

21. Irrigation Sector

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21. Irrigation Sector

21.1 Introduction to the sector

The irrigation sector is one of the major sectors of the Nepalese economy providing irrigation facilities from both surface and ground water sources to 1,055,617 ha of land out of an irrigable area of 1,766,000 ha by the end of the Eighth Plan (1991-1996). A further 249,400 ha of land is projected to be irrigated by the end of the Ninth Plan (1997-2002). Though the area to be irrigated by the end of the Ninth Plan is expected to reach 1.30 million ha, the year round irrigation facility available by the end of the Eighth Plan was just 37%. An investment of almost Rs 25 billion is set for the Ninth Plan with an average cost of Rs. 100,000.00 per ha of development.

The areas to be irrigated lie scattered in mountains, hills and the Terai and this calls for appropriate irrigation design to meet the specific requirements of the topography in each area. Except for a few projects built with government's own resources in the past, almost all the projects now built are Farmer's Managed Irrigation Systems (FMIS) Rehabilitation Projects with the participation of Water Users Associations (WUA,s) and operated and maintained by them on completion.

The Department of Irrigation classifies irrigation projects as small, medium and large for hill and Terai areas as follows:

Types of Irrigation	Small	Medium	Large
Hill	<50ha	50-500ha	>500ha
Terai	<500ha	500-2000ha	>2000ha

21.1.1 Institutions

The Department of Irrigation (DOI) under the Ministry of Water Resources (MWR) is the key government agency charged with the development of irrigation in Nepal. It is headed by a Director General (DG) assisted by 5 Deputy Director Generals (DDGs). It has 5 Regional Irrigation Directorates (RIDs), one each in the five development regions and one District Irrigation Office (DIO) in each of the 75 districts of the country.

The Agricultural Development Bank of Nepal (ADBN) has also been providing financial resources both in terms of loans, government subsidies and technical assistance for the development of surface and ground water schemes. It had made irrigation facilities available to 139,701 ha by the end of the Eighth Plan.

Nepalese farmers have also been responsible for the development of more than 25,000 FMIS in the past which account for as much as 382,000 ha of the total irrigated area so far developed.

21.1.2 Donor Involvement

In the donor side, the two key international institutions involved are the World Bank (WB) and the Asian Development Bank (ADB) responsible for the Nepal Irrigation Sector Programme (NISP) and Second Irrigation Sector Programme (SISP) respectively, the former covering the Western Development Region, Mid-Western Development Region and Far Western Development Region and the latter Central Development Region and Eastern Development Region. Other donors involved are the Saudi Fund for Development, Kuwait Fund for Arab Economic Development, International Fund for Agricultural Development (IFAD), European Commission (EC), the Oil Producing and Exporting Countries (OPEC) Fund, Japanese International Co-operation Agency (JICA) and United States Agency for International Development (USAID).

21.2 Irrigation Sector Policy

The Ministry of Water Resources promulgated the Irrigation Policy, 2049 in 1992. It was subsequently amended four years later in 1996 and a new version brought out as Irrigation Policy, 2049 (First Amendment 2053).

The stated objectives of the Irrigation Policy are:

- To develop the irrigation system that is quickly built, sustainable, reliable and environmental friendly.
- To implement the new schemes, as well as the rehabilitation programmes in the ageold FMIS, with the farmers participation and make capable and strengthen the Water Users Groups (WUGs) towards mobilisation of financial resources, utilisation and distribution of water with a view to enable farmers to operate and maintain such schemes and systems on their own.
- To establish the reliability of irrigation services and increase productivity possible with the timely application of water in necessary amounts through effective investment in technically, financially and environmentally sound irrigation systems that can yield quick and greater returns.
- To pursue the policy of including irrigation as a principal component in the multi-purpose projects as well as establish the tradition of maintaining an up-to-date list of feasible irrigation schemes in various river basins and sub-basins.
- To maintain a regional balance in irrigation development compatible with water resources potential.
- To bring unanimity in the implementation process among the government and donor agencies involved in irrigation development.
- To gradually increase the participation of water user groups in the different stages of project implementation without any adverse impact in its effectiveness and decrease the government responsibility in construction, operation and maintenance and likewise increase the role and responsibility of user groups in different phases of programme implementation.
- To increase the research and training capability of Departmental Units in the matters of irrigation technology and management practices.
- To establish the tradition of using the levied irrigation service charge towards the development of irrigated agriculture and management upon enactment of such legal measures empowering the Water Users Association to raise the irrigation service charge and replace the practice of regular government involvement in the reconstruction of irrigation projects.

The 20 year Agricultural Perspective Plan was launched by HMGN in 1995 with agriculture as the Centrepiece with priority inputs as irrigation, fertiliser, technology, road, power and others providing support for the accelerated agricultural growth and marketing besides availing employment opportunities for the idle rural poor and raising the stagnated national economy to a rapid growth path. The Plan is heavily dependent upon groundwater as a quick means of perennial irrigation input both from shallow and deep tubewells for providing year round irrigation to cover 40% of the total irrigated area of about 1.5 million ha during the plan period.

21.2.1 Legislation

The *Water Resources Act, 2049* under Section 7 has established the priority order on the utilization of water resources and "Irrigation" comes second with "Drinking Water and Domestic Uses" occupying the first. Thus, it is seen that the Act gives due importance to the use of Water in irrigation. Other than this and general provisions on the issues related to water covering irrigation, the Act specifically mentions irrigation in 2 places in Section 4 and Section 24 Sub Section 2 (a) regarding the individual use of water as irrigation and framing rules related to irrigation.

HMGN has also brought into practice the *Irrigation Regulation, 2056*, exercising the power to frame rules under Section 24 of the *Water Resources Act, 2049*.

This Regulation, among other things, focuses on the formation of the water users group, registration with the DIO, its election and its duties and responsibilities. It also mentions the formation of the Users Co-ordination Group for the coordinated use of water from different canal reaches and its registration with the DIO. It also talks about the establishment of O&M fund for the operation and maintenance of canals to be operated by the user group. As provided in the Regulation, HMGN can hand over the project or any part of it to the users group. It also provides for the constitution of (1) an Irrigation and River Control Committee under the chairmanship of the Chief District Officer, its duties and responsibilities, (2) Service Charge Committee under the chairmanship of the DIO chief and (3) a Project Board under the chairmanship of the Secretary, Ministry of Water Resources for the implementation of large irrigation projects.

With this Regulation coming into force, its predecessor i.e., Irrigation Regulation 2045 has been repealed.

21.3 Guidelines and Standards

Table 21.1 Principal Irrigation Sector Reference Documents

Area	Published Documents	Agency Responsible
Policy	<i>Irrigation Development Policy for The Fulfillment of Basic Needs, 2045</i>	MWR
	<i>Irrigation Policy, 2049</i> <i>(First Amendment, 2053)</i>	MWR
	<i>Agricultural Perspective Plan</i>	NPC/ADB
Legislation	<i>Water Resources Act, 2049</i>	MWR
	<i>Irrigation Regulation, 2056</i>	MWR
Standards and Specification	<i>Procedural Guidelines for Farmer Managed Surface Irrigation Systems, January 1999</i>	NISP, DOI, MWR
	<i>Operational Procedural Manual</i> <i>(Revised August 1997 - updated June 2000)</i>	SISP, DOI, MWR
	<i>Irrigation Users Group Manual, 2050</i>	NPC
	<i>Irrigation Management Turnover Procedures, 2055</i>	DOI, MWR
	<i>Rate Analysis Norms, DOI, 2056</i>	Approved by HMGN
Planning	Section dealing with this topic has been dealt in detail in steps 1 to 6 in <i>Procedural Guidelines for Farmer Managed Surface Irrigation Systems (FMIS), January 1999</i> and in Chapter 4 of <i>Operational Procedural Manual (Revised August 1997 - updated June 2000)</i>	NISP, DOI, MWR with support from the World Bank. SISP, DOI/MWR with support from the Asian Development Bank.
Design	<i>Planning, Design and Strengthening Project (PDSP) Field Design Manuals</i> in 21 Volumes. Prepared by Sir McDonald and Partners.	Prepared under Planning and Design Strengthening Project, UNDP (NEP/85/013)/World Bank.
	<i>M1. General System Planning</i>	

Area	Published Documents	Agency Responsible
	M2. <i>Survey and Mapping</i> M3. <i>Hydrology and Agro-Meteorology</i> M4. <i>Soils and Land Use</i> M5. <i>Sociology and Farmer Participation</i> M6. <i>Groundwater Irrigation</i> M7. <i>Headworks, River Training Works and Sedimentation</i> M8. <i>Distribution Systems, Canals and Canal Structures</i> M9. <i>Drainage</i> M10. <i>Engineering Cost Estimating and Economics</i> M11. <i>Infrastructure Planning</i> M12. <i>Tender Documents and Construction</i> M13. <i>Operation, Maintenance and Management</i> G1. <i>Upgrading of Farmer Built and Operated Systems</i> G2. <i>Shallow Tubewell Development</i> G3. <i>Small/Medium Scale Project Development</i> G4. <i>Rehabilitation of Government Schemes</i> D1. <i>Interim Field Design Manual</i> D2. <i>Field Design Manual</i> D3. <i>Standard Structures Designs</i> D4. <i>Simulation Model Manual</i>	
Environment	<i>Environment Protection Measures for Hill Irrigation Schemes in Nepal. Field Handbook</i>	DOI/MWR with support from ILO/UNDP
Construction	Sections dealing with this topic have been dealt with in some detail in sub sections under Step-12 of the <i>Procedural Guidelines for FMIS</i> and Chapter 8 of the <i>Operational Procedural Manual</i> .	NISP, DOI, MWR with support from the World Bank. SISP, DOI, MWR with support from the Asian Development Bank.
O&M	Section dealing with this topic has been described under the heading O&M Responsibilities in Section Step-14 of the <i>Procedural Guidelines of FMIS</i> and under heading Operation and Maintenance in Chapter 10 of the <i>Operational Procedural Manual</i> and M13 <i>Operational, Maintenance and Management of the PDSP Manual</i>. Study on O&M of irrigation projects under NISP was completed recently and the report is being finalised.	NISP, DOI, MWR with support from the World Bank. SISP, DOI, MWR with support from the Asian Development Bank and UNDP Study conducted with the support from the World Bank

21.4 Key Processes in the Project Cycle

At present irrigation activities are going on in all the five development regions with ADB involvement in the first two and WB in the remaining three beginning from East to West. These two key institutions have been instrumental in framing irrigation procedural guidelines for implementation of mostly FMIS and some new irrigation systems, which do not exceed 2000 ha in size in the Terai, and 500 ha in the hills and mountains. The technical procedures followed in both are almost similar other than the administrative procedures followed by the Banks as the lending institutions. Other institutions and donor countries are also following these guidelines in implementation of irrigation projects. Key processes involved in the irrigation project cycle are described in brief below and illustrated in Figure 21.1.

