology. (see photographs 30, 31 and 32). A new aqueduct is required.

2.1.4 Location 3 Figure 2.1 - Panjwai Irrigation Canal Offtake

The intake works feeding this important irrigation canal have been badly damaged by the Arghandab river (see photographs 46-49). Complete remodelling of the works is therefore required.

2.1.5 Location 4 Figure 2.1 - Panjwai Drainage Area

A system of field drains is urgently required to drain this badly waterlogged area (see photographs 63 and 64) into a recently constructed collector drain skirting the area to the South West.

2.1.6 Location 5 Figure 2.1 - Malajat Drainage Area

Damaged canal banks have resulted in the ingress of irrigation supplies into the drainage system causing very high water tables and salinity problems (see photographs 65 -72). Canal bank repairs, field drains and a re-aligned collector drain will be necessary to rehabilitate the area.

2.1.7 Location 6 Figure 2.1 - Rahman Wash

The Sangisar irrigation canal crosses a natural drainage channel at this location. Branches have been traditionally repaired by manual labour, but neglect over the past ten years, coupled with excessive flooding have greatly exacerbated the problem (see photographs 34-40). Repair works and a more permanent solution are required.

2.1.8 Location 7 Figure 2.1 - Zahir Shahi Canal Offtake

This major structure requires new irrigation control and river gates (see photographs 42 and 43).

2.1.9 Location 8 Figure 2.1 - Zahir Shahi Bifurcation

This structure requires minor but essential repair work on its four radial gates (see photograph 41).

2.1.10 Location 9 Figure 2.1 - Babawali Distribution Structures

This complex of hydraulic structure has been constructed to divert supplies from the Zahir Shahi system into five traditional irrigation canals. Flow control gates and earthworks require rehabilitation (see photographs 44 and 45).

2.1.11 Location 10 Figure 2.1 - Jui Lahore Canal

This is an ancient canal which was constructed during a time when the Arghandab river bed levels were much higher. Over the ensuing years bed levels have inevitably dropped leaving the offtake high and dry. All attempts to resolve this problem have failed, a more drastic solution is called for (but is possibly not going to be practicable or justifiable). Short of a major cross river structure, pumped supplies are possibly the only simple solution, but O&M exigencies will probably preclude this approach. No further attention is therefore paid in this report to this project.

2.1.12 Location 11 Figure 2.1 - Manar Canal

This ancient canal has the same problems as the preceding case but not to the same extent. Save the Children Fund has resourced some helpful but incomplete reconstruction works. Additional inputs are required.

2.2 Helmand

2.2.1 General

The Helmand is Afghanistan's largest river which, in the area visited, flows essentially North South from Lashkagar, a government held town. Just South of Lashkagar the Helmand River is joined by the Arghandab.

Hereon the river could be classified as being "mature" and flows through a flood plain bounded by deserts on each side (see photographs 50 and 53). The flood plain comprises uniform sandy silts of good fertility (see photograph 6) interspersed with deposits of river-run gravels and pebbles. As would be expected the river shows a strong meandering pattern, with wavelengths significantly in excess of 1 km. Deposits building up behind the meanders as they move progress slowly downstream include silts.

There are three major agricultural areas in the general area under consideration. Darweshan is the most southerly, then to the South West of Lashkagar is the Boghra system (which feeds the two areas of Marja and Nadi Ali) while the Shamalam system begins just South of Lashkagar. The Boghra and Shamalan systems are separated by a small area of high ground otherwise the areas are for all intents and purposes contiguous. All three are irrigated by water abstracted from the Helmand river.

It is possible therefore to think in terms of two agro-ecological zones:

- (1) The Helmand flood plain which comprises extensive arable production with some limited livestock. Production focuses on wheat (see photographs 7 and 8), with some raisins, cotton and alfalfa. It is also reported that opium poppies have been grown in the region but no evidence of this was seen by the consultant;
- (2) The higher ground between Marja and Shamalan systems which is covered with coarse grazing material.

As with the Arghandab area, Helmand Valley has also seen its share of military activity with resulting devastation, although not to the same extent. Cratering of fields for instance is actually quite insignificant, but nonetheless damage to homes and other buildings has been very extensive.

