APPENDIX-10 ENVIRONMENT

ENVIRONMENTAL IMPACT ASSESSMENT
SCOPING REPORT AND TERMS OF REFERENCE

CHAPTER 1 INTRODUCTION

APPENDIX-10 Environment discusses environmental policies and regulations in Nepal, present environmental conditions in and around the Study area, possible environmental impacts caused by the Project and the mitigation measures to minimize them. In the compilation of this Appendix, inputs have been received from Department of Irrigation (DOI), Ministry of Water Resources (MOWR), Ministry of Population and Environment (MOPE), District Development Committee (DDC) and other district level offices, SILT Consultants LTD of Nepal, CEMAT WATER LAB (P) LTD of Nepal, field observation and surveys, interaction with farmers and fishermen as well as findings and results from other Appendixes.

This Appendix consist of five chapters, namely, Chapter 1 INTRODUCTION, CHAPTER 2 ENVIRONMENTAL REGULATORY SETTING-UP IN NEPAL, CHAPTER 3 WATER QUALITY, CHAPTER 4 ISSUES DUE CONSIDERED AND THE MITIGATION and CHAPTER 5 PLANNING ASSESSMENT.

CHAPTER 2 ENVIRONMENTAL REGULATORY SETTING-UP IN NEPAL briefly reviews the environment-related policies, legislation and guidelines relevant to irrigation development as well as the concerned central and local level institutions in Nepal.

CHAPTER 3 WATER QUALITY discusses the results of water quality test of surface water including effluents from the two paper mills, namely, Baba Paper Mill and Arvind Paper Mill in the Study area and also ground water near the mills. The former, Baba Mill, has "treatment ponds". However it hardly function as treatment facilities, it only reserves the wastewater. Besides, Arvind Paper Mill doesn't have any kind of facilities.

CHAPTER 4 ISSUES DUE CONSIDERED AND THE MITIGATION describes major possible adverse impacts to the environment by the proposed project and their mitigation measures, including issues on paper mill effluence, impact on fishing community, impact on water users along Sunsari river and impact on aquatic biodiversity. The results of four farmer-level consultation meetings, which were held for public consultation as a step of scoping required by Environment Protection Act, 1996 and Environment Protection Rules, 1997, are also reported. Finally, an environmental monitoring plan is discussed briefly.

CHAPTER 5 PLANNING ASSESSMENT briefly examines possible alternatives in terms of command area, amount of intake, location of the intake, intake design and water sources.

CHAPTER 2 ENVIRONMENTAL REGULATORY SETTING-UP IN NEPAL

This Chapter reviews the environment-related policies, legislation and guidelines relevant to irrigation development as well as the concerned central and local level institutions.

2.1 Environmental Act, Regulations and Policies

His Majesty's Government of Nepal (HMG/N) included the need for an environmental study in selected areas (programs and projects) since the Sixth Five Year Plan period (1980-1985). The environmental policies were further elaborated and reinforced in the consecutive Periodic Plans. The Environment Protection Act (EPA), 1996 and Environment Protection Rules (EPR), 1997 are the specific acts and regulations directly related to environmental study and assessment while there are a number of other relevant acts and policies that need to be considered when implementing irrigation projects.

The EPA was formulated taking into consideration that sustainable development could be achieved through creating a balance between the economic development and environment protection. It defines various words; for example, "Environment", "Scope" and so on. Furthermore it provides to carry out Initial Environment Examination (IEE) or Environment Impact Assessment (EIA) of the proposals as prescribed.

2.1.1 Relevant Policies

1) National Environment Impact Assessment Directives, 2050

The objectives of these directives are to adopt preventive as well as protective measures for minimizing the adverse impacts on the environment while implementing projects and to integrate environmental aspects in different stages of project development. The format of the EIA study has been prescribed. These directives have also prescribed the method and procedure to be adopted for public participation and involvement of local people at the time of project finalization as well as methods of evaluation of environmental impacts.

2) Environmental Policy in the Ninth Five Year Plan (1997-2002)

The objectives of the Ninth Plan were to improve the working procedures of the Environment Section of the different Ministries, enforcement of mandatory and voluntary measures of pollution control by fixing emission and effluent standards, to build up capability of people in the environment sector, participation in planning of local communities, NGOs, particularly involving women and under-privileged people and to maintain coordination among the agencies involved in environmental activities. The following policy and working strategy (among others) were adopted to obtain the objectives:

- The EIA procedure to be made participatory,
- Government agencies, local bodies, communities and private sector are to be mobilized as partners in environmental management activities like developing public awareness, impact evaluation and implementation of mitigation measures,
- Community participation and involvement of users groups in forestry management,

watershed development and bio-diversity conservation is to be encouraged and

- Legal and procedural arrangements are to be made for the implementation of International Treaties and Conventions ratified by His Majesty's Government.

3) Environmental Aspects of the Irrigation Policy 2049 (first amendment 2053)

The Irrigation Policy has made the following provisions to minimize the adverse environmental impacts during and after implementation of irrigation projects:

- For minimizing adverse environmental impacts likely to be caused by irrigation systems, an EIA or IEE study shall be conducted at the time of feasibility study of the project on the basis of National Environment Impact Assessment Directives, 2050. The project shall be designed and implemented on the basis of recommendation made in such study,
- Priority shall be given to the efforts towards proper on-farm water utilization and
- Less expensive sources of energy shall be identified and emphasis shall be given to development and promotion of modern irrigation technology that can be operated through such sources.

