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**MINISTRY OF MAHAWELI DEVELOPMENT
MAHAWELI AUTHORITY OF SRI LANKA**

**Mahaweli Economic Agency
Mahaweli Engineering and Construction Agency**

MARD PROJECT



**Pimburattowa
via Polonnaruwa**

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**REVIEW OF
OPERATION & MAINTENANCE OF
SYSTEM B
IRRIGATION FACILITIES
MADURU OYA PROJECT
SRI LANKA**

by

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(Report No. 228)

**MARD PROJECT
PIMBURATTAWA**

MARCH 1994

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Introduction

The main and branch canals of the irrigation network in System B is comprised of concrete lined canals with capacities ranging from 1 cumec to 65 cumec. The left bank main canal which is 52.88 km long, presently irrigates 13500 ha. The total length of the branch canals is 71.3 km. The irrigation system will cover approximately 21,000 ha. of land when the left bank area is fully developed. The MEA, responsible for the operation and maintenance (O&M) of the canal system, has decided to conduct an examination of Operation and Maintenance practices of System B in every two years. The general guidelines as set out in "Review of Operation and Maintenance Program - Field Examination Guidelines" (Publication of US Bureau of Reclamation) are to be followed in these examinations. A three member external inspection team conducted a review of O&M practices on 17th and 18th March 1994. This report presents their observations, recommendations and the current O&M practices in System B.

Purpose and scope of inspection

The purpose of the inspection is to review current O&M procedures, policies and practices of system B and to recommend modifications to improve current practices to ensure effective O&M to prolong the life of the canal net work and minimise recurrent O&M costs. The inspection will also help to accommodate the need for year-around irrigation by reducing breakdown maintenance which warrants canal closure periods.

The scope of the inspection is to;

- * Evaluate the adequacy of the O&M programme of System B;
- * Disclose conditions that might cause disruption or failure of operation;
- * Determine the adequacy of the structures and facilities to serve their intended purposes;
- * Note the extent of deterioration as the basis for planning maintenance, repair or rehabilitation;
- * Review of current operating practices;
- * Determine the degree of operational safety at the facilities; and
- * Obtain data for improvement of design, construction, maintenance and operation practices

Preparation

Inspection Team

The inspection team was made up of the following members representing three organisations responsible for construction and maintenance of irrigation systems in Sri Lanka.

1. Mr. Ivan Silva, Deputy Director, Department of Irrigation.
2. Mr. K. A. D. S. Chandrasiri, Deputy Resident Project Director, Mahaweli Engineering and Construction Agency.
3. Mr. S. K. Chandrasekara, Chief Engineer, Headworks Administration, Operation and Maintenance Unit.

The following persons participated as observers.

1. Mr. T. D. P. Karunathilake, Chief Irrigation Engineer, Mahaweli Economic Agency.
2. Mr. D. C. S. Elakanda, Deputy Resident Project Manager, Mahaweli Economic Agency.
3. Mr. Nimal Wickramaratne, Water Management Engineer, Mahaweli Agriculture and Rural Development Project.
4. Mr. K. Satgunasingam, Chief Engineer, Mahaweli Agriculture and Rural Development Project.
5. Mr. M. F. M. Fallil, Engineer, USAID.

Mr. Karunathilake, CIE, coordinated all the activities of the inspection team. Ms. Renuka Wickramasinghe, Civil Engineer, MEA, Mr. Abeywickrama, Civil Engineer, Mr. Sivakumar and Mr. Athula Pushpakumara, Engineering Assistants, accompanied the team.

Background Information

Mr. K. Satgunasingam briefed the inspection team on the objectives of the proposed review of Operation & Maintenance programme. He also summarised the field examination guide lines for the inspection team. He stated that this programme would help to identify and initiate rectification of O&M problems of the Project. Mr. D.C.S Elakanda (DRPM) MEA presented an overview the irrigation system and the O&M practices of MEA.

The following documents were available for reference.

- a) Review of operation and maintenance (ROM) programme field examination guide lines.