Many of the area's erstwhile inhabitants are reported as still being in refugee camps in Pakistan, but those who have remained or returned are beginning reconstruction activities in their settlements and homesteads. Furthermore, considerable activity has clearly been focussed on canal maintenance and in fact was observed by the consultant even on a Friday. The people are therefore keen to restore their situations to normality once more and to this end are expending both time and effort (see photograph 15).

All three schemes were visited by the consultant, although prevailing security problems precluded detailed inspections of Marja and part of the Shantulan scheme.

The same problems were generally in evidence at all three schemes thus they are not treated separately in the following paragraphs - except in the case of significant specific items which will be obvious to the reader.

Thus:

- (1) practically all irrigation water control structures require new gates and/or winding gear; no effective flow control is possible at any point in the three schemes (see photographs 17 and 19-23);
- (2) canal banks are in essentially very good condition, but some portions require reconstruction as a matter of some priority - especially downstream of certain cross-regulators where undercutting is being caused by reverse eddies (see photographs 18 and 24-26);
- (3) some cross regulator stilling basins have damaged riprap aprons which should be repaired if minor downstream damage is to be avoided (see photographs 28 and 29);
- (4) one cross regulator on the Darweshan system needs complete reconstruction (see photograph 27);
- (5) urgent river bank protection works are required at a point where the Helmand river will soon begin to encroach on the Darweshan main canal exit works (see photograph 50);
- (6) access roads along the main and secondary canals need grading (see photograph 14 right hand side);
- (7) no flow measuring devices were in evidence; good irrigation management requires that consideration is given to the provision of suitable facilities;
- (8) as a result of poor irrigation management and other factors, waterlogging and resulting salinity problems are extant over much of the project areas leading to massive yield decreases and farm abandonment (see photographs 55-60). This is especially so at Marja (see photograph 56). There is a need therefore for extension activities addressing the disciplines of on-farm water management (at present, due to the poor performance of the irrigation systems many farmers are irrigating from the drains (see photograph 78); thus accelerating the salinisation process); this training element should also address the question of micro-land levelling (see photograph 61);
- (9) existing drainage systems need major rehabilitation and remodelling works as a matter of some urgency (see photographs 73-77 and 79-82);
- (10) it is clear that the existing drainage systems were only intended to handle surface run-off and as such are not adequate to draw down water tables, a field drainage system is therefore required;

- (11) if the drainage issues are addressed completely then the possibilities of a leaching programme should be considered.

Not included in the above list, is the need for reconstruction of the Darwshan irrigation intake works. But this is already in progress with MCI as implementing agency under UNDP-OPS funding and as such is not addressed in the main text. Instead it is covered in Appendix B.

3 DETAILS OF INTERVENTIONS REQUIRED FOR THE ARGHANDAB SYSTEMS

3.1 Harambance Drainage Area

This area used to support some 1,000 families who, before the military situation sent them fleeing to refugees camps in Pakistan, used to grow a main crop of wheat and a second crop of horticulture from their land. Wheat yields were impressive at a claimed Figure of 1,250 kg/ferib (6.25 tonnes per ha) and the horticultural crops were successfully exported to Pakistan making the area prosperous in local terms.

Those families who have already returned from the refugee camps are reconstructing their war damaged homestead compounds and attempting to begin farming once more. The area in question was irrigated and drained by simple infrastructure provided by the pre-invasion government. But ten years of war and neglect have resulted in severe damage to the crucial infrastructure which the people are attempting to repair or reinstate. Their efforts with respect to the simple irrigation systems are perfectly satisfactory (see photographs 9 and 10) but little success is being enjoyed with their attempts to drain the area. The mission was taken to see several small, self-help drains, but in none was the water flowing, indicating an inability of the people to align the channels properly.

Yet the high water table which characterises the area will have a detrimental effect on crop yields and soil chemistry and must therefore be dealt with.

The fact that the people are proving able to rehabilitate their irrigation channels while remaining unable to sort out their drainage is explained by the prior existence of the irrigation channels which just need cleaning out, whereas the drains require excavation from scratch.