2.1.2 Relevant Acts and Rules

1) Environment Protection Act, 1996 and Environment Protection Rules, 1997

According to the act, the proponent has to prepare and process for approval of the IEE/EIA reports. It also calls for not implementing the proposals without approval of such reports. The Act empowers the Ministry of Population and Environment (MOPE) for the approval of EIA reports.

In the process of effective implementation of EPA, 1996 the EPR, 1997 (first amendment 1999) has also been enforced. The EPR was framed in exercise of the power conferred by Section 24 of the EPA.

The EPR contains elaborate provisions on the process to be followed during the preparation and approval of projects requiring an EIA, including the scoping report, terms of reference, public consultation and environmental auditing. The MOPE should also make the EIA report public for 30 days for seeking public opinions and suggestions. **(**See **Figure-1** in Attachment**)**

2) Water Resources Act (WRA), 2049 and Water Resources Regulations (WRR), 2050

The Act empowers HMGN to fix quality standard of water for different usage by a notification published in the Nepal Gazette. It has prohibited polluting water and clearly emphasizes to avoid or minimize impacts of soil erosion, landslide or other significant adverse environmental impacts during the utilization of water resources. According to the WRR the proponent is obliged to analyze environmental impacts of the proposed action and include impact mitigation and safety measures including arrangements for displaced people. The Regulation contains provisions for compensation for land and property acquired or for any loss by the project activities.

3) Local Governance Act, 1999

It has empowered the Village Development Committees to construct irrigation schemes, and implement river training works, afforestation, biodiversity conservation and other activities for environmental management.

4) Soil and Watershed Conservation Act, 1982 and its Rules, 1985

These contain several provisions to regulate human activities in the watershed in order to minimize soil loss and reduce landslides and flood problems.

5) Land Acquisition Act, 1978

Clauses (2) and (3) of Article 17 of the Constitution of the Kingdom of Nepal, 2047 provide that personal property shall not be acquired except for public welfare activity and appropriate compensation shall be paid adhering due procedure of law. The Land Acquisition Act is the principal act with respect to land acquisition and paying compensation there of. HMGN has the power to acquire personal land including houses or other constructions by paying appropriate compensation. The Act has prescribed the procedure to be followed for acquiring the land. There is provision for the formation of a compensation fixation committee and the matters to be considered while doing so. The owner of the land has right to appeal if s/he is not satisfied with the compensation fixed by the committee. However, she/he cannot deny providing land.

The policy and practice of concerning environment and the formulation and implementation of programs that empower people have increased environmental awareness. The processes of expanding activities favorable to environment and the practice of EIA have been started. Despite the fact that there are various provisions to protect environment and control pollution in the EPA, they haven't been done to institutionalize the process and the system in agencies such as Ministry of Agriculture and Ministry of Water Resources, etc. In turn, the tolerance limit for the quality of exhausted air and the standard of drained water of some industries have been determined though, its implementation has yet to be made effective.

2.2 Environmental Regulatory Setting-up relative to Irrigation Development

Integration of environmental aspects in development Project and programs was started in the mid 1980s following the donor's environmental guidelines. His Majesty Government of Nepal (HMGN) in early 1990s drafted the National EIA guidelines and endorsed it in 1993. This guideline prompted HMGN to internalize Environmental Study in development planning as it contributed to identify adverse impacts of the development proposals on the environment. In the mid 1990s, various sectoral agencies also started the development of sectoral EIA guidelines under the broad framework of the National EIA Guidelines.

Sectoral frameworks facilitate the implementation of the National Conservation Strategy for Nepal undertaken by the National Planning Commission in collaboration with the World Conservation Union (the IUCN). These environmental guidelines like "Environmental Impact Assessment Guidelines for the Water Resources Sector" have been conceived and produced to form a complementary sequel required to the National EIA Guidelines. They

apply to irrigation and power Projects and don't include drinking water.

As mentioned in **Chapter 2.1**, the EPA prescribes implementation of IEE or EIA by proponent. The Projects to be carried out IEE or EIA are mentioned in Schedule 1 and 2 in EPR. When one proponent plans a Project related to irrigation, whether IEE or EIA implementation is needed or not, depends on the scale and the location as follows:

Table 2.2.1 Scale and Project type for IEE or EIA implementation

Project type	IEE	EIA
New schemes		
1. Terai Plain	25-2,000ha	>2,000ha
2. Hill valleys	15-500ha	>500ha
3. Hill slopes and mountains	15-2,000ha	>200ha
Rehabilitation of existing schemes		
1. Terai Plain	>500ha	-
2. Hill valleys	>200ha	-
3. Hill slopes and mountains	>100ha	-

As the project area covers about 16,800ha, EIA implementation is required. In case of EIA, public notice is required to get any opinions or suggestions from Municipal or Village Development Committees (VDCs) where the Project will be conducted.

2.3 Concerned Government Offices and Activities

2.3.1 National Institutions

MOPE was formed in September 1995. A cabinet decision specified MOPE's mandate to be responsible for formulating and implementing policies, plans and programs, conducting surveys, studies and research, monitoring and evaluating programs and acting as a national and international focal point in the domain of population and environment.