- b) Summary of ROM guide lines
- c) Layout map of the canal system
- d) As built drawings of the main irrigation system
- e) O&M Manual for System B
- f) Recommendations of the last review

Itinerary

The inspection was conducted on the 17th & 18th of March 1994. The main canal from Head works up to 33+000 km and branch canals of R1, R3, L1, L2, L3 and structures along these canals were examined on 17th March 1994. On the 18th the Main canal from 33+000 km to 52+880 km and branch canals of L4, L5, L6, R6 and structures along these canals were inspected.

FACILITIES / PROGRAMMES EXAMINED

LEFT BANK MAIN CANAL & BRANCH CANALS

General

The entire length of 48+00 km of the main canal and branch canals (L1, L2, L3, L4, L6, R1, R3 & R6) were examined. In general both lining and the structures in the main canal appears to be in good condition through out its entire length. As the canals water levels were maintained at full supply depth or closer to it in most sections the condition of the lining of the bottom area and the accumulated silt in the canal could not be examined. This report is mainly based on the visual observation and information gathered from the O&M staff. The condition of the main canal beyond 33+00 km was not good compared to the first 33+00 km. This was due to the security problems in the area.

Cleaning

There were a number of stumps and small plants at the edge of the linings and deterioration of these stumps and growing of these plants may damage the lining. It is advisable to uproot these stumps and plants carefully, without making any damage to the lining and filling the voids with suitable material. Growth of plants that have tall growing potential should be controlled on the canal banks. It was noted that some places in the lining grass growth over the cracks and joints. Action should be taken to uproot all these and replace the joint by filling materials and cracks to be treated with epoxy grouting. Otherwise this might develop and can be detrimental to canal lining and create seepage paths in canal banks which may lead to the canal breaching. In many branch canals heavy aquatic weed growth was observed. This should be cleaned as this could be a serious problem to the canal

operations. The hydrilla plants have come up on the silted channel bed of LB/R1. This can be removed manually and be buried or burned as appropriate. Weeds, anthills, trees and tree stumps need to be removed from the banks of mainly the branch canals. If this cannot be done manually it may be necessary to use chemicals to control stumps that are difficult to uproot. Hence, it is suggested to study the possibility of using chemicals to control plants which are difficult to uproot.

Silting

The velocity of the flow of the main canal is around 1.5 m/sec. for the design discharge of 65 cumec/sec. At the time of inspection corresponding discharge of the canal was 13.5 cumec/sec. But the water surface of the canal is regulated at Full Supply Level in order to facilitate water issues to the branch canals. Hence the velocity in the canal may be less and may cause to the silting of the bed. This was visible in some part of the canal but not a serious problem now. Because of that this type of siltation cannot be expected as a problem as it will be on a dynamic equilibrium. Heaps of debris with different sizes of rock particles, were piled up at the foot of channel just upstream of the Regulator at 9+450 of LB/L1. This needs immediate removal as it may disrupt canal flow.

The Stream intercrossing at 4+637 km of LB main canal to Mc tank needs to be desilted in order to send the water along the stream without any disturbance.

Lining

A few cracks of the concrete lining were noted both in cut sections and in fill sections. This is mainly due to the saturation of earth due to the percolation of surface runoff. It is recommended that the side drains of the road be cleaned to drain water freely away from the collected pool. Action should be taken to seal these cracks early and it is suggested that this be scheduled through a maintenance programme. The damage caused to the lining at the crossing point of LB - L6 and market road to Kudapokuna from Welikanda in Zone 3 should be repaired early.

At 4+300 of LB/L6 Bridge came up after construction of canal lining, and the surface runoff are coming in to the canal and gullies have formed around the structure as the wing walls of the R/B abutment are insufficient. Careful study to be done to avoid these situation and damaged lining just down stream of this structure to be repaired.

The space between the canal lining and the bridge abutment in the main canal should be filled with a sealant at almost all the reinforced concrete transitions under the Regulator, Bridge and Wasteway structures.