21.4.1 Information Dissemination

In a bottom-up process, the farmers obtain information and application forms about the candidate irrigation projects from among the District Irrigation Office (DIO), District Agriculture Development Office (DADO), Agriculture Service Centre (ASC) and District Development Committee (DDC). Simultaneously, DIO and DADO also provide information about the irrigation programme and procedures to the respective Village Development Committees (VDCs) of potential irrigation projects. The Regional Irrigation Directorate maintains an inventory of existing projects and data on water resources availability in the river sub-basins with the help of the Regional Office of the Department of Hydrology and Meteorology (DHM). The Department of Irrigation (DOI) at the centre co-ordinates the dissemination to media and policy makers.

21.4.2 Application for Project Funding

At the farmers level, farmers hold group discussions and form adhoc Water Users Association (WUA) Committee. The WUA Committee prepares the programmes and fills in the application forms and submits them to DIO through ASC with an upfront cash deposit of Rs 50 per ha. The DIO in turn screens to verify the applications received whether they meet the selection criteria for the identification study.

21.4.3 Project Identification

The farmers at this stage liaise and discuss proposals with the Identification Team to substantiate their demand. The DIO and DADO/ASC staff make site visits to collect data, prepare identification reports and classify the schemes as major or minor, rehabilitation or new projects.

21.4.4 Prioritisation for Feasibility Study

In every DIO, a District Appraisal Committee (DAC), chaired by the officer in charge of DIO and comprising the district chiefs of the Department of Agriculture (DOA) and the Agricultural Development Bank of Nepal (ADBN), exists for the appraisal of projects from the Identification Study. The District Irrigation Engineer (DIE) presents all the Identification Study reports to DAC for their discussion and prioritisation for further study.

21.4.5 Feasibility Study or Feasibility Study with Detailed Design and Cost Estimates for Minor Projects

The DIE at this stage prepares programmes for feasibility studies for prioritised projects including detailed designs and cost estimates for minor projects. DIO and DADO staff or local consultants undertake the feasibility study based on discussion and information shared with WUA on identification of sites and cost estimates.

21.4.6 Appraisal and Approval of Major Irrigation Project

The DAC appraises the feasibility reports and recommends to the Regional Appraisal and Approval Committee (RAAC). The Regional Irrigation Director chairs the RAAC with the Regional Agriculture Director, Regional Director, National Planning Commission (NPC) and the Controller of ADBN as members of RAAC, and invites other officials as deemed necessary. Copies of the feasibility report are distributed to RAAC members prior to the meeting. If the cost estimate of the project is greater than Rs. 10 million, the approval of DG/DOI is sought for the clearance of the feasibility report. At the regional level, a Mobile Irrigation Team (MIT)

undertakes the site verification and appraises the project feasibility report. For a major rehabilitation project, the DIO with the help of the WUA undertakes the detailed surveys for submission to the Regional Irrigation Directorate (RID). The MIT checks the detailed design and cost estimates with its recommendations following the site verification. The Project Implementation Committee at DOI at the centre undertakes the technical review, endorsement of the feasibility study and detailed design.

21.4.7 Approval of Project and Tender Document Preparation

Depending on the cost estimate of the project, it is either cleared by RID or RAAC or DG/DOI. If the cost is less than Rs 1 million, it is cleared by RID if greater than Rs 1 million and less than Rs 10 million it is vetted by RAAC with the provision that site verification to be done by MIT for cost above Rs 5 million. For the cost above Rs 10 million, the DG/DOI approves the project based on the recommendation of the Project Implementation Committee (PIC) at the DOI. Once the project is approved, all the key players ie. RAD, DIO and DADO are informed of the decision Likewise, the DIO informs DDC and WUA. DIO at this stage finalises tender documents and detailed cost estimates with WUA including cost sharing based on the prevailing irrigation policy be it in cash or labour.

21.4.8 Resource Mobilisation

The DIO prepares the Project Implementation Plan (PIP) and program working together with WUA for approval of RID. RID prepares the budgetary requirement for the project by March every year for inclusion in the Annual Budget upon clearance by DOI. At this stage, the upfront cash is also made up to 0.5% of the total cost estimate with the deposit of the balance amount by WUA to the joint accounts of WUA/DIO.

21.4.9 Formalise Farmer Organisation and Participation

As more formal commitments are required from the farmers (now an adhoc WUA Committee only) after the project approval towards the successful implementation of the project, the step to be taken is to formalise the WUA constitution and draw up bylaws for the WUA. The DIO with the help of an Association Organiser (AO) helps the farmers to that end. The WUA constitution is formalised following a group meeting (General Assembly) after all officials have been democratically elected and they have given their approval to it. The next step is the registration of WUA. As provided in the Irrigation Regulation 1999, the WUA is to be registered with the District Irrigation Office (DIO). Prior to the promulgation of this Regulation, WUA was registered with DWRC which is still the deciding authority in the matters of irrigation use and river control issues.

After the WUA is registered, the WUA signs the Memorandum of Agreement with DIO in front of the General Assembly. The Agreement among other things contains the breakdown of work which each party agrees to undertake in completing the project. The DIO undertakes the baseline survey to set benchmarks for PBME survey to be conducted upon completion of the project. The sociologist in MIT assists in WUA training towards mobilisation of resources for the construction of the project.

21.4.10 Construction

The DOI part of the work is tendered. The DIO or RID or DOI awards the successfully bidding contractor based on the authority in FAR. However, construction work is only to begin upon fulfilment of the percentage share in work being contributed by WUA as per irrigation policy (presently 15% of total). In order to maintain transparency between the WUA and DIO in the matters of construction supervision, a joint Construction Committee of 10-15 persons drawn from the beneficiaries with at least four WUA members is constituted to supervise and monitor the DOI part of the work as well as that of WUA as mentioned in the Memorandum of Agreement. The DIO staff are also to supervise the works in the matter of quality control and construction management. The Mobile Irrigation Team (MIT) and Monitoring Evaluation Team (MET) from RID are also monitoring the progress of works and their quality control.

21.4.11 Commissioning

It is a very important phase of the project cycle. The WUA has to satisfy itself of the work so far executed. WUA makes a walkthrough with DIO and DADO/ASC staff over all the works done to identify defects and operational problems. DIO on its part makes sure that the contractor rectifies defects during the maintenance period besides any extra works to make the system complete. DIO prepares the Completion Report and organises signing with WUA of the Certificate for Work Completion once the WUA confirms works undertaken under the MOA are complete. The RID receives a copy of the Completion Report and a Certificate and maintains in its Management Information System (MIS) records.