As programs on population and environment are multi-sectoral and multi-dimensional in scope, they can't be implemented by a single ministry. Many current activities can be conducted in collaboration with concerned line agencies. Therefore, MOPE plays a role as a facilitator and focuses on implementing activities which so far have not been properly addressed by other agencies and which are priority issues of population and environment.

The scope of work of the MOPE has been divided into two domains; Primary and Supportive functions. Primary functions shall be executed at MOPE's own initiative with the cooperation of other agencies as required and Supportive functions shall constitute cooperation and help to be extended to other ministries and agencies in executing their programs and activities.

There are three divisions in MOPE, namely Administration division, Population division and Environment division under the Secretary. There are common primary and supportive functions of the Ministry, and in addition to them, there are population-related functions and environment-related functions of the Ministry. Out of the above three divisions, Environment division directly deals with EIA/IEE, formulation of environment regulations

and monitoring and evaluation etc. The number of staff as experts in the division is around twenty. Environment-related functions of the division (except common items) are as follows:

1) Primary Functions

- Amend, as necessary, existing policies and action plans and formulate national policy and action plans on the main aspects of environmental conservation,
- Formulate, refine and implement environmental impact assessment guidelines,
- Study existing laws on different aspects of environmental conservation, amend and establish the legislative framework,
- Implement the provisions of and obligations arising from international agreements, treaties and conventions on environment,
- Conduct studies and research on environmental matters, and conduct or participate in related training,
- Identify pollution indicators and indices to set standards and
- Prepare an annual "state of the environmental report" and disseminate information on the status of environment in Nepal

2) Supportive Functions

- Help develop and implement a code of conduct to check adverse environmental impact due to activities conducted by different institutions,
- Control pollution through research and encourage recycling and appropriate disposal of waste products,
- Monitor to ascertain whether different agencies, industries, communities and organizations have adhered to the defined environmental standards, and impose penalties on those violating the gstandards,
- Be involved in EIA of cross-sectoral Projects and
- Organize high-level training within and outside the country to prepare expert human resource in the area of environment management.

2.3.2 Local and District Organizations

The project covers 13 VDCs and their assistance is of great significance for the implementation of the project and subsequent operation and maintenance. The VDCs can also co-operate the project for land and property acquisition and compensation, if any. NGOs in the Project area, District Administration Office and District Development Committee are local level organizations concerned directly or indirectly. WUAs also are to be involved in all stages of the Project development as per the existing Irrigation Policy.

CHAPTER 3 WATER QUALITY

3.1 Surface Water Quality

Water quality is an important concern in terms of efficient irrigation and environmental protection. History is a witness the fact improper water like saline water, brings about deterioration of soil fertilities. The Study Team conducted a series of water quality tests in both rainy season and dry season in 2001.

3.1.1 Water Sampling and Water Quality Analysis

Surface water quality checks at six points were done. The points are located at Shankarpur Canal, upstream, middle stream, downstream of Sunsari river, Garaun Khola and down stream of Budhi River as shown below. The location of sampling points is shown in **Figure-3** of the Attachment.

Table 3.1.1 Location of the Sampling Points

Station No.	River	Location
1	Shankarpur	Shankarpur Canal
2	Sunsari -U	At upstream of Sunsari river on the E-W highway bridge
3	Sunsari-M	At middle stream of Sunsari river near at Siphon
4	Sunsari-D	At downstream of Sunsari river, in Sucumbashitor
5	Garaun Khola	At Garaun Khola in Jalpapur
6	Budhi-D	At downstream of Budhi River in Laljtol

The test of characteristic physical parameters such as temperature, pH, Electric Conductivity (EC), bacteriological test and Dissolved Oxygen (DO) was performed at the site. The test of other parameters was performed in a laboratory. The samples supplied for the test were transported being kept in refrigerated containers to the laboratory with care. Integrity of them was maintained with the application of best sample and suitable sample preservation.

The parameters analyzed in the laboratory are as follows; T-C in TSS, Suspended Solids (SS), Total Nitrogen in Total Suspended Solids (T-N in TSS) Bicarbonate, Nitrate, Nitrite, Ammonia, Total Phosphate, Chloride, Sulfate, Calcium, Magnesium, Total Hardness, Iron, Sodium, Potassium, Arsenic, Manganese, PV value which equals to Dissolved Organic Carbon, Chemical Oxygen Demand (COD) and Biological Oxygen Demand (BOD). These tests were committed to CEMAT WATER LAB (P) LTD, water qualities were tested under the responsibility of Ground Water Division, DOI.

All methods based on Standard Methods (APHA-AWWA-WPCF) or on Methods for Collection and Analysis of Water Samples for Dissolved Minerals and Gases (United States Geological Survey) were applied.

3.1.2 Results

Most of particulars such as EC, pH and etc. show lower value than irrigation standard values adopted in this Country, namely FAO recommendation of irrigation water and recommendation maximum concentration of trace element in irrigation water in England. .

(See **Table-1** and **Table-2** in Attachment)

On the other hand, the values of DO at most of sites don't satisfy Japanese irrigation standard. Generally, an amount more than 5 mg/l for DO is applied to the limitation for irrigation purpose in Japan. The samples from rivers range 3.8-6.89mg/l; the upper of the stream, the higher values are. This may result from that the part of river water comes from under ground. The standard for irrigation water in Japan also suggests that EC higher than 30mS/m λ 18℃ may have some impact on the yield of paddy and EC of Sunsari-D (downstream) is slightly over that value in dry season.