Side drains

Side drains have been constructed parallel to the canals in the cut sections to drain excess surface runoff into the canal or away from it. These drains had not been recently cleaned in most sections and ponded water was visible in a few locations. The drains should be cleared with minimum disturbances to the grassed side slopes. Drains which do not have turfed sides slopes should be turfed to minimise silt entering into the canal. In case where surface runoff cannot be diverted, such runoff may be diverted into the canal provided that catch pits be constructed at the inlets of canal to prevent the silt carrying the canal. The branch canal side drains appear to be in a greatly neglected state compared to the main canal side drains. The cut sections should be monitored closely and if problems with the lining are apparent, the weep valves should be checked to ensure that they are functioning properly. Also it was learned that parts of valves constructed with brass are usually removed by local people. A remedial action is needed for this as this affects the durability of the canals.

Seepage

A section of the canal lining on the R.B. of L-4 at 0+100 (approx.) is badly damaged. This section has to be demolished and re-done. The side drains need to be cleaned and restored to the design profile. All borrow areas adjoining the canals should be suitably drained. There were three burrow pit areas by the side of the canal where water gets pooled up. Investigations are to be carried out in order to drain these water freely away from the pool to the natural drains.

Structures - Main Canal and Branch Canals

General condition

The structures are very important in the Canal System. Generally almost all the concrete structures are in satisfactory condition. In few places it was observed that iron frames and spindles of the gates of turnouts were damaged. Early action to be taken to correct them. It was observed that the waste way outlets at just upstream of the regulators are unsafe for pedestrians as there is a gap between the road and the structure. This to be either covered with a fence or a slap. Downstream of the structures (stilling basin) are in satisfactory conditions against erosion. All deteriorated joint fillers are to be replaced with suitable material. A leakage of water through the drop cum regulator at 9.45 km in L.B - L1 was observed and this needs immediate repairs.

Head wall of turnout structure to LB/L2 needs to be raised in order to retain the canal back fill and the back filling of the turnout structure needs to be done.

It is also necessary to investigate the requirement for bridges across the Main and Branch canals and implement planning, design, and construction of needed structures.

Gates & Hoists

It appears that hoist mechanism has not been lubricated for considerably long period and grease nipples are rusted and blocked.

Some bolts and grease cups are missing. As these cups had been turned out of brass which is removed by locals for various uses, it is recommended to replace the same with some plastic material in order to avoid any theft. Oil levels could not be checked since tools were not available for opening of the oil sump. In most of these places, counters provided with the gear box to indicate the gate opening size, were not functioning and vertical scales are provided to overcome this problem. Those scales to be repainted.

As corrosion is taking place in control gates, gate arms, cable drains and hoist gear castings painting of these parts should be done without further delay to prevent further propagation. The seals appear to be in satisfactory condition.

The radial gates have not been painted for years. In some gates primary coat is also exposed. Action should be taken to paint the gates without further delay after sand blasting of corroded parts. All necessary equipment are available for this purpose. The last inspection team has recommended to investigate the feasibility of using cathodic protection on the metal gates of System B facilities. Since cathodic protection prolongs the painting cycle, it is recommended to study the feasibility.

Fencing

Fencing constructed at certain sections of the main canal around structures are damaged by wild animals. Guard rails are damaged and parts missing at a few location. These should be repaired.

O & M Roads

O&M roads have been constructed along one side of the main and branch canals with bitumen surfacing. It was observed that road surface is deteriorated at numerous places. Side drains have been blocked permanently and used as foot paths close to the settlements. This causes water table build up at the area and cause damages to the canal lining as well as to O&M roads. This practice cannot be avoided unless some other appropriate alternative such as placing of 2'x 3' precast slabs over the side drains in such places to use as foot paths. In some places surface water runs off over the road due to inadequate drainage facilities and leads to deterioration of the road surface. The O&M road was not constructed along the cut and cover section and the syphon across Kuda Oya. It is advisable to propose a suitable structure to use as O&M road at syphon across Kuda Oya. There is a large space

provided at the tail end of each O&M road of the canals to facilitate for vehicle turning. It was observed that straw being burned on these spaces (LB/R3) after the harvesting and this might seriously damage the tarring surface. Settlers to be educated not to use these spaces for burning straw. The O&M road in a section along L-6 is damaged due to settlement. The cause could probably be a malfunctioning Wasteway. This section of the road should be cut open, the Wasteway connection examined and repaired accordingly.