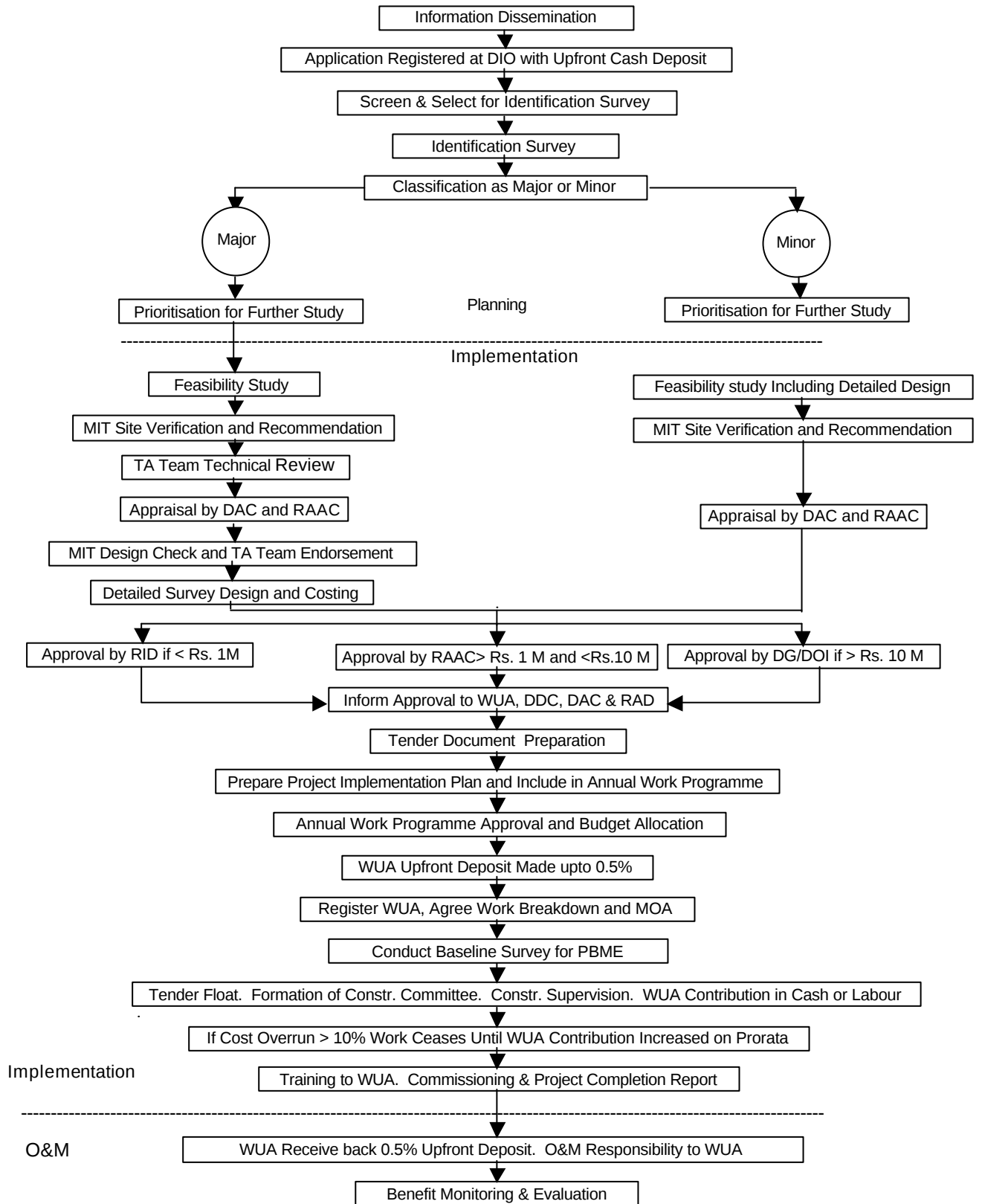
21.4.12 Operation and Maintenance

This is yet another important phase of the project cycle to see that the project completed is fully operational and there is a strong will to operate and maintain it on the part of the WUA. The WUA has, therefore, to be fully capable through training and mobilization of resources. It receives back its 0.5% cash deposit as seed money for future O&M. Beneficiary farmers and the WUA undertake the full responsibility of operation and maintenance. In order to be capable towards this, the WUA with the help of a NGO strengthens its linkages with support services and line agencies. The DIO continues to advise WUA and beneficiary farmers on their responsibility for O&M and supervise O&M and water management training. The RID though extricated of O&M budget makes provisions for unforeseen disasters.

21.4.13 Benefit Monitoring and Evaluation

The RAD conducts a PBME survey at this stage through a Regional Monitoring Committee with Regional Agricultural Director as Chairman to monitor the overall impact of the project with the earlier conducted baseline survey as benchmark, the DIO and WUA providing all the necessary support to the Committee. The schematic diagram of the Project Cycle is given in Figure 21.1.

Figure 21.1 IRRIGATION PROJECT CYCLE



21.5 Surface Water Irrigation

21.5.1 Project Identification

As a general principle, all new irrigation schemes should be based on the river basin planning concept meeting agricultural needs in a sustainable manner and efficiently using a combination of water diverted from the surface stream and water seasonally drawn from groundwater storage or pond storage.

Upon dissemination from various quarters, candidate irrigation projects are generated at DIO. They are, however, yet to be identified and their status known. The DIO should pool together all the available information including Geographical Information System (GIS) where this is available to give a boost towards the identification and pre-feasibility of such projects. They are:

- 1:50,000 topographical maps relevant to district or region
- 1:50,000 soils, land use and land capability maps relevant to district or region (Land Resources Mapping Project - LRMP)
- 1:50,000 aerial photographs relevant to district or region
- Climatological records of nearby meteorological stations and hydrological records from nearby gauging stations.
- 1:125,000 geological maps (LRMP relevant to district or region).

The identification visit should be conducted by an engineer and experienced overseer of DIO. It is necessary to have some beneficiaries at the site to lead the identification team to the proposed project site and interact with the team.

The site visit will include:

- An inspection of the general topography and where relevant geology (particularly for hill projects) checking the relative elevations of the proposed intake and the commanded area with the help of an Abney level or altimeter and the maps of the proposed area already in possession.
- An inspection of existing land use, cropping and soils on the commanded area.
- An inspection of potential water sources (river, springs, groundwater)
- Discussions with local farmers and government officials on water sources and availability, crops, markets, land ownership, existing water right, willingness to participate and share the cost of implementation and such other issues relevant to development.

Following this identification visit, the next phase of the study ie, pre-feasibility is to be decided depending on the potential of the identified projects although some small potential projects can directly proceed to the feasibility stage.

21.5.2 Pre-feasibility Study

A pre-feasibility study is intended to confirm whether a project is worth studying in depth for a full feasibility level and conducted by a multi-disciplinary team of an irrigation engineer, hydrologist, agriculturist, social scientist and a small survey party of overseers.

The general features of the study are as follows:

- i. As a first step towards the study, the catchment area and proposed project command area are to be located on the topographic map and the aerial photos. Likewise, the proposed intake and the main canal alignment are to be tentatively located on the map and air photos and a tentative system layout made.

- ii. The general topographic mapping should be confirmed by limited spot levelling and distance measurement between key features
- iii. Preliminary hydrological analysis for the identified sources should be conducted using the available data to find out the availability of water for the proposed project, the likely magnitude of floods, low season flows, sediment and soil erosion problems.
- iv. An assessment of land capability and suitability for irrigated agriculture should be made from site inspection and a limited survey.
- v. Possible alternatives for water source, main canal and distribution canals should be studied.
- vi. Preliminary cropping patterns and associated water requirements should be derived to firm up the potential irrigation area with the rule of thumb of 1 l/sec per ha for summer crop and 0.4 l/sec per ha for winter crop for the Terai and 2 l/sec per ha and 0.8 l/sec per ha for hills.
- vii. Possible sources of construction materials should be identified at the proposed site.
- viii. Initial environmental and social assessments should be listed (scoping, possible IEE).
- ix. Assessment of roads and access should be made.
- x. Assessment of marketing facilities for envisaged crops should be made.
- xi. Assessment of socio-economic impact should be made.
- xii. Discussions should be held with beneficiary farmers on their willingness to participate and share their part of the cost and implementation of the project.
- xiii. Costs and benefits should be estimated to justify the implementation of the project.
- xiv. Further studies needed to raise the project to the feasibility should be established.

For rehabilitation projects, the focus of the pre-feasibility study is somewhat different because the system layout is already known. The study should address:

- i. Defects in the existing system and ways to rectify them
- ii. The cost of rectification and the likely increase in benefit
- iii. Viable alternatives to full rectification and their costs
- iv. Modification of the operating system to improve system efficiency.

At the end of the pre-feasibility study, it should be possible to decide whether to proceed with a feasibility study having already known the project features, its financial viability and the interest of project beneficiaries.

21.5.3 Feasibility study

The main objective of a feasibility study is to fully assess the feasibility of project implementation in both technical and economic terms and to form a basis for financing by external agencies or government.

Most of the main detailed survey is carried out at the feasibility stage. Based on this, the system layout is fixed and canals and structures are designed. Accuracy in the survey work is of utmost importance as the successful functioning of the system is dependent on construction at the correct location and level. Accuracy of contour elevation (0.25 m interval) for the layout of tertiary and field channels is very important and must be cross checked with a network of benchmarks (at 0.5 km interval). The main activities are as follows:

- Locate and survey intake and main canal alignment and fix benchmarks. Prepare site plan of intake, strip plan and profile of main canal showing benchmark on the location.
- Fix the major hydraulic structures along the main canal and carry out site surveys. Prepare site plans of major hydraulic structures.

- For all new hill and Terai projects, carry out topographic surveys using ground survey techniques. For large Terai projects, carry out aerial survey with ground control and then produce topographical maps to suitable scale using ground control survey data. This is better done under a contract with a specialized firm.
- For major projects, prepare cadastral maps of the command area with the statement of full land records of plot number, owner's and tenant's name. The map should be prepared in GIS and land records computerised to facilitate updating of land records every year.
- For surface water schemes, carry out topographical survey along the river channel including cross-sections at suitable intervals showing existing banks, riverbed condition etc.
- In the case of a rehabilitation project, locate structures in the canals to be rehabilitated and prepare dimensioned sketches of canals needing repairs on the existing maps.
- Develop an appropriate cropping pattern from among the adopted alternatives.
- Establish needs for processing and marketing of produce.
- Estimate crop water requirements on a half monthly basis balanced with the 80% reliable half monthly river flows.
- Establish the sources and availability of water in average and dry years and maximum flows for the headwork and intake design and establish maximum flows from hydrological records of the streams for cross drainage works in the main canal and subsidiary canals using flood frequency of 1 in 100 or more for major structures and 1 in 50 for medium structures where limited flow records are available.
- Determine the area to be irrigated.
- Estimate water balance at the diversion site considering the existing use and likely future uses upstream and down stream on the river below to avoid future conflicts. For shortage in water supply, supplement with groundwater in Terai and pond storage water in Terai and hills to meet the water balance.
- Design the irrigation and drainage system in river valleys in Terai for multiple cropping in consultation with WUA.
- Design appropriate desander/desilting basins to remove sediments from the canal systems for large projects.
- Consider and screen alternative solutions for distribution of water.
- Prepare and cost outline designs of intake main canal, branch and appurtenant structures in main and branch canals, based on the update Rate Analysis Norms prepared by DOI and approved by HMGN.
- Establish other infrastructure needs.
- Estimate benefits (direct and indirect)
- Carry out economic and financial analysis to calculate incremental benefit/cost ratio (B/C), net present value (NPV) and internal rate of return (IRR), for with and without project, and various project alternatives.
- Review environment, social and economic impacts of project development and include costs for mitigating measures.
- Establish the commitment of project beneficiaries to get involved in the entire project cycle and share their part of the implementation cost.
- Establish the institutional arrangements required for the project operation and maintenance.
- Establish the mechanism of raising service charges from the project beneficiaries.
- Prepare a Project Implementation Plan.
- Prepare a financial plan

The following maps and survey drawings should be produced :

- Topographic map of the project showing key features and layout of the canal system at the scales shown:

Large/medium Terai project	1:5000
Small Terai project	1:2500
Large/medium hill project	1:2500
Small hill project	1:1250
- Site Plan of the headworks with 1m contour interval for hill projects and 0.25m for Terai projects.
- Topographic maps with above contour intervals should have the same scale as the new cadastral maps in Terai and hills when done in metric system.
- Longitudinal section of the source river

Steep river	500 m	u/s and d/s of headworks
Medium river	2 km	u/s and d/s of headworks
Large river	5 km	u/s and d/s of headworks
- Cross- sections of the source river:

Steep river	100 m intervals	u/s and d/s of the headworks
Medium river	250 m intervals	u/s and d/s of the headworks
Large rivers	500 m intervals	u/s and d/s of the headworks
- Longitudinal section of the main canal.
- Cross- sections of the main canal at 100 m and 250 m intervals in hill and Terai respectively.
- Strip plan of the main canal alignment with contour interval 1 m for hill projects and 0.25 m for Terai projects
- Site plans of major hydraulic structures (principally cross-drainage structures) with contour interval of 1 m for Hills and 0.25 m for Terai.