To do this successfully will require the following inputs:

- (i) A simple topographic survey of the area in question.
This will take an experienced and properly equipped surveyor no more than one month including the preparation of contoured base maps - his labourers can be supplied by the community;
- (ii) A rational drainage layout design based on soil conductivity tests.
This will require some two weeks of a drainage expert's time once the above mapping has been finalised;
- (iii) Accurate pre-construction setting out.
This will require approximately two weeks of a surveyor's time along with a supply of timber of timber pegs and string neither of which will be re-usable;
- (iv) Possible assistance in the form of an excavating machine of some sort or a suitably equipped tractor plus fuel and lubricants, etc;
- (v) Supervision during excavation.

The actual period of implementation cannot be estimated prior to the preparation of the drainage system design but it is very unlikely to span more than one cropping season.

In addition to very obvious drainage problems pertaining in the area, it was reported that two main canals feeding the area have been damaged leading to disrupted supply in the field channels. This problem is addressed in section 3.9 below.

3.2 Gurgan Aqueduct

The western end of the tongue of land lying between the Tarnak and Dori rivers used to be irrigated from the Arghandab river via the Zahir Shahi/Babawali system.

To reach the area in question, however, water has to be conveyed across the Tarnak river which is too deeply incised and possibly not reliable enough to irrigate from directly.

Two previous attempts at conveyance structures have comprised open flumes which crossed the Tarnak supported on six plinths. Both attempts have failed due to the plinths falling over.

Foundation conditions at the site are very difficult. Detailed inspection was not possible due to the depth and velocity of flow in the river. It appears however that the bed comprises deep layers of friable silt as shown in photograph 32. Such material cannot be expected to provide safe foundation for a structure of this nature.

Clearly a different approach is required, i.e. one that is not affected by possible flood damage or inadequate foundations.

It is considered by the consultant that the river is not so wide as to preclude the possibility of used a cable stayed crossing (pipe or flume). In other words, two supporting towers should be constructed, one on each bank. The actual crossing can then be suspended from cables strung between the two towers and anchored back to solid ground. Of the two possible crossing types, the pipe alternative would be most favourable as it will prove much lighter than concrete flume.

Such a crossing will need to be designed by a structural engineer experienced in the design of cable stayed structures and is likely to prove complicated to construct. Thus highly experienced and specialist involvement will be required at every stage during the implementation of the solution. This is therefore not really an opportunity for MCI except perhaps as regards a purely co-ordinating role.

3.3 Panjwai Irrigation Canal Offtake

The Panjwai irrigation canal supplies some 15,000 jeribs (3,000 ha) of mixed wheat and barley land with crucial irrigation supplies with almost 2,000 families depending on it.

The canal itself is fairly well maintained (see chapter 6) and conveys water to the farms from a free offtake at the Arghandab river. At the offtake the river course is highly braided and unstable (see photograph 46).

Since the original offtake collapsed (see photograph 48) various attempts to provide new offtakes have been frustrated by the shifting alignment of the various branches of the river. The current solution comprises a stick weir (photograph 46) which deflects flow into the lead canal, approximately 1.5 km upstream from the old offtake. It has been sited so far upstream of the

original offtake in order to regain the command that river alignment and bed changes have reduced at the original site.

Downstream of the old offtake the canal is in a good state of repair but the new lead canal has not been adequately planned or executed. Photograph 47 for instance shows a portion of the canal over 50 m wide and contained by a very flimsy embankment, a more rational and durable approach is therefore called for.

The shifting nature of the river, however, means that construction of a completely durable Panjwai main offtake will not be practical or cost effective. It is, however, possible to greatly improve on the existing situation.

First of all, to ensure command, any new offtake must, like the existing temporary structure, be sited a distance upstream of the original structure. Some 2 km upstream of the old intake the river's left bank is characterised by an approximately semi-circular deposit of coarse material (marked by three crosses on photograph 49).

Figure 3.1 comprises a sketch plan (not to scale) which indicates how a possible new offtake might be aligned in relation to this deposit. Its situation at the extremity of the semi-circular deposit takes advantage of the sizable stream being deflected by the steep hard hillside.