In turn according to irrigation standard for paddy in Japan, less than 6mg/l for COD is applied (No standard in Nepal) though, some samples from rivers are over the standard value. Especially value at Station No.3, sampled from middle of Sunsari river in dry season, is quite high, showing 59.7mg/l. Considering the values of BOD also show the similar trend and two paper mills are located at upstream of station No3, the Team concluded it results from wastewater of the paper mills. (Station No.2 (Sunsari-U) is located about 100m upstream of paper mills, not be affected).

Since water intake point is just before inflow of the wastewater, the water for irrigation will be free from the effluent. Judged from that and results above, it can be said that the water quality of the Sunsari river is suitable for irrigation. Details of water quality check results are shown in Attachment.

3.2 Ground Water Quality around Paper Mills

From the water quality test of hand-pump wells in May 2001, electric conductivity (EC) of the Study area is known to range roughly from 20 to 55 mS/m λ 18℃. However, a sampling test of hand-pump wells near the discharge channel of Baba Paper Mill showed rather higher values, so that the Study Team decided to check the water quality of the hand-pump wells around the mills to analyze the impact of discharge to the ground water.

The highest EC values of 60 to 70 mS/m λ 18℃ are observed about 400 to 500 m away from the paper mill and the correlation of EC values and the distance from the paper mill is obvious. There is another peak about 900 m away from the paper mill and it could be explained by the facts that the discharge channel turns 90 degrees to Sunsari river at around 270 m point, and there are two reservoirs near the River. Also the impact by the effluent is not so clear at 1,000 m from the paper mill. Concrete lining of the discharge channel up to 270 m point was completed by the end of August 2002 and the impact to the groundwater is expected to be minimized soon. (See **Figure-4** and **Figure-5** in Attachment)

CHAPTER 4 ISSUES DUE CONSIDERED AND THE MITIGATION

4.1 Introduction

Irrigation projects primary provide water for farming, the project, however, faces to a problem that available water is not sufficient to cover whole command area. The flow in the river is lower than irrigation requirements during winter and spring. The 80% probability and average flow of the Sunsari river are given below: and minimum flow is 3.694 m^3/s.

Table 4.1.1 80% Reliable Mean Monthly Flows of Sunsari river

	80% cum/s			Average cum/s		
	First 10 days	Middle 10 days	Last 10 days	First 10 days	Middle 10 days	Last 10 days
Jan	4.048	4.191	3.835	4.953	5.128	4.693
Feb	3.902	3.954	3.845	4.774	4.838	4.704
March	3.694	3.719	4.093	4.519	4.550	5.007
April	4.136	4.382	5.793	5.061	5.362	7.088
May	6.461	8.689	10.120	7.905	10.631	12.382
June	13.484	21.225	21.183	16.498	25.969	25.918
July	32.703	30.060	35.121	40.013	36.779	42.972
Aug.	26.513	29.928	24.463	32.439	36.617	29.931
Sep.	22.445	26.809	19.647	27.462	32.801	24.038
Oct.	14.871	12.640	7.355	18.195	15.465	8.999
Nov.	5.598	4.928	4.059	6.849	6.030	4.966
Dec.	4.280	3.962	4.084	5.237	4.848	4.997

Taking water from the river, whose flow is originally low, can give any impacts. They may be; dilution of industrial effluent from the paper factories, decreasing of fish catch, change of biodiversity of the river, difficulty of presently practiced pumping up from Sunsari river for irrigation, etc. Following issues are considered important, which affect the environmental resources, even if little is done at any stage of construction and operation.

Table 4.1.2 Summary of Activities and Adverse Impcats

Project Stage	Activities	Likely Adverse Impacts	Elements of Environment																	
			Physical								Biological				Socio-economic					
			Water quality		Ground water		Water volume		Land		Fishes		Vege-tation		Health		Eco-nomic		Social, cultural	
			Magnitude	Extent	Magnitude	Extent	Magnitude	Extent	Magnitude	Extent	Magnitude	Extent	Magnitude	Extent	Magnitude	Extent	Magnitude	Extent	Magnitude	Extent
Construction Stage	Migration of labors during construction	Loss of woods, sanitation											△	△	△	△				
Operational Stage	Reducing flow in the river	To make water quality worse	●	●							●	●	●	●	○	○	●	○	△	△
		To make less habitat area									●	◎					●	○		
		Lowering velocity of the flow									○	○								
		Less quantity of water available					○	◎					○	○			○	◎		
		Lowering ground water table along the river			△	○											△	○		
	Reducing sediment load of the flow	Downstream erosion at the initial stage							◎	◎										
	Headwork construction	Upstream sedimentation															○	○		
	Canal operation	Sedimentation in the canal							○	○							○	○		
	Stagnation of water	Vector-borne disease													△	△				

Note: ●= very high or large
◎= high or large
○= medium
△= low or small

4.2 Paper Mill Effluence

4.2.1 Present Condition

Two paper mills, namely Baba Paper Mill which consumes approximately 4,000 m^3 of water per day and Arvind Paper Mill which recycles paper and consumes approximately 150 m^3 of water per day, are located near the proposed site for the headwork. The two paper mills discharge wastewater into the Sunsari river via reservoirs for Baba and directly for Arvind. Baba Paper Mill has two reservoirs of approximately 50m (length) x 20m (width) x 1m (depth) beside Sunsari river, however, the total capacity is about 2,000 m^3 and is about a half of the daily water consumption. That means Baba Paper Mill needs to discharge the effluent twice a day at full operation, so that it is sometimes difficult to discharge only at night, which is an agreement with the VDC concerns.