Data requirements to support a feasibility study typically include:

- Aerial photography at 1:10000 scale with ortho-photo mapping or topographic survey at 1:5000.
- Site surveys of major structures e.g., headworks and major structures location.
- Soil survey and land capability mapping at 1:25,000 (semi-detailed).
- Survey of existing crops, cropping patterns and agricultural practices.
- Hydrological/meteorological data to support analysis of flood frequency, dry year flows, sediment run-off, erosion, crop water requirements etc.
- Geo-technical data at major structure sites including headworks.
- Permeability tests along routes of major canals.
- Tests on materials at identified sources of construction materials.
- Cost and benefit estimating data (e.g. construction costs, crop yields and prices etc).
- Survey of land ownership, ward boundaries for initial establishment of tertiary units.

21.6 Groundwater Irrigation

Almost 20% of the irrigated area in Nepal is from groundwater available in varying quantity and quality in the Terai plain with the Bhabar Zone below the foot-hills and above the plain recharging the supply put at approximately 6 billion cubic metres of which about 10% is so far exploited.

Procedures for groundwater investigation applications which are different from surface water projects are described below:

21.6.1 Data Collection

- Geological maps (1:125,000) from the Department of Survey to provide information on the sub-soil strata. Hydrogeological maps from the Groundwater Development Board in the Department of Irrigation.

21.6.2 Project Identification

- Visit the project site and discuss with farmers about the possibility of groundwater.
- Prepare a list of existing dug wells, hand pumps and shallow tubewells with their locations in the project area and measure their depths.
- Establish through discussion whether wells can be used for drinking water and fish farming.
- Establish through discussion whether diesel or electricity is available in the project site to decide the type of pumps to be used during the construction phase.

21.6.3 Pre-feasibility Study

- Prepare 1:50,000 scale hydrogeological map, list the existing wells with measured depths and locations and determine the seasonal fluctuation of the groundwater table. Conduct random pump tests on existing wells for drawdown and recharge characteristics.
- Determine the groundwater potential of the project area by geophysical survey (seismic refraction, electric resistivity methods).
- Check and verify subsoil strata interpreted from the geological maps, conduct borings at roughly 10 km intervals in the project area, depth 30-40 m for shallow wells and 120-250 m for deep wells of 4" diameter for shallow and 6-10" diameter for deep wells
- Determine the rate of discharge, recharge and drawdown through pump tests in the test holes. Drawdown of 10 to 40 m in a deep well is considered acceptable.
- Take borehole samples at every 2 m depth to define the physical properties of subsoil layers.
- Take pumped water samples for laboratory tests to determine irrigation suitability.
- Take permeability and resistivity tests to check the well efficiency.
- Determine the discharge-pressure relationship in an artesian well by measuring the pressure of water gushing forth and discharge of water through V notch.
- Confirm with Nepal Electricity Authority (NEA) whether electricity will be available for operating electric pumps in the project area.

21.6.4 Feasibility Study

There will be enough indications at the pre-feasibility study whether to proceed for feasibility or not. If yes, take the following activities to refine the works already undertaken at the pre-feasibility level study.

- Review the performance of the test wells installed during the pre-feasibility study stage.
- Confirm the groundwater potential in the project area by carrying out additional test boring every 5 km in the project area and conducting several tests as mentioned in the pre-feasibility.
- Prepare a more detailed hydrogeological map of the whole project area with the update performance results of drawdown, permeability, recharge, bore logs etc of all the test wells.

21.6.5 Design and Construction

Having obtained all information about the characteristics of the wells to be installed, shallow or deep tubewells can be constructed in the project site with the procurement of contract for each

category with detailed specifications for pipe assemblies including the appropriate pumps to go with them. A shallow well unit and deep well unit have generally irrigating potentials of 2.5 to 4 ha and 40 - 120 ha blocks respectively.

All the data generated during the construction of new tubewells should be entered into the hydrogeological map of the project to get more refined results later.

21.7 Environmental Assessment

At the feasibility study stage environmental studies from Initial Environmental Examination (IEE) to full Environmental Impact Assessment (EIA) are needed to be conducted under the *Environment Protection Rules, 2054* pertaining to Rule 3 Schedules 1 and 2 depending on the size of the irrigation project as follows:

	Terai Plain	Hill Valleys	Hill & Mountain with Steep Gradient
Category A requiring IEE	25-2000 ha	15-500 ha	10-200 ha
Category B requiring EIA	> 2000 ha	> 500 ha	> 200 ha

Other than above, IEE will apply for areas irrigating more than 500 ha in the Terai, more than 200 ha in the hill valleys and more than 100 ha in the hill mountain areas with steep gradient under the new rehabilitation irrigation systems.

IEE will also apply in any water resources development activity displacing 25-100 persons having permanent residence, flood control through dams in the Terai and river control in areas exceeding 1 km in length.

Likewise, EIA will apply in any water resources development activity displacing more than 100 people having permanent residence, multipurpose reservoirs and inter-basin water transfer and use.

From the criteria given above, all the irrigation projects to be constructed whether new or rehabilitation will have to undergo IEE or EIA depending on the size of the project or the degree of impact. An EIA may be required after having gone through IEE.

A checklist of environmental parameters in irrigation as a model sample given in Form 17 of *Procedural Guidelines for Farmer Managed Surface Irrigation Systems* illustrates the assessments of environment impact from the following aspects during the entire cycle of the project implementation indicating the damage caused to the environment with recommended feasible protection measures.

- Environment effects due to project location
- Environment problem relating to design
- Problems during construction stage
- Problems relating to operation
- Realization of enhancement measures
- Overall environment review criteria

All projects have to be individually examined in those six aspects and sub-headings under them for them to be implementable. The mitigation measures with their costs mentioned in the IEE and EIA reports have to be included in the total cost estimate of individual projects to make them environmentally sound. The model sample to be used both for IEE and EIA is presented in Table 21.2.

Table 21.2 Checklist of Environmental Parameters in Irrigation Projects

Actions Affecting Environmental Resources and Value (A)	Damages to Environment (B)	Recommended Feasible Protection Measure (C)	IEE (D)			
			No Significant Impact (D1)	Significant Impact		
				Small (D2)	Moderate (D3)	Major (D4)
a. Environmental Effects Due to Site Selection						
i. Encroachment into forests/swamplands	i. Loss of precious natural resources.	i. Careful planning/design/operation plus offsetting				
ii. Impediment to movement of wildlife, cattle and people	ii. Impediment of wildlife and disruption of local economic/socio-economic activities					
iii. Impediment of historical/cultural monuments, buildings and values	iii. Loss of precious values					
iv. Conflicts in water supply rights	iv. Socio-economic inequities					
v. Regional flooding/drainage hazards						
b. Problems from Oversights in Planning and Design						
i. Watershed erosion	i. Project benefits impaired	i. Appropriate attention in project formulation				
ii. Downstream water quality problem	ii. Impairment of downstream beneficial uses	ii. Careful planning/design operation				
iii. Suitability of water supply quality for irrigation	iii. Project benefits impaired	iii. Careful planning/design operation				
iv. Overpumping of groundwater	iv. Water right conflicts, salinisation, ground subsidence	iv. Careful planning/design operation				

Actions Affecting Environmental Resources and Value (A)	Damages to Environment (B)	Recommended Feasible Protection Measure (C)	IEE (D)			
			No Significant Impact (D1)	Significant Impact		
				Small (D2)	Moderate (D3)	Major (D4)
v. Adequacy of drainage	v. Projects benefits impaired	v. Careful planning/design operation				
vi. Land tenure problems	vi. Projects benefits impaired	vi. Careful planning/design operation				
vii. Farmer credit limitation	vii. Projects benefits impaired	vii. Careful planning/design operation				
viii. Feasibility of cooperatives	viii. Projects benefits impaired	viii. Careful planning/design operation				
ix. Feasibility of water users association	ix. Projects benefits impaired	ix. Careful planning/design operation				
x. Disruption of existing farmer cooperative system	x. Projects benefits impaired	x. Careful planning/design operation				
xi. Use of agricultural chemicals	xi. Project benefits impaired plus damage to downstream water quality	xi. Careful planning/design operation				
xii. Selection of pesticides	xii. Project benefits impaired plus environmental contamination	xii. Careful planning/design operation				
xiii. Land use conflicts	xiii. Social conflicts/project benefits impaired	xiii. Careful planning/design operation				
xiv. Inequities in water distribution	xiv. Social conflicts/project benefits impaired	xiv. Careful planning/design operation				
xv. Canal maintenance	xv. Project benefits impaired	xv. Careful planning/design operation				
xvi. Passageways	xvi. Loss of wildlife plus disruption of local economic/socioeconomic activities	xvi. Careful planning/design operation				
xvii. Scouring hazards	xvii. Project benefits impaired	xvii. Careful planning/design operation				