O&M roads along the latter part of the main canal and along all the branch canals is in need of extensive repairs. A preventive maintenance program should be in place once the repairs are effected.

The O&M road in a section along L-6 is damaged due to settlement. The cause could probably be a malfunctioning wasteway. This section of the road should be cut open, the wasteway connection examined and repaired accordingly.

Construct O&M road along the cut and cover section and syphon across Kuda Oya.

Safety

Chain link fencing is provided to keep the people and animals out of and away from dangerous reaches of the canals. Chain link fencing around some of the main canal structures and handrails were found to be either damaged or missing. Some of these have been damaged by wild animals. This should be repaired or replaced as these areas are highly dangerous and people should be discouraged from bathing in these locations.

Signs of erosion are appearing on canal banks at bathing places. This needs attention under preventive maintenance program.

Operating programme

Flow regulation at regulator structures should be through controlled gate openings. At regulators with two gates, both gates should be operated at similar openings. This was observed at all regulators on the main canal except Regulators No. 11 and 12, where flow regulation was controlled only through one of two gates and through the Wasteway. As such turbulence effect were not noticed in down stream of the structures in most locations.

The measurement of discharges at these locations will be very useful to estimate conveyance losses and also the proper water management. Hence, establish sufficient number of flow measuring points in the main canal with the maximum use of existing structures or install calibrated gauge posts.

A few spindles of the distribution channel gates were bent. This

may be due to faulty operation or by wild animals. This must be checked and required immediate attention. Stops can be installed on gate stem to prevent forcing of gate and bending of stem. Operation Maintenance and Inspection guidelines should be prepared for each structure and issued to all operating staff.

Equipment

The equipment available for the O&M of canal net work is not sufficient. Equipment such as draglines and/or hydraulic excavators normally needed for a project of this nature are not available. The DRPM (Water Management) is unable to attend to minor mechanical defects of regulators etc. as he has no Mechanical Engineering staff directly under him, even though mechanical equipment is available. It is very important that a few mechanical personal should be attached to the DRPM (Eng).

It appears that equipment procured under the MARD Project, and said to be in the custody of the Mechanical Engineer/ Workshop, is not readily available for O&M of irrigation facilities in System B. This was especially so in the case of the Boom truck and the mobile welding Generators. It is understood that these are being used in areas outside System B as well. Equipment purchased for the O&M of System B Irrigation facilities should be made available to System B activities on a top priority basis. Steps should be taken to purchase additional requirement of vehicles (Pick-up Trucks) and equipment required for O&M works.

Training

Establish and implement an ongoing training program for all system B O&M personnel to train them in O&M proper principles, practices. In conjunction with this training, senior O&M Engineer in MEA involved in System operations could attend the U.S. Bureau of Reclamation O&M workshop (held in February each year) and study other selected O&M activities in the U.S. for a four week period.

Conclusions

In general condition of the canal system is satisfactory. Most of the corrective actions suggested by the previous inspection team had been completed. The inspection team is satisfied about the general condition of the System B canal system and efforts of MEA staff to maintain the canal system. The observers who participated in 1992 inspection said that the conditions and practices of O&M has improved since then. However there are indicators of lack of maintenance in some parts of the canal. The team feels that O&M staff is doing an adequate job in maintaining the canal system with limited resources available.

However, additional personal and equipment are necessary to implement a satisfactory O&M program. The inspection team, therefore, expects readers of the report to give necessary assistance to O&M staff to implement recommendations. It is also suggested to develop a tracking or monitoring system to ensure the

implementation of the recommendations under direct supervision of the Chief Irrigation Engineer of MEA.

The report presents recommendations that would assist greatly in performing required system maintenance in a satisfactory and sustainable manner. The identified deficiencies need to be corrected on a priority basis. We have used the following procedure suggested in the Field Examination Guidelines. A typical recommendation has three parts to it, for example : 94 - 2 - A.