The works as suggested comprise a deflection weir. By means of the weir, water is deflected into a lead channel down which it flows to the site of the old offtake which should be reinstated as a means of controlling inflow. There is very little freeboard available in the river for much of the year. Thus a weir spanning the whole river, as well as being extremely expensive, would also have a potentially dangerous backwater profile during high flows. This would result in flooding of upstream land that is currently being returned to economic use in the form of orchards.

Clearly, this is only one suggestion based on a short inspection of the site in the time available. Before actual implementation, a more detailed analysis of this and possibly other options must be undertaken by a qualified irrigation or hydraulic structures specialist. Even so the following schedule of materials and manpower requirements will provide a reasonable basis for planning.

Some 16,000 cubic metres of gabion baskets will be required for the proposed embankment and deflection weir and 900 cubic metres of Reno mattresses (flat gabion baskets normally 0.3 m in thickness) for the protection works. Although not perfect, the coarse material comprising the myriad banks which characterise the river here will be suitable for filling the gabion baskets.

The original control structure can be reinstated with some 5 cubic metres of reinforced concrete and new vertical lift gates.

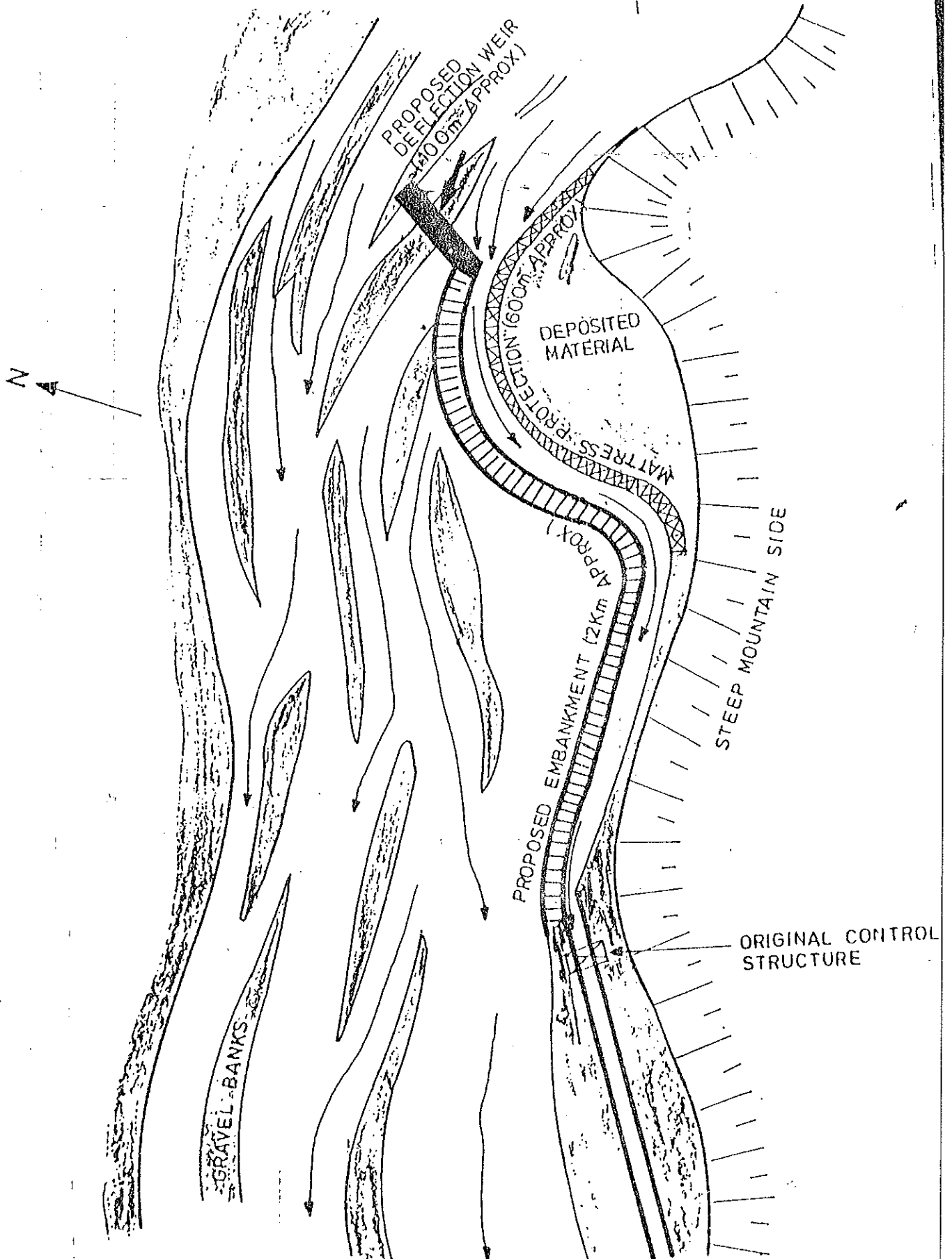
At least three skilled masons will be necessary to supervise the works which will require some 20,000 mandays to complete assuming that the gabion baskets are to be filled by hand.