The smell of the wastewater is strong especially along the channel and at the two reservoirs of Baba Paper Mill. The people living downstream of the paper mills are complaining of smells, dying of fishes, skin rashes and funny taste of head part of the fishes caught at Sunsari river. They sometimes protest against the paper mills about the water pollution, and it has become a social problem cited in a newspaper.

There is on-going international assistance in industrial section in Nepal. Danish International Development Agency (DANIDA) is implementing Cleaner Production (CP) and Environment Sector Program Support (ESPS) in five industrial sectors including paper mills. Construction of an effluent treatment plant (ETP) jointly managed by Baba and Arvind Paper Mills is now expected to start in December 2002.

4.2.2 Effluent Quality

1) Test of Water Quality of effluent

Samplings were done twice; first in August 2001 for both Baba and Arvind Paper Mill, second in June 2002 for Baba paper Mill only. The locations are at the effluent outlets of Arvind Paper Mill and Baba Paper Mill. The sampling technique and the analysis methodology were applied mainly based on Standard Methods "APHA-AWWA-WPCF, 19th edition" and on "Method for Collection and Analysis of Water Samples for Dissolved Minerals and Gases". The test of characteristic physical parameters such as temperature, pH, Electrical Conductivity, and DO was performed at the site.

The parameters analyzed in a laboratory are follows; Salinity, Total Suspended Solids (TSS), Total Volatile Solids (TVS), Total Dissolved Solids (TDS), Total Alkalinity, Bicarbonate, Carbonate, Hydroxide, Nitrate, Nitrite, Ammonia, Total Phosphate, Chloride, Iron, Lead, Zinc, Copper, Cadmium, Chromium, Sodium, Potassium, Arsenic, Mercury, Cyanide, COD, BOD, Oil & Grease, Phonetic Compounds and Fluorine.

2) Results

Table 4.2.1 Effluent Quality and Standard

Parameters	Results			NS*	German Standard 1)	Units
	Arvind	Baba (1st)	Baba (2nd)			
T. Suspended Solids	**1,634.6**	**1,445.9**	**436.9**	30 – 200	<20	mg/l
Ammonia (NH_3)	1.64	**133.00**	**25.57**	< 50	–	mg/l as N
Chloride (Cl)	139.5	**744**	**198.4**	–	<350	mg/l
Lead (Pb)	0.06	**0.17**	**0.12**	< 0.1	–	mg/l
Chromium (Cr)	0.08	**0.26**	**0.13**	<0.1	–	mg/l
Sodium (Na)	25	1,104	828	–	–	mg/l
COD	**252**	**2,965**	**2,570**	< 250	<85	mg/l
BOD	**168**	**2,025**	**1,416**	30 – 100	<25	mg/l

NS* = Nepal Bureau of Standards and Metrology (Ne.Gu. Na. 229-2047).

Resource: 1) Galvonotechnic(1971, 62, No.12sss L'ultima acqua, A.Canuti, 1974, AFEE 2482/2)

The wastewater from the paper mills contains high-level values of TSS, BOD, COD and so on. Because micro fiber, mineral, saccharide, alcohol, lignin and its decomposition materials made in the process of paper production, bring about increase of these values. The results of the test conducted in July 2002 shows similar trend.

The detail results of water quality check are shown in **Table-3** in attachment. The particulars beyond standards specified "Tolerance limits for industrial Effluents Discharge into inland surface waters", Nepal Bureau of Standards and Metrology (NBSM) are COD, BOD, Lead (Pb), Ammonia, Chromium (Cr) and TSS. Chloride value is also higher as compared to the German Standard. Discussions are followed focusing on these particulars. (See **Table-4** and **Table-5** in Attachment)

2.1) TSS

TSS is an important parameter for wastewaters, because it can lead to the development of sludge deposits and anaerobic conditions when untreated wastewaters are discharged in an aquatic environment. NBSM tolerance limits for TSS for discharging industrial effluents into inland surface water is 30–200 mg/l. The value of TSS in both samples is many times higher than the standard, 1,634.6 and 1,445.9 from Arvind and Baba Paper Mill, respectively. Therefore, the effluent should not be discharged into the river directly without treatment.

2.2) COD

COD is one of the indicators to assess degrees of surface water pollution. The COD value of Arvind Paper Mill is 252, not so high. On the other hand, that of Baba Paper Mill is 2,965, quite beyond the standard that indicates permissible COD level is less than 250. Therefore, any countermeasures should be taken against the wastewater to the River.

2.3) BOD

BOD is a parameter most widely used for assessing organic pollution to both wastewaters and

surface waters. The BOD test results are used to determine; quantity of oxygen required to biologically stabilize the organic matter, size of the waste-treatment facilities and efficiency of the effluent treatment plants (ETP). BOD values of paper mills are 168 for Arvind and 2,025 for Baba Mill. These are badly beyond the standard, which is 30-100.