Actions Affecting Environmental Resources and Value (A)	Damages to Environment (B)	Recommended Feasible Protection Measure (C)	IEE (D)			
			No Significant Impact (D1)	Significant Impact		
				Small (D2)	Moderate (D3)	Major (D4)
c. Problems During Construction Stage						
i. Erosion control	i. Loss of soil plus damage to downstream water quality	i. Careful construction stage planning plus monitoring				
ii. Other construction stage hazards	ii. Adverse environmental effects	ii. Careful construction stage planning plus monitoring				
iii. Monitoring during construction	iii. Without this, serious adverse effects likely to occur	iii. Provision of monitoring				
d. Problems Stemming from Deficiencies in Operation						
i. Inadequate O&M	i. Loss in Project efficiency	i. Careful operation plus monitoring				
ii. Adverse soil modifications	ii. Loss in Project efficiency	ii. Careful operation plus monitoring				
iii. Changes in groundwater hydrology	iii. Adverse effects on other water and land use	iii. Careful operation plus monitoring				
iv. Water-oriented disease hazards	iv. Increase in communicable disease in service area and region	iv. Careful operation plus monitoring				
v. Toxic chemicals hazards	v. Adverse effects on aquaculture and downstream water quality	v. Careful use of agricultural chemicals including training				
vi. Fertilizer runoff hazard	v. Adverse effects on aquaculture and downstream water quality	v. Careful use of agricultural chemicals including training				
vii. Operations monitoring	vii. If not provided, operations inefficiency is likely	vii. Provision of monitoring				
viii. Aquaculture water supply	viii. Serious aquaculture losses	viii. Careful operation to ensure continuing supply				

Actions Affecting Environmental Resources and Value (A)	Damages to Environment (B)	Recommended Feasible Protection Measure (C)	IEE (D)			
			No Significant Impact (D1)	Significant Impact		
				Small (D2)	Moderate (D3)	Major (D4)
e. Realization of Enhancement Potentials						
i. Community water supply in service area	i. Non realization of very valuable Socio-economic gains	i. Project component for this				
ii. Aquaculture in service area	ii. Non realization of very valuable Socio-economic gains	ii. Project component for this				
f. Overall Environmental Review Criteria						
i. Unwarrented losses in precious resources	i. Long-term environmental and economic losses	i. Careful planning				
ii. Unwarrented accelerated use of resources for short- term gains	ii. Long-term environmental and economic losses	ii. Careful planning				
iii. Adverse effects on national energy exchange situation	iii. Adverse effects on national economics	iii. Careful planning				
iv. Unwarrented hazards to endangered species	iv. Long - term environmental losses	iv. Careful planning				
v. undersirable population migration to urban sector	v. Identification of urban socio-economic problems	v. Careful planning				
vi. Increase in affluent/ poor income gap	vi. Intensification of national socio-economic imbalances	vi. Careful planning				

21.8 Social Assessment

This study is done together with IEE or EIA at the feasibility stage of the irrigation project, combined with the feasibility study or as a separate study together. An irrigation project like any other development project has social impacts. These impacts have positive or negative effects depending on whether they have helped towards the betterment of society or adversely affected people's lives. There are many groups within the community affected by the project such as: project beneficiaries, as well as project-affected people who may be poor and disadvantaged in many ways. These and other related issues should be studied under the social impact assessment. They are as follows:

- Beneficiary or user group
- Project affected people
- Poor and depressed people
- Gender issues
- Impact on local culture and cultural heritage
- Impact on local economic activities.

The social assessment study team should identify the beneficiaries or the user group and find out their feelings and aspirations about the project and the extent of their involvement and cooperation in realizing the project. In fact, the user groups will have a sustained living and further prosperity in the success of the project. So their role in the successful implementation of the project is very vital from the point of the cooperation they extend in implementing the project and their commitment in operating and maintaining it on completion. The social assessment team should take this opportunity to motivate the user groups towards this goal.

The team should also meet all project affected people who have either lost their habitation and land or means of their livelihood to hear their grievances and mitigate them by providing employment in the upcoming project and in severe cases making such employment available even in the O&M phase. The team should also identify the poor and depressed to see if the upcoming project would be of any help to alleviate poverty in the project area by availing them opportunity for labour.

Gender issues should also be tackled through enhancement programs such as water supply especially in the hills where the women find very difficult to collect a pail of water. Women's voice should be recognised in the implementation of the project through appointing them as members of the WUA. Where temples and shrines have come on the way of construction, they need to be rehabilitated to maintain the cultural heritage of the area intact.

The construction activities in the project area will bring economic benefits with opportunities for employment for people lying idle and this will help to develop the area. With all these good things happening, it may be likely that some bad things like environmental degradation, heavy drinking, gambling and prostitution may also creep into the project area with the induction of a large labour force from outside.

Any social cost on account of this assessment has to be added to the project cost to maintain the social fabric of the project.

21.9 Project Implementation Plan

The project implementation Plan (PIP) is a concise summary of all activities beginning with the approval of the project leading to its completion. The PIP shows the activities in sequence to be undertaken with key milestones dates for completion of each activity and responsibility of each organization involved in the activity.

Depending on the cost estimate of the project, it is either cleared by RID, RAAC and DOI. Once the project is approved, then the process of detailed engineering begins with the preparation of cost estimates, which is the responsibility of DIO. The detailed design is checked by the MIT from RID.

At this stage the adhoc WUA is formalized with its formation and registration with DWRC, the CDO as its Chairman issuing the registration certificate.

WUA raises the balance upfront cash deposit to 0.5% of the cost estimate to be placed in the joint WUA/DIO account and agrees to bear the percentage share of the cost of construction on behalf of the beneficiaries as per the irrigation policy. Likewise, DIO prepares the annual budget and passes on to RID for the part of the share to be borne by DOI. There is also work breakdown to be done on each side and a memorandum of agreement is signed between DIO and WUA to this effect. Before the floating of the tender for the part of the work to be done by DIO, it undertakes the baseline survey to establish the benchmarks for the project to be checked, followed by the PBME survey.

On preparation of the bidding documents from the standard bid documents by DIO for the DOI part of works, bids are invited from among the classified contractors. The DIO can directly award the construction works to the WUA where the cost of works does not exceed Rs 2.5 million and the WUA is capable enough to handle the job. The WUA Chairman, Vice Chairman and Secretary of WUA are invited to attend the pre-bid meeting with the contractors. The bid documents among others clearly mention the role of WUA in the construction supervision. A representative of WUA is involved in the tender evaluation and WUA informed of the tender award to the successful bidder. However, no agreement is to be signed with the bidder till land acquisition and water right issues are resolved by WUA.

Before the construction begins, a Joint Construction Committee of 15-16, comprising members from DIO, WUA (minimum 4 elected members) and other project beneficiaries, is constituted to oversee the construction works on the part of DOI as well as WUA in order to maintain full transparency and receive full co-operation from the users during the entire construction period. The Committee will also see that the quality control of works is maintained at all levels. While the construction work is going on, DIO gives training to WUA for the efficient operation of the system on completion.

Upon completion of the construction works, test running of facilities is done by DIO and WUA for rectification of any defects during the maintenance period and a completion report is jointly prepared and certificate of work completion given to the contractor.

The next phase of work for DIO is to prepare O&M plan together with WUA and return the upfront cash deposit of 0.5% of the project cost to WUA for bearing the part cost of O&M.

The PBME survey of the project impact is carried out after 1 year of completion of the project by RAD and main indicators checked with the benchmarks set by the earlier baseline survey prior to construction of the project. A typical PIP of the irrigation project is presented herewith in Table 21.3.

Table 21.3 PROJECT IMPLEMENTATION PLAN (PIP)

NAME OF PROJECT _____ DISTRICT _____

ACTIVITIES (Responsible Organisations)	YEAR						YEAR						YEAR					
	J-F	M-A	M-J	J-A	S-O	N-D	J-F	M-A	M-J	J-A	S-O	N-D	J-F	M-A	M-J	J-A	S-O	N-D
Project appraisal and approval (DIO, RID & DOI)																		
Detailed engineering survey (for Major Rehab.) (DIO/WUA)																		
Detailed engineering design and cost estimation (DIO)																		
MIT check designs (RID)																		
Formation of WUA & registration (DIO/WUA)																		
Work breakdown & Agreement (DIO/WUA)																		
Prepare budget & resources allocation (DIO/RID)																		
Conduct Baseline Survey for PBME																		
Prepare tender documents (DIO)																		
Call tenders and evaluate (DIO)																		
Raise cash contribution (WUA)																		
Pre-construction conference (DIO/WUA)																		
Formation of Construction Committee (DIO/WUA)																		
Construction works and supervision (DIO/WUA)																		
O&M training (DIO/WUA)																		
Maintenance period for defect correction (DIO/WUA)																		
Preparation of completion report (DIO/WUA)																		
Completion and test run (DIO/WUA)																		
Monitoring and evaluation																		
PBME Survey (RAD)																		

21.10 Irrigation Management Transfer Procedures

Turnover of irrigation projects for management by the beneficiaries has been an important step in the correct direction initiated by HMGN. This is being done through a separate project, the Irrigation Management Transfer Project (IMTP), implemented with the assistance of the ADB and USAID. The objective is to transfer irrigation projects presently operated and maintained by the Department of Irrigation, HMGN without the participation of project beneficiaries in operation and maintenance of projects. These projects implemented earlier, though having potential benefits for irrigation, have not been fully exploited in the absence of user participation and have become a financial burden from year to year.

With the *Water Resources Act 2049*, providing the transfer of any water resources project to the user association and the *Irrigation Policy 2049* following it with the formulation of Irrigation Rules, the irrigation management transfer to WUA is gaining momentum and has already taken the shape of IMTP with the assistance of the donor community.

The project was implemented in 1995/96 with the target of transferring the management of 11 irrigation projects in two phases. The first phase transfer of three projects has been completed and the transfer of eight remaining projects is to be completed by 2001.

Depending on the success of IMTP, other projects will also be turned over to WUA for their operation and maintenance, extricating DOI of the responsibility of bearing the high cost of O&M and yet not receiving the expected results.

IMTP implementation has been conceived in four phases: (1) Initial Organization Phase (2) Preparation Phase (3) Implementation Phase (4) Post Turnover Phase. Each phase has been indicated in the following Figures 21.2, to 21.5 taken from the *Irrigation Management Turnover Manual* in Nepali prepared by IMTP in 1998.

The flow charts for the four phases included herein for the intended use of future turnover of projects are self explanatory and they tell the processes involved in each phase in clear terms.