3.4 Panjwal Drainage Area

Land lying to the South and East of Panjwai township suffers from poor drainage and resulting salinity. It is well served by irrigation systems, originating either at the Panjwai offtake (as discussed above) or the Babawali distribution complex (see section 3.9) below. It therefore represents a high potential crop growing area, particularly in respect of wheat and raisins.

FIGURE 3-1

SCHEMATIC SKETCH OF PROPOSED
NEW LAYOUT AT PANJWAI
IRRIGATION OFFTAKE
(Not to scale)



Drainage however is crucial and to this end a collector drain has already been excavated along the southern border of the swampy area as indicated on Figure 2.1 and photograph 64.

Without a series of field drains, however, the collector drain will be limited in usefulness. Help is therefore needed to design and install a simple drainage system.

The inputs required are the same as those at Harambancee, although actual implementation may take a little longer since, despite being a smaller area, access around Panjwai's swampy area is much more problematic than at Harambancee.

In terms of execution however, there are likely to be planning and logistics advantages and hence cost savings if MCI undertake the Harambancee and Panjwai projects with one team.

3.5 Malajat Drainage Area

This area is situated immediately due South of Kandahar city and is well served by a gradually converging network of fairly large drains. The name given above is that given to the mission during the field trip. The general plan drawing of the network as on file at the Helmand valley Authority headquarters in Lashkagar refer to the system as the "Karz-Zakir Unit Outlet Drains" and the reader's attention is drawn to the IIVA drawing bearing that title, numbered 760-15 and dated 30th of September 1969. This large scale drawing is in full agreement with the drainage layout as indicated on Figure 2.1, the relevant portion of which has been enlarged to produce Figure 3.2.

At present however, water is not moving in the drains and water tables are extremely high. This is seriously affecting agricultural redevelopment in the area particularly as regards the preparation of new raisin fields (see photograph 69). Despite the excessively high water tables observed during the field trip there was ample visual evidence that water tables had been even higher a short while before as in many locations soil was saturated across a layer some 15 cms above the water table (see photographs 66-68) a phenomenon not easily explained by capillary rise.

There are two apparent reasons for the water logging.