2.4) Nitrogen/Ammonia

The effects of high nitrogen (inorganic ammonia) are increase in chlorine demand; toxic to fish; depletion of oxygen as an effect of oxidation, growth of undesirable aquatic life. An NBSM tolerance limit for ammonia for discharging industrial effluents into inland surface waters is 50mg/l. The concentration of ammonia in the sample from Baba Paper Mill is 133.0, found to be higher than the NBSM limit.

2.5) Lead (Pb), Chromium (Cr)

Values of Lead and Chromium of wastewater from Baba are quite high; showing 0.17 for Lead, 0.26 for Chromium, over the standard value. The reason of this status is not obvious. However, some chemicals, which are used for paper production, include these elements. So that fractions of them may be discharged from the mills. They have great importance in the treatment and disposal of wastewaters, because of their toxicity.

2.6) Chloride (Cl), Sodium (Na)

Value of Chloride is 139.5 for Arvind Mill and 744 for Baba Mill. Meanwhile value of Sodium is 25 for Arvind Mill and 1,104 for Baba Mill. Both Chloride and Sodium values for Baba are higher than the standard. Chemical compounds, which contain Sodium and Chloride, are often used for bleaching of paper in factories. Therefore, it is perusable that these high values have come from the chemical compounds. Since chloride is frequently associated with sewage, the value can be an indicator to assess extent of the dispersion of sewage in water bodies.

3) Conclusion

As the present situation is not already permissible, SRIP may not be allowed to take any more water during lean period unless otherwise the factories take any kind of measures of reducing the effluent.

4.2.3 Impact on the Water Quality of Sunsari river

1) Assessment of Effluent of Paper Mills to Sunsari river

Additional water quality check was done from August 4 to August 16, 2002 to analyze the impact of effluent of Arvind and Baba Paper Mills to Sunsari river. The parameters tested were temperature, pH, Electric Conductivity (EC), DO, turbidity and salinity and the test was performed at the site. The sampling points are 1) headwork site near the E-W Highway bridge, 2) upstream of Arvind outlet, 3) downstream of Arvind outlet, 4) upstream of Baba outlet, 5) downstream of Baba outlet, 6) downstream of Baba channel, and 7) Suskratare Hatia 3km downstream. (See **Table-6** in Attachment)

2) Results

EC data at the downstream of Arvind outlet range from 17.09 to 52.82 [mS/m] λ 18℃. On the other hand those at the downstream of Baba channel range from 26.57 to 41.10 [mS/m] λ 18℃. Arvind Paper Mill is using 90% of recycling paper and 10% of husk for production so that the effluent of recycling process and that of agricultural process have different water qualities. That is the reason why the range is wider at effluent from Arvind. The distance between Arvind outlet and Baba outlet is about 200m, yet the EC value of upstream of Baba outlet does not show the impact of Arvind effluent. Same result is shown by the data of EC at 3km downstream. The analysis of dry season and rainy season data in 2001 also shows that the impact of the effluent of two paper mills cannot be seen by EC as a parameter (See **Figure-6** in Attachment).

DO data at the down stream of Arvind outlet ranges from 1.77 to 3.18 mg/l and are significantly lower than the data at upstream and 200m downstream (Up Baba Outlet), however the DO at Up Baba Outlet and Down Baba Outlet are even higher than the data of upstream and DO does not show the impact of effluent. DO data from the analysis in 2001 also show that DO at Sunsari-D is 4.68 mg/l and is even higher than 4.20 mg/l at Sunsari-U and 4.12 mg/l of Sunsari-M. DO data in dry season might indicate the impact (See **Figure-7** in Attachment).

As a conclusion, DO and EC are not suitable parameter to see the impact of effluent from the paper mills to Sunsari river. Instead Chloride, Sodium, COD and BOD, which are generally main waste from the paper mills, are adequate for the parameters. These values at Sunsari-M, which are about 7km downstream of the outlets, are high in dry season, even in rainy season (See **Table- 1 (1), (2)** in Attachment).

3) Simple Estimation

The proposed headwork is located at an upstream side from the paper factories, so that the irrigation water will not receive any of the industrial effluent. However, the effluent content against the Sunsari river flow will increase after the headwork starts diverting the Sunsari river water into Shankarpur and Suksena canals. The present content in the leanest season is estimated to be about 1.6 % of the river flow (leanest flow is assumed at 3 m3/s). It would, however, become as high as 16 % of all the leanest season flow if the headwork diverted as much as 90% river water as usually practiced in Nepal.

The impact assessment considers these two scenarios; ETP construction and production increase under different diversion volumes. Impact associated with the water diversion can be discussed in terms of change of the concentration of COD and BOD since these are the main wastes coming through the paper production. Assessment on COD change is exampled below, and the change of COD and BOD is summarized in Table 4.2.2 and Figure 4.2.1.