Figure 21.2 Irrigation Management Transfer

1. Initial Organisation Phase

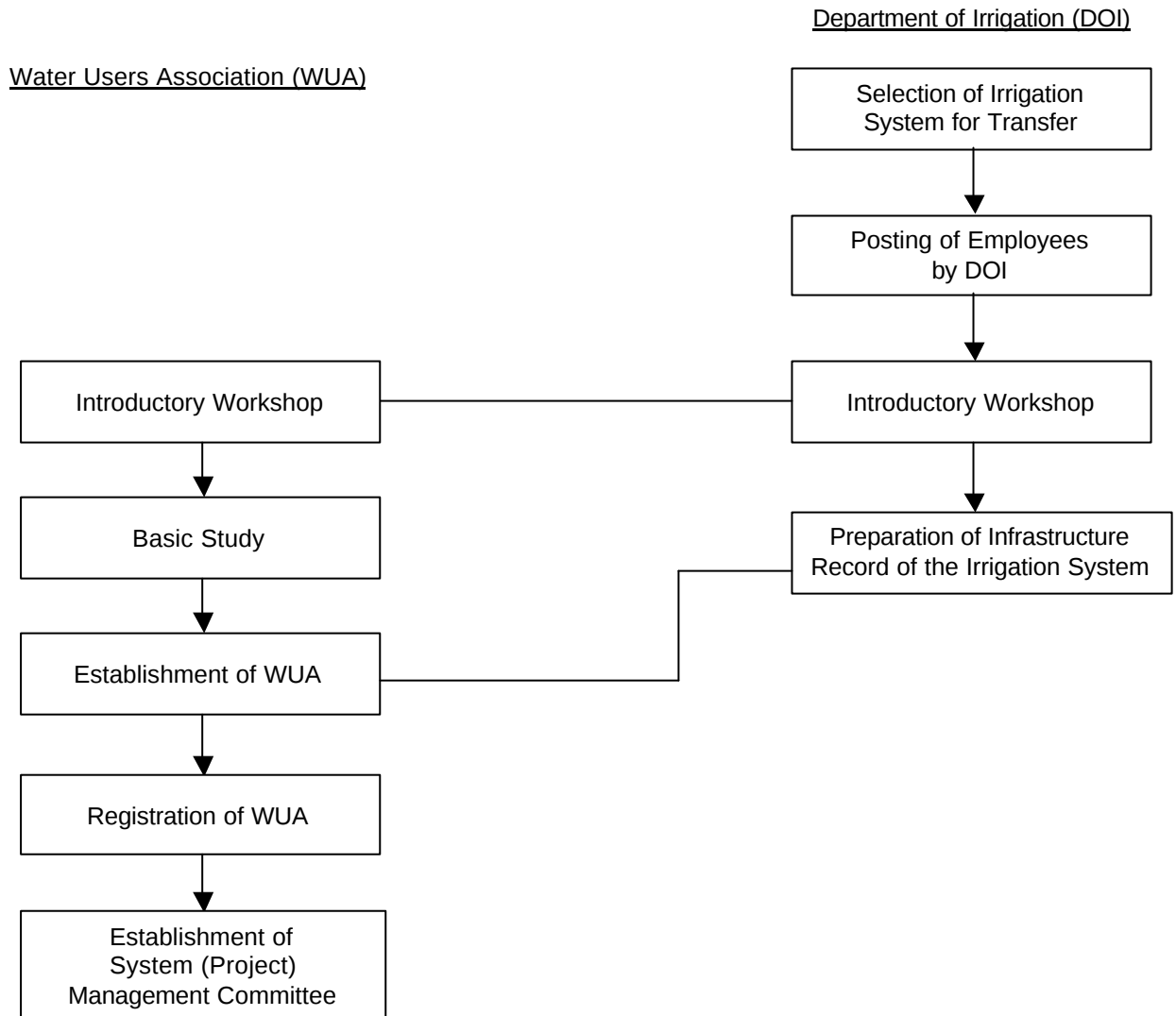


Figure 21.3 Irrigation Management Transfer

2. Preparation Phase

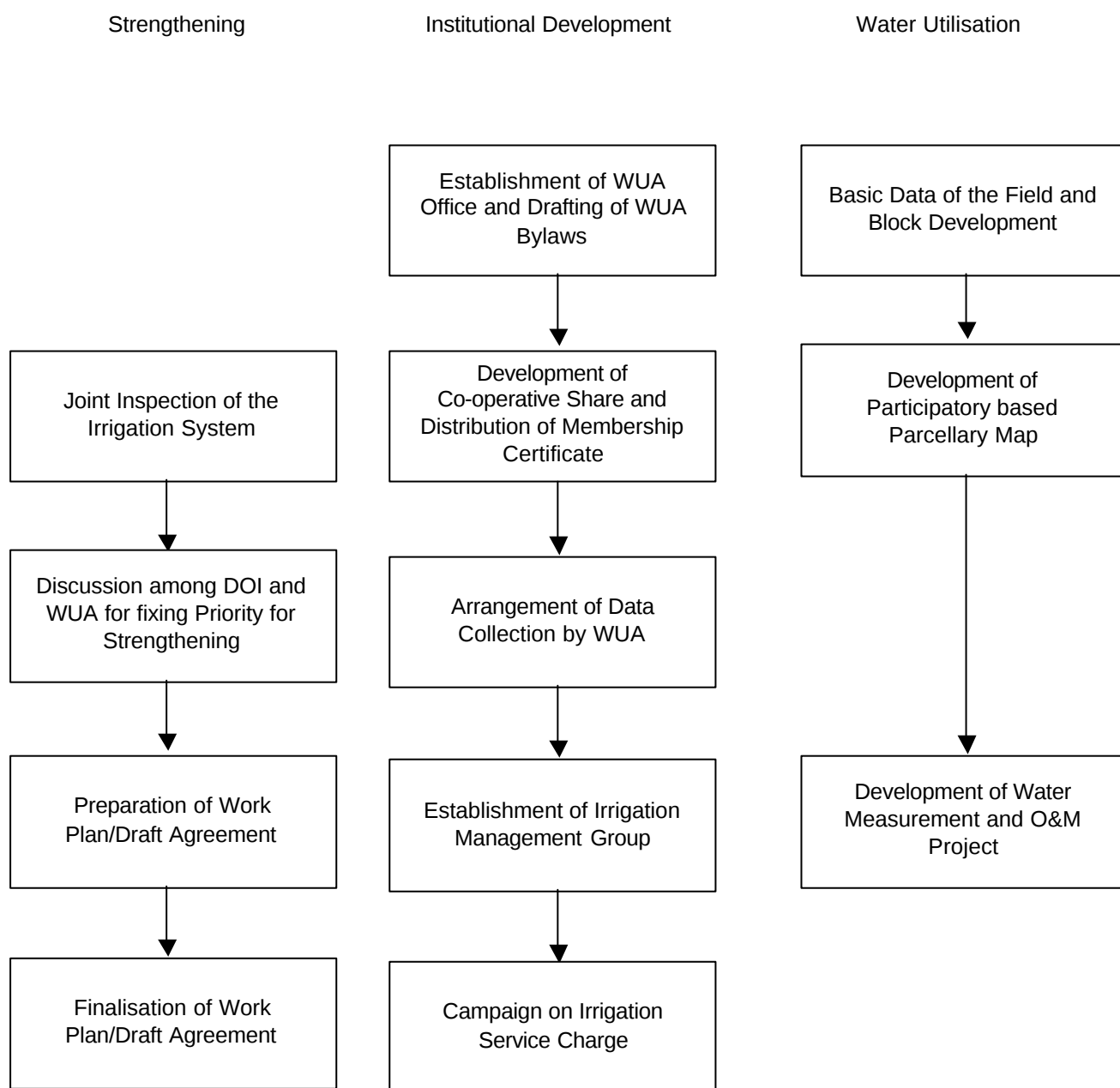


Figure 21.4 Irrigation Management Transfer

3. Implementation Phase

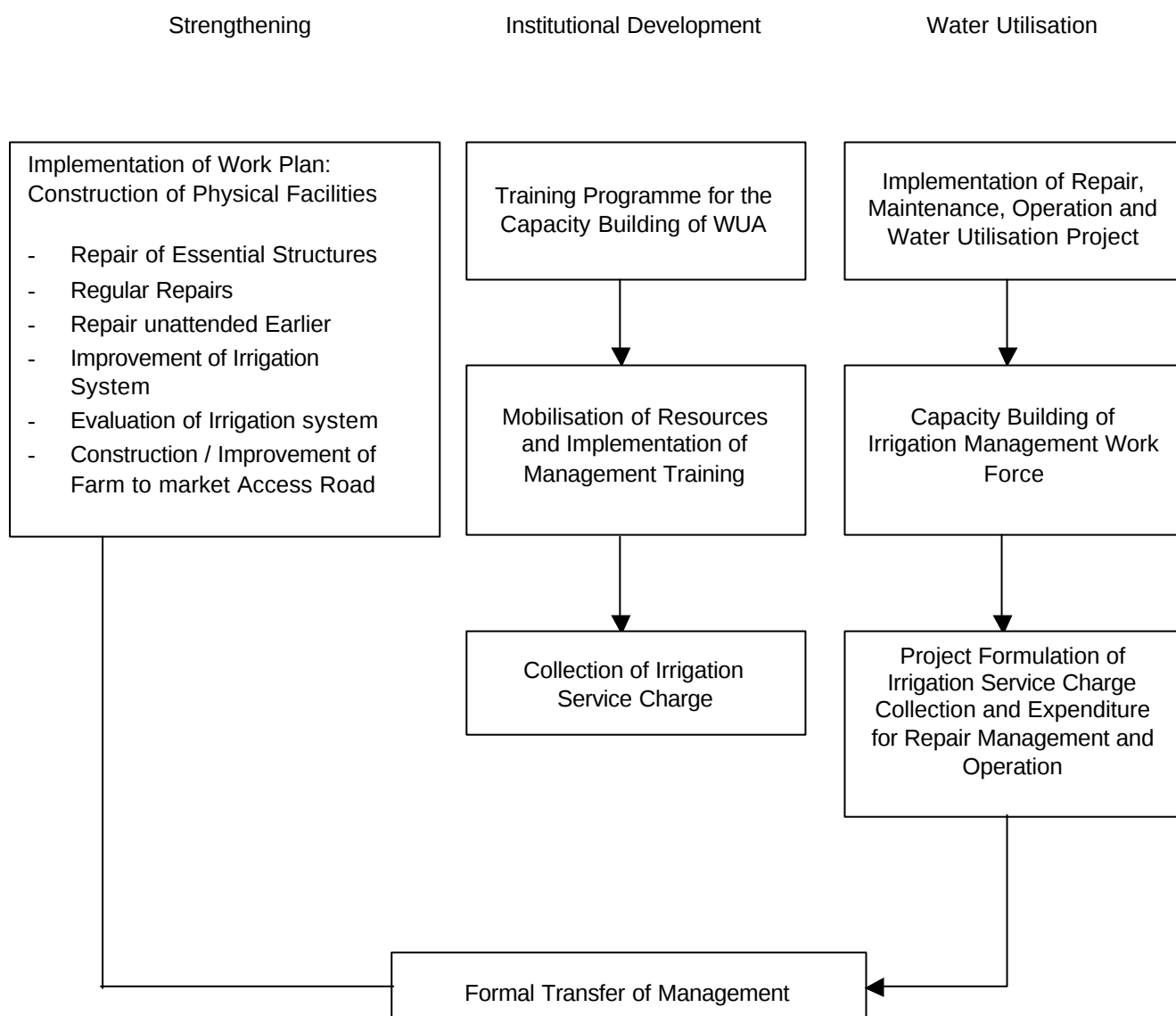
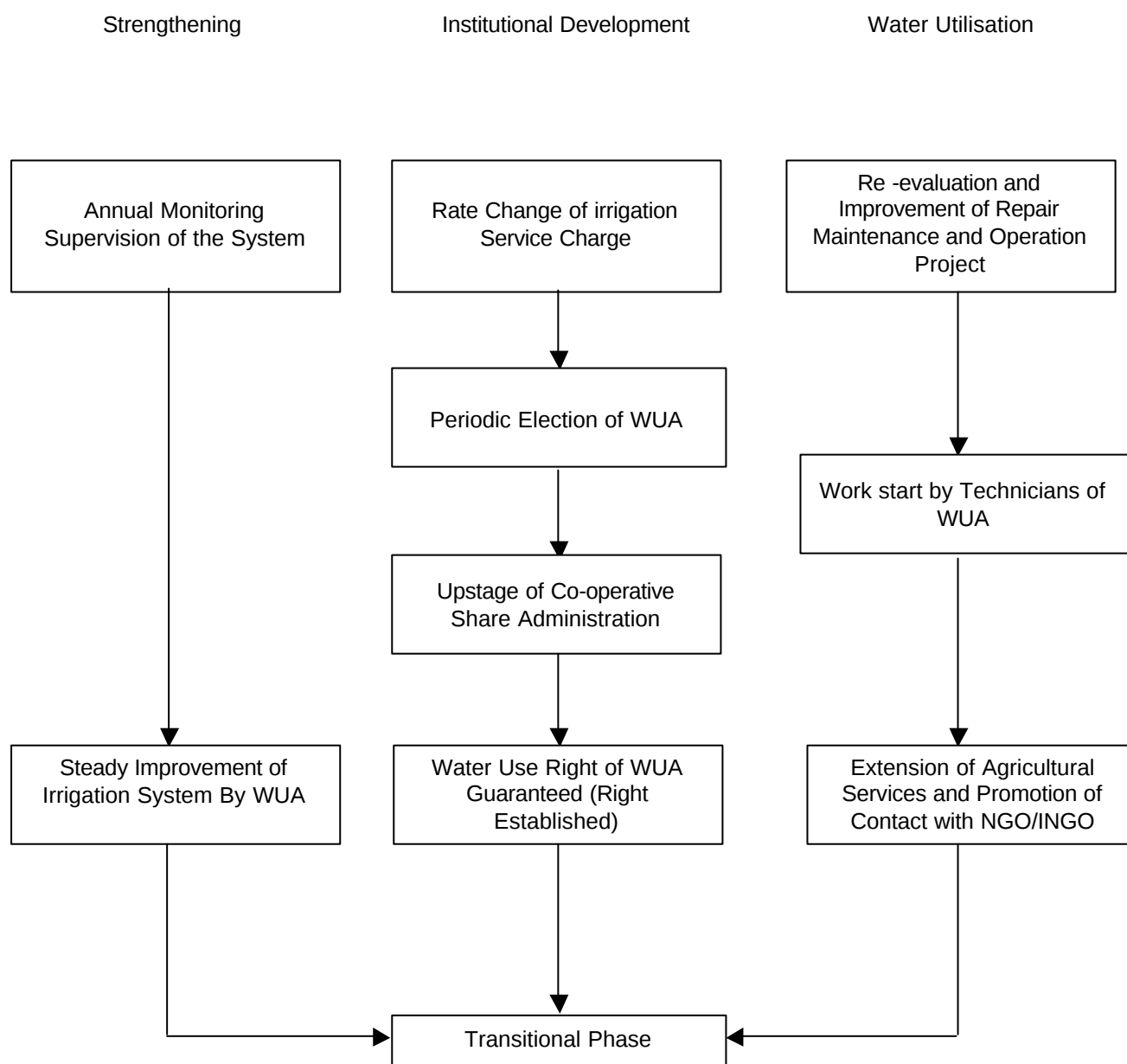


Figure 21.5 Irrigation Management Transfer

4. Post Turnover Phase



21.11 Engineering Design

21.11.1 General Principles

Once feasibility is done and established and source of financing is confirmed, the process of detailed design of the project begins mainly to determine a reliable cost estimate and to prepare procurement documents for construction and supervision which interalia contain the detailed design. Though most of the design works of relevant structures, main canal, branch canals, tertiary canals and the appurtenant structures might have been designed at the pre-feasibility and feasibility levels, any detailed design left out earlier has to be done now, and construction drawings may be prepared to give an early start to the project.

While designing new schemes, alternatives should be given to following points as far as practicable:

- The farmers should always be consulted about the type of structures they need and how they plan to operate and maintain.
- In proposing a new design, make sure that traditional village practices are compatible with it.
- Follow traditionally proven and time tested local designs with modifications where necessary within acceptable limits.
- Do not build structures that shift the responsibility for operation and maintenance to the government.
- Designs must be made with repair and maintenance in mind with the possibility of use of local materials.
- Build small but strong civil works in the hills with the least disturbances to stable slopes.
- Arrange a field visit to see the system in operation prior to selecting a design.
- Always stress on the quality control of works executed.

21.11.2 Desk Study

The desk study is undertaken to identify the remaining works to be done for the detailed design following which detailed drawings are prepared. If better alternative solutions in terms of head-works, intake, main canal alignment, distributaries, branch canals, main structures in the main canal and subsidiary canals exist, they should be confirmed now without major deviations in the scope of the project or changes in the cost of the project. The type of structures involved as headworks, intake structures, regulating group (head regulator, turn out, cross regulator, check drops, check inlets etc.) conveyance group (inverted syphons, drops etc.) and cross drainage structures (as superpassage, aqueduct, siphon) and protective structures (escape, overflow spillways, side channel spillway) and water measuring structures should be clearly categorized for detailed design and cost estimate purposes.

21.11.3 Surveys

Various types of survey works are to be undertaken to implement the engineering design. They are:

- Repeat traverse survey for the marking of benchmarks on permanent structures and all other structures proposed in the project.
- Survey of the affected structure or structures and canal alignments.
- Site surveys of structures.