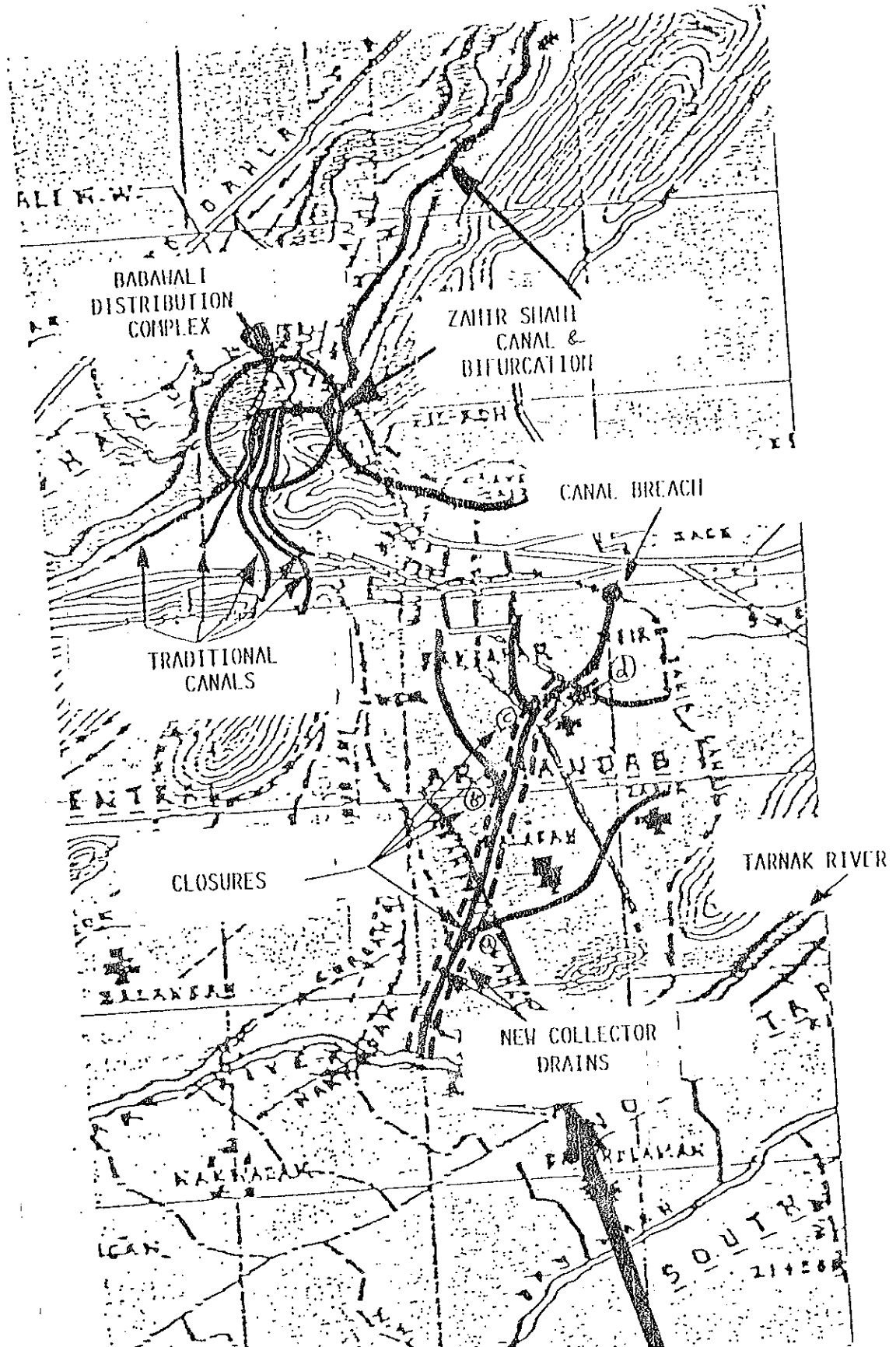
First, flows in the drains are impeded by silt and vegetation (see photograph 65). Secondly and more importantly, water flowing through a breach in an irrigation canal flowing through Kandahar city is entering one of the Malajat drains as shown in Figure 3.2. This water was seen to be backing up into other drains in the system (see photograph 70). So instead of drawing water tables down, the drains are actually delivering water thereby contributing to rather than solving the problem.

To make matters worse, however, farmers are actually pumping water from the drains for irrigation purposes thus accelerating the salinisation of the soils.

The simplest solution to the problem, in technical terms at least, would be to repair the canal breach in Kandahar city and clean out the drains. But the city is still in government hands thus there is no guarantee that the canal will be repaired and kept water tight.

It may therefore be considered necessary to isolate the drain which is carrying the irrigation water. This can be easily carried by closing off the tributary drains with earth dams at their point of confluence with the drain to be isolated.

Figure 3.2
Malajat Drainage Area and
Babawali Distribution complex



Two new collector drains would then be required one to drain the area to the right of the isolated drain into the Tarnak river, the other the left side, into the same river.

Both drains would be some 8 km in length and would require excavating at a rate of 25 cubic metres cut to spoil per metre. Excavation on this scale would best be carried out mechanically. Various approaches would be appropriate ranging from a tractor with a back acting bucket to a motorised box scraper.