COD of Baba effluent: 2,965 mg/l (1st sampling)
Water consumption of Baba: 4,000 m^3/day

COD of Arvind effluent: 252 mg/l
Water consumption of Arvind: 150 m^3/day

COD at 3 km downstream 59.7mg/l in dry season (measured on 6/7 May 2001)
Discharge of Sunsari river: 2.7 m^3/s (the leanest runoff, measured on 6/7 May 2001)

The COD load is calculated by the concentration value times the amount of water, so that:

2,965 mg/l x 4,000 m^3/day = 11,860 kg/day of COD load by Baba
252 mg/l x 150 m^3/day = 37.8 kg/day of COD load by Arvind
12,000 kg/day of COD load in total

2.7 m^3/s x 60 s/min x 60 min/hr x 24 hr/day =233,280m^3/day of water in Sunsari river in dry season
233,280m^3/day + 4,000 m^3/day + 150 m^3/day =237,430≒240,000 m^3/day
240,000 m^3/day of water in total in dry season

12,000 kg/day /240,000 m^3/day = **50mg/l of additional COD downstream** (in the leanest season)

It is a very simple way of estimating the COD assuming the value downstream is proportional to the amount of discharge. The minimum runoff calculated by tank model in 80% probability is 3.69 m^3/s, and diversion of river water is considered at 50%, 80%, and 90% of the 3.69 m^3/s.

Base flow (80% probability of Sunsari river runoff):
3.69 m^3/s x 60 s/min x 60 min/hr x 24 hr/day =318,816 ≒ **320,000 m^3/day of water**

Baba Paper Mill has already installed a new line with 30t/day production capacity, meanwhile present capacity is 10t/day, so that in the case study, "production doubled" and "production four times" are also considered. Beside, innovation of ETP funded by DANIDA enables to reduce the value of COD by 80%. Estimation of COD additional to downstream in each case is as follows.

Case 1. **No ETP:**

If **50 %** of the water used for irrigation: **75 mg/l of additional in dry season** ×
(12,000 kg/day / (320,000 m^3/day x 0.5)= 75mg/l)

Case 2. **COD load is** reduced **to 20 %** (target for DANIDA ESPS) by ETP:

(12,000 kg/day x 0.2 / 320,000 m^3/day = 7.5mg/l of additional in dry season)

If **50%** of the water used for irrigation: **15 mg/l of additional** ○
(12,000 kg/day x 0.2 / (320,000 m^3/day x 0.5) = 15.0mg/l)

If **80%** of the water used for irrigation: **38 mg/l of additional** ○
(12,000 kg/day x 0.2 / (320,000 m^3/ day x 0.2) = 37.5mg/l)

If **90%** of the water used for irrigation **75 mg/l of additional** ×
(12,000 kg/day x 0.2 / (320,000 m^3/day x 0.1) = 75.0mg/l)

Case 3. **Production** doubled **but COD unit load is reduced to 20%** by ETP:

(12,000 kg/day x 2 x 0.2/320,000m^3/day = 15mg/l of additional)

If **50%** of the water used for irrigation: **30mg/l of additional** ○
(12,000 kg/day x 2 x 0.2 / (320,000m^3/day x 0.5) = 30 mg/l)

If **80%** of the water used for irrigation: **75 mg/l of additional** ×
(12,000 kg/day x 2 x 0.2 / (320,000m3/dayx0.2) = 75.0mg/l)

Case 4. **Production four times but COD unit load is reduced to 20%** by ETP:

(12,000 kg/day x 4 x 0.2/320,000m^3/day = 30.0mg/l of additional)

If **50%** of the water used for irrigation: **60mg/l of additional** ×
(12,000 kg/day x 4 x 0.2 / (320,000m^3/day x 0.5) = 60.0 mg/l)

If **80%** of the water used for irrigation: **150 mg/l of additional** ×
(12,000 kg/day x 4 x 0.2 / (320,000m^3/dayx0.2) = 150mg/l)

Case 5. **Production doubled** but COD of effluent follows **Nepali Standard** of 250 mg/l:

250 mg/l x 4,150,000 l/day = 1,037.5 kg/day of COD load in total
1,037.5 kg/day / 320,000m^3/day = 3.2 mg/l of additional
1,037.5 kg/day x 2 / 320,000m^3/day = 6.5 mg/l of additional

If **50%** of the water used for irrigation: **13 mg/l of additional** ○
(1.037.5 kg/day x 2 / (320,000m^3/day x 0.5) = 13.0mg/l)

If **80%** of the water used for irrigation: **32 mg/l of additional** ○
(1,037.5 kg/day x 2 / (320,000m^3/day x 0.2) = 32.4mg/l)

If **90%** of the water used for irrigation: **65 mg/l of additional** ×
(1,037.5 kg/day x 2 / (320,000m^3/day x 0.1) =64.8mg/l)

Case 6. **Production four times** but COD of effluent follows **Nepali Standard** of 250 mg/l:

250 mg/l x 4,150,000 l/day =1,037.5 kg/day of COD load in total
1,037.5 kg/day x 4/ 320,000m^3/day = 13.0mg/l of additional

If **50%** of the water used for irrigation: **26 mg/l of additional** ○
(1,037.5 kg/day x 4 / (320,000m^3/day x 0.5) = 25.9mg/l)

If **80%** of the water used for irrigation: **65 mg/l of additional** ×
(1,037.5 kg/day x 4 / (320,000m^3/day x 0.2) = 64.8mg/l)

[Note: ×: water quality will be worse than the present condition 50mg/l]
[○: water quality will be better than the present condition 50mg/l]