- Longitudinal, cross-sectional and strip surveys of alternative alignments of the main canal and subsidiary canals. Longitudinal, cross-sectional and strip surveys of main drains and side drains.

- Any other survey required for the engineering design.

21.11.4 Design

The whole economics of the project hinges upon the engineering design. So it must be done with utmost care.

Design of the selected alternative of the headwork or intake should be undertaken.

As far as possible a headwork should be avoided in favour of a simple side intake and a temporary diversion structure where required, as it will be very expensive to operate and maintain a diversion structure in characteristically steep rivers. Where a diversion structure is warranted and the river slope is 1:100 or steeper, a simple trash rack (a modified Tyrolean Weir), tested and found suitable in many hill irrigation projects in Nepal, should be designed following the model design.

For the Terai plain, weirs or barrages should be considered as feasible. These are structures built on floating foundations on alluvium soil and are tested as reliable structures in Nepal. The designs for intakes, weirs and barrages can be found in any standard books on irrigation and PDSP Manuals D2 and M7.

Canals for the alluvium soil in the Terai should be designed for regime flow with non-scouring and non-silting characteristics based on Lacey theory and Kutter's roughness co-efficient "n" with the help of design charts.

The hill canals should be especially considered in design aspects in view of the environmental considerations arising from geological conditions giving rise to soil erosion, landslide and slope failure. A relatively steep canal will be favorable to diminish the size of the canal and reduce the number of 'fall' structures which otherwise will be required. Side spillways at each km of canal should be provided to check the entire length of canal being affected in case of blockages following heavy rain and landslides. Cast-in-situ pipes should be used in landslide areas instead of open lined canals where the slide materials may cause problems to the safe operations of canals. Selection and choice of type of cross drainage works should be based on whether the riverbed is rising or falling. While any standard type of fall structure will be good in the hill project, Sharada type of fall structure has been found suitable in the Terai plain in the Nepalese context. Each individual structure not covered in the feasibility study should be designed other than the similar ones for the correct estimate of quantities. Similarly, main canals, other canals and drains should be designed. Where CAD facilities with the software design of headwork, intake, canals, drains and cross drainage and other structures are available, they should be used to make the design process simpler and less time consuming and for quick results.

21.11.5 Cost Estimate

The cost estimate should be worked out for all the final items based on the Rate Analysis Norms, HMG, 2056 beginning with headwork, main canal and subsidiary canals, structures lying in them and cross drainage structures. This cost should then be checked with the cost worked out at the feasibility level to confirm there is no major change to affect the analysis carried out earlier. Where CAD facilities are available, they should be used for quick results.