"94" Refers to the year in which the examination was conducted.

"2" Refers to the category, priority, or urgency placed on the recommendation. These are category 1, 2, or 3 as described below.

"A" Refers to the order of the recommendation in a particular report, by category (A, B, C, etc).

Recommended O&M activities within the examination report are given one of three category designations, depending on their criticality. The followings are definitions of each recommendations category.

Category 1: Recommendations involving matters of high importance which sets forth action to be taken during a prescribed period to ensure structural and project integrity and proper functioning.

Category 2: Recommendations which cover a wide range of important matters where action is needed to prevent or reduce future damage or to preclude eventual failure.

Category 3: Recommendations which are sound and beneficial to the future of project. Suggestions to initiate standards and accepted practices or to continue procedures now in progress for continued improvement in project O & M.

Recommendations

94-1-A : Inspect and clean Main and Branch Canal drains and provide appropriate crossing structures where necessary to ensure their proper operation and schedule future drain inspection and maintenance work on the preventive maintenance (PM) program.

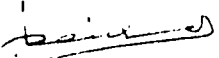
94-1-B: All main canal regulator gates should be cleaned of corrosion and painted. Gate lifting cables and guide grooves should be lubricated regularly.

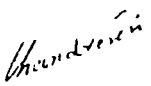
94-1-C: Replace missing oil caps, and locking devices.


94-1-D: Remove weed, plant growth and stumps from canal banks and schedule for future periodic inspection and removal on PM program.

- 94-1-E : The downstream side of the hume pipe drop structures at 9+ 450 km on the main canal needs to be backfilled and turfed. A water leak at the D/S end of the hume pipe needs repair.
- 94-1-F: The O&M road in a section along L-6 is damaged due to settlement. The cause could probably be a malfunctioning wasteway. This section of the road should be cut open, the wasteway connection examined and repaired accordingly.
- 94-1-F : Heavy erosion was observed all around the market road bridge abutments at 4+300 km on L-6. Storm water disposal has to be carefully planned and diverted away from L-6.
- 94-2-A: Implement a PM program and annual maintenance plan and schedule future needed inspection on an established frequencies with following up action.
- 94-2-B: The space between the canal lining and the bridge abutment in the main canal should be filled with a sealant at almost all the reinforced concrete transitions under the Regulator, Bridge and Wasteway structures. Refer type structure drawing.
- 94-2-C: O&M roads along the latter part of the main canal and along all the branch canals is in need of extensive repairs. Repair damage to O&M roads along canals and schedule future inspections and work on the PM program.
- 94-2-D: Assign the recommended number of Mechanical personnel to DRPM (Eng).
- 94-2-F: Establish and implement an ongoing training program for all system B O&M personnel to train them in O&M proper principles, practices. In conjunction with this training, senior O&M Engineer in MEA involved in System operations could attend the U.S. Bureau of Reclamation O&M workshop (held in February each year) and study other selected O&M activities in the U.S. for four week period.
- 94-2-F: Purchase equipment needed for the O&M of System B irrigation facilities.
- 94-2-G: Remove all hydrilla and other aquatic weeds in Branch canals. Investigate the possibility of using grass carp for hydrilla control.
- 94-2-H: Study the feasibility of using cathodic corrosion protection on the metal gates.
- 94-3-A: Investigate the possibility of using chemicals to control plants which are difficult to uproot.

- 94-3-B: Construct O&M road along the cut and cover section and syphon across Kuda Oya.
- 94-3-C: Repair chain link fencing and hand rails of the places where they are broken/or removed.
- 94-3-D: Investigate the requirement for bridges across the Main and Branch canals and implement planning, design, and construction of needed structures.
- 94-3-E: Establish sufficient number of flow measuring points in the main canal with the maximum use of existing structures or install calibrated gauge posts.
- 94-3-F: Honey combs at upstream face of end regulator of LB/L2. These areas to be chipped and apply epoxy grouting.


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