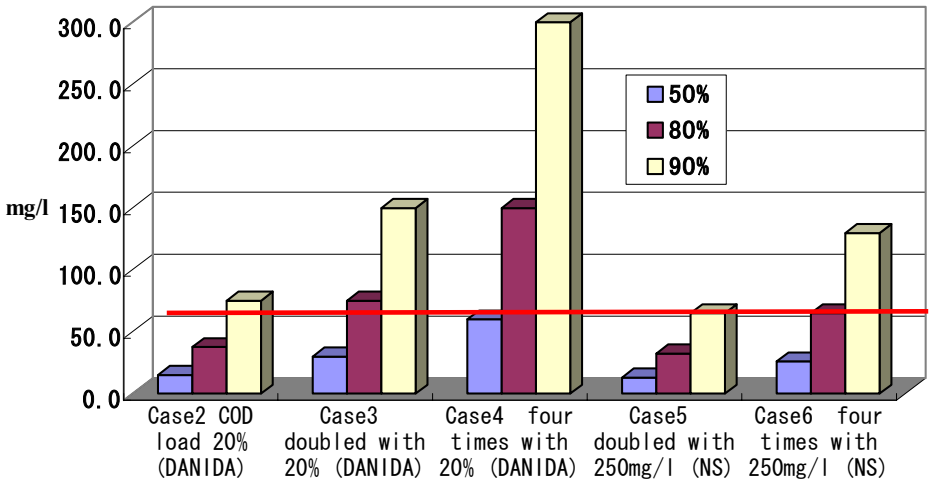


Figure 4.2.1 Estimated COD Values

Estimated Chloride, Sodium, and BOD values calculated with applying the same way of COD estimation hereinbefore are shown below.

Table4.2.2 Estimated COD, BOD, Cl and Na values (mg/l)

	Rate for irrigation of the river	Case2 load 20% (DANIDA)	Case3 doubled with 20% (DANIDA)	Case4 four times with 20% (DANIDA)	Case5 doubled with NS*	Case6 four times NS*	Present Condition
COD	50%	15.0	30.0	**60.0**	13.0	25.9	**50.0**
	80%	37.5	**75.0**	**150.0**	32.4	**64.8**	
	90%	**75.0**	**150.0**	**300.0**	**64.8**	**129.7**	
BOD	50%	10.1	20.3	**40.5**	5.1	10.1	**33.8**
	80%	25.3	**50.6**	**101.3**	12.7	25.3	
	90%	**50.6**	**101.3**	**202.5**	25.3	**50.6**	
Cl	50%	3.8	7.5	15.0	-	-	**12.5 **(600)**
	80%	9.4	**18.8**	**37.5**	-	-	
	90%	**18.8**	**37.5**	**75.0**	-	-	
Na	50%	5.5	11.1	**22.1**	-	-	**18.4 ***(200)**
	80%	13.8	**27.6**	**55.3**	-	-	
	90%	**27.6**	**55.3**	**110.5**	-	-	

Water quality will be worse than the present condition

*No regulation of Cl and Na in NS (Nepal Bureau Standard of Methodology)

**Japanese Standard for Irrigation of paddy

***Japanese Standard for Drinking water

Concerning Sodium and Chloride, provided that 80% of the River water is diverted for irrigation with Paper Mills production of doubled or four times, the value of Cl will be higher than present condition. Japanese standard, however, sets the value of Sodium for drinking water is less than 200 mg/l and that of Cl for Irrigation of paddy is less than 600mg/l. They are quite higher in comparison with calculated value in above. So that even if 90% of water is used for irrigation, it can be concluded that there are no serious problems regarding of Sodium and Chloride.

The findings for each cases based on the above table and figure are as follows:

Case A 50 % use of Sunsari river water for irrigation

As far as the Paper Mills reduce the load to 20% of present value by ETP, even if the production is doubled, values of COD and BOD will not exceed present one and it is likely to have less adverse to the water. However in case of four times production a requirement that the Paper Mill factories have to obey the NS, is should be necessarily satisfied.

Case B 80 % use of Sunsari river water for irrigation

If the paper production remained the same as the present with operation of the ETP, which reduces the effluent to 20%, 80% water diversion would not worsen the values of COD and BOD. However, if the paper production is doubled, the COD and BOD will be worsening than the present condition. If the factories reduce the effluent to the level of Nepal Standard, 80% diversion would not so worsen the present condition though COD under four times production would become a little worse than the present.

Case C 90% water diversion during lean period:

90% water diversion may be out of consideration since the values of COD and BOD would be worsen badly even under the condition that the factories abide by the Nepal Standard except BOD under doubled production with Nepal Standard compliance.

Taking into consideration these situations and findings, recommendations are as follows:

- The factories should reduce the effluent with assistance from DANIDA or otherwise by their own responsibility. If the present situation prevails, the SRIP should not take any water during lean period since the present situation is already beyond the permissible level.

- On condition that the factories install an ETP reducing the effluent to 20%, the SRIP may take Sunsari water up to 50 %. However, if Baba factory runs the production line with the full capacity (four times production than the present), the situation would become worse than the present situation even with the ETP. According to the table above, three times more production would be still within the present condition. Therefore, 50% water diversion during lean period should accompany careful monitoring of both paper production and the river water quality. Also, compensation for fisheries may have to be considered.

- If the SRIP intends 80% water diversion, the Government should enforce the factories to obey the Nepal Standard. Unless otherwise the factories abide by the Nepal Standard, the SRIP should not proceed to the 80% water diversion. Compensation