21.11.6 Drawings

The drawings of all individual structures and typical details and their site plans are produced at suitable scale as required and prescribed.

Longitudinal sections and cross sections of main canals, subsidiary canals and drains should be drawn in scales mentioned earlier for the hill and Terai projects.

Where CAD facilities are available, they should be used for quick results.

Preferred scales used in the drawing are 1:100, 1:25, 1:250, 1:50, 1:500 and multiples of 10 of above as required.

21.12 Pre-construction Activities

For the successful execution of the construction of a typical irrigation project, there are a number of pre-construction activities to be undertaken which were described in some detail in the PIP earlier. Because of the importance of the activities, they are summed up as follows:

- Formalization of adhoc WUA with the formation of WUA along with the drawing up and approval of the constitution and by-laws by the WUA General Assembly.
- Registration of the WUA with DIO.
- Deposit of the remaining balance of the upfront cash by WUA to make up to 0.5% of the cost estimate.
- WUA mobilization of labour or cash contribution as its percentage share of the cost of construction as per the irrigation policy.
- Preparation of the land acquisition plan for the project by DIO for land to be acquired under *Land Acquisition Act, 2034*.
- Preparation of annual budget by DIO for submission to RID for the part of the share of construction cost to be borne by DOI.
- Breakdown of work to be done by each side and a memorandum of agreement signed between DIO and WUA to this effect.
- Conduct the baseline survey of the project area to establish the reference benchmarks for the project to be checked by PBME one year after the completion of the project.
- Tender call, pre-bid conference, tender evaluation and approval of the part of the work to be done by DOI with the participation of WUA.
- Joint call of preconstruction conference by DIO/WUA to brief the General Assembly of WUA on the work breakdown agreement and joint policies and procedures regarding the implementation of the project agreed between DIO and WUA and formal approval with or without amendments based on discussion from the Assembly with back-up input from the contractor on the construction works.
- Formation of a joint construction committee composing members of DOI and WUA (at least four elected members) and project beneficiaries for construction supervision and quality control of works undertaken by contractors and the WUA supported by construction supervisors on the payroll of DIO.

21.13 Implementation Modality

The implementation modality of an irrigation project depends on the size and nature of the project and the donor community. The donor community assists almost all irrigation projects, small or medium. The World Bank and the Asian Development Bank have been implementing NISP and SISP in Nepal and so also EC in Mid-western Region. These projects require the involvement of WUA in the implementation with the cost sharing arrangement between DOI and WUA to give the feeling of ownership to the latter.

WUA's part of the contribution is covered by labour provided by the beneficiary farmers in the form of mostly unskilled labour maintained in Labour Attendance Form Annex 17 of SISP Operational Procedural Manual and as mentioned in the memorandum of agreement between DIO and WUA.

The DIO part of the work is done through procurement of works and goods following ICB or LCB procedures depending on the magnitude of works. Procurement procedures and standard bidding document for works, goods and consultants are contained elsewhere in PWDs Parts II and III.

In procuring the expatriate consultancy services, it is now HMGN practice to ask for the association of local consultants for the services to be provided by them with a view to build up

the local capacity. Similarly, in the procurement of works in ICB, the involvement of local construction company has been sought. These provisions should be made in procurement of consultancy services and works in case of irrigation sector as well.

District Irrigation Office (DIO) of DOI as the implementing unit of the Department under the overall supervision of RID demands that it should be strengthened with requisite number of technical staff and other support services including all PDSP manuals prepared by the consultants with UNDP assistance to be competent to handle the projects. Similarly, RID should be strengthened taking into consideration the number of projects it has to supervise. This calls for institutional strengthening of DIO and RID. In short, the implementation modalities among others for the irrigation sector will include the following:

- Institutional strengthening of DIO and RID
- Guidelines and SBDs to be followed during implementation
- Method of procurement of consultants both local and expatriate
- Method of procurement of goods and works through both ICB and LCB
- Standard conditions of contract
- Particular conditions of contract as applicable to individual project
- Any other relaxation or concession applicable to procurement of works, goods and services.

21.14 Construction Activities

As in the pre-construction activities, there are a number of procedures to be followed for the construction management of an irrigation project leading to its successful conclusion with both WUA and DIO issuing the joint completion certificate. As the project is jointly implemented by WUA/DIO, every construction activity has to be transparent and WUA involvement in the project is expected to give the feeling of ownership of the project right from the beginning to the O&M stage. Transparency is *sin qua non* for beneficiary participation in any development project. The activities may be enumerated as follows:

- Start of construction with the segregation of works both by cost and volume of works to be done by WUA and contractor for the part of the work to be borne by DOI and collection of cash contribution by WUA for beneficiaries not providing labour.
- Training conducted by DIO especially to the Construction Committee members of WUA to familiarize them with the components of the work and the engineering terminology severally used in the project and such items affecting the quality of work, supported by construction supervisors employed by DIO.
- Supervision by Joint Construction Committee of construction works being done by WUA and the contractor on day-to-day basis.
- Subsequent measurements leading to the final measurement including quality check of works accomplished by WUA and the contractor to be jointly done and verified for recommendation for payment.
- Cessation of all construction activities on surpassing the cost estimate by 10% until agreement is reached on the cost sharing principle on a pro-rata basis as agreed earlier. Such cases should be avoided with strict screening measures at the outset.
- Start of project commissioning with a joint walkthrough by WUA and DIO over the completed project facilities and rectification of defects if any by the concerned parties for the safe test run of the system.
- Joint certification of the Completion Report by WUA/DIO in a formal ceremony attended by the General Assembly of the WUA and line agencies viz DOA, AIC, ADBN and others involved in the construction of the project.

The Completion Report among others should have the following information for future reference:

- Salient features of the project
- Short description in chronological order of activities undertaken
- Problems and constraints encountered during the execution of the project
- Itemwise work details carried out by DOI and WUA depicting the total cost of the project
- Approval formats of the project for RID, RAAC and DG/DOI
- Site plan of the project
- Construction drawings of main and special structures as built
- Agriculture data related to present cropping pattern and yield.
- Plan of Operation and Maintenance Manual
- Environmental Monitoring and Follow-up Manual

21.15 Operation and Maintenance

Operation and maintenance (O&M) of a project is an important stage in the project cycle. Upon commissioning of the irrigation system, it is to be operated and maintained by WUA as per the Memorandum of Agreement between DIO and WUA. The successful operation of the system by WUA would have been established if the expected benefits would have been realized with the minimum of problems and mobilisation of resources at its disposal.

The WUA should be encouraged from all quarters to do its job.

DIO should immediately return 0.5% of the project cost deposited earlier as upfront cash to WUA for using it as seed money towards the O&M of the system.

While DIO should try its best to build up the capability of WUA through intense training, WUA should be fully aware of its responsibility towards maintaining the system intact for all time to come. WUA should be additionally strengthened with the improvement of its organizational structure for O&M instilling the leadership qualities at all levels.

As "seeing is believing", an effective way of training WUA leaders is to take them to a successful irrigation system operated and maintained by another fraternal WUA to be told of the success story and the key issues involved in operation from the farmers' mouth. Nothing could be more convincing than this.

The WUA should also be encouraged for improving system O&M from within improving the cropping calendar, improving water distribution, improving system maintenance and improving conflict management.

The WUA should be enthused towards increased crop production through support services such as extension, credit, agricultural inputs, post harvest facilities and marketing once the supply of irrigation water is ensured.

The financial resources available to WUA as irrigation service charge, membership fees, fines, penalties and other sources of income should be efficiently handled to make O&M of the system sustainable.

The WUA should be made mindful of the monitoring of O&M as a pre-requisite to evaluation and improvement of the irrigation system.

The WUA should be guided to hold the periodic review and assessment of irrigation system to be posted of all events such as crop calendar implementation. Water distribution, maintenance activities, collection of irrigation service charge, resolution of conflicts, information on training activities etc. which will be basic information available to be presented to the General Assembly of WUA once when it is held.

21.15.1 Special O&M Requirements

After every monsoon rain, the irrigation system should be thoroughly checked for some necessary repairs to be attended to as "a stitch in time saves nine" is very well applicable here.

Following continuous rainfall during the monsoon, some emergency repairs may be required to restore the diversion works and repair the substantially damaged system. WUA may not have enough resources to attend to such repairs. In such circumstance, RID needs to come forward at the initiative of DIO to reinstate the system and make it functional.

21.16 Benefit Monitoring and Evaluation

Project Benefit Monitoring and Evaluation (PBME) is an important component in the implementation cycle of an irrigation project. Its aim is to verify the projected benefits in the project report such as increase in irrigated area, increase in production and income, participation of WUA members in benefits, sustainability of the irrigation system, environmental stability and protection. A baseline survey is, therefore, conducted earlier by DIO before the construction of the project prior to tender call to set the benchmarks for the project area such as irrigation status, productivity of land, condition of WUA members, environmental condition etc. to be compared with the benefits accrued upon completion of the project.

For benefits to be generated from the project, it has first to be successfully operated in the first year after completion. O&M responsibility as per the Memorandum of Agreement between DIO and WUA lies with WUA. On completion of the project, WUA has to operate the system efficiently to obtain the projected benefits with the help of related institutions like DIO, DADO and other line agencies directly connected with agricultural development.

The members of the Regional Monitoring Committee headed by the Regional Agriculture Director therefore conduct the follow-up survey a year after completion of the project and subsequent years by means of a Household Survey with the help of a format containing all the relevant information relating to the project area. Format F in *Procedural Guideline for FMIS* gives the detail of information to be collected. A sample survey of the selected households is conducted to get the relevant information in the format. The data thus obtained are checked with those obtained during the baseline survey setting the benchmarks for the main indicators. The data received from PBME are very useful for steering the project to correct path to generate the projected benefits and they should be disseminated among all related organizations. Necessary budget should be allocated in DIO and DADO for conducting such surveys.

Usually, an outsider to get an independent feedback of the project conducts an impact survey of the project five years after completion. The information received from the survey are unbiased and therefore, very helpful in rectifying defects, if any. The budget should also be allocated for such a study in DIO.