Closing off the tributary drains could be done by hand labour at something close to 75 mandays per closure. This figure assumes that 75 cubic metres of fill material are required per closure at a rate of 1 cubic metre per manday. The closure works will be accomplished more easily if sand bags can be utilised to form coffer dams upstream and downstream of the dam. At least four such closure dams will be required marked a, b and c on Figure 3.2.

Drain clearing could also be carried out by hand labour. The scale of the clogging is not great and the problem tends to be localised. A reasonable estimate of manpower requirements would assume that a team of ten labourers could undertake the work in less than two months.

Finally, and not so far returned to, there are serious breaches in the drain banks which have most likely been caused by shell or missile fire (see photograph 68). These again can be repaired by hand labour.

To summarise therefore, the Malagat drainage system requires:

- (i) 16 km by 25 cubic metres/metre of machine excavation for two new collector drains;
- (ii) 300 labourer mandays to close the tributary drains or the equivalent in machine time;
- (iii) 500 labourer mandays to clear out the collector drains;
- (iv) manpower as required to repair breached banks (actual amount not known without detailed survey of entire system).

If MCI decides to proceed with this project it should be noted that there is a chance that a system of field drains may also be required. Any field drainage requirements could be addressed along the same lines as the Harambance and Panjwai drainage areas and even by the same team.

[note: military activity since the preparation of this report have resulted in the fall of Kandahar city to mujahidin forces. This situation is likely to pertain indefinitely. Thus it may now be decided to repair the breach in the canal referred to above in which case major remodelling of the Malagat drainage system will not be required. Instead it will be sufficient to reinstate the drainage system as originally envisaged and de-silt where necessary.]

3.6 Rahman Wash

The Sangésaj canal conveys water from the Arghandab River to some 15,000 jeribs (3,000 ha) on its right bank. The predominant crop is raisins although some wheat and barley is grown.

Approximately 13 km downstream from the offtake (which is in good repair) the canal crosses a seasonal natural drainage channel, the Rahman Wash which regularly washes the canal out. Some of the flood water then proceeds down the canal depositing coarse material while the rest spills over the farm land which extends for some 500 metres between the canal's left bank and the Arghandab river.

Normally the resulting breach is repaired in time for the irrigation season but unusually high floods in recent years have resulted in damage considerably greater than usual. A more permanent solution is called for.

The solution will have two objectives, first the canal has to be protected from the destructive floods flowing down the wash. Secondly, the flood water have to be passed safely to the river.

There are at least three ways to meet the first objective:

(i) A tank style crossing

A tank crossing comprises a large pool into which both canal and drain can pass through the nature of the relevant outflow structures tends to force excess flows to continue down the drainage system rather than enter the canal system. This approach is best suited to more undulating topography than that which pertains at the site in question and is not considered appropriate in this case;

(ii) A Siphon carrying the drain under the canal;

(iii) A Siphon carrying the canal under the drain.

As a general rule it is always best to apply a restriction to the channel containing the known, in this case the canal. Thus the solution proposed will be to construct a masonry and/or concrete siphon which will carry the irrigation water under the wash, thereby allowing the flood waters to flow unimpeded to the river.

Which brings us to the second objective, i.e. the safe passage of the flood waters to the river. There is really only one sensible approach and that is to simply excavate a channel from the canal to the river. The channel of course should have a similar cross section to the wash itself. Unfortunately, such a channel will have to pass over existing and intact farm land (pomegranates, raisins, fodder and some cereals). Apparently, however, farmers benefiting from the Sangésaj canal are prepared to club together to pay for an easement along the line of the extended wash.

A possible arrangement of the proposed works is shown in Figure 3.3. It is a schematic arrangement only. The works should be subjected to a detailed design exercise by a suitably qualified expert. Of importance during the design analysis will be the matter of how fast the flow through the siphon will have to be in order to avoid siltation within the structure. To an extent this could be self regulating (in other words as the siphon begins to clog, the velocity increases until a state of equilibrium is reached). Of course, increased velocity is only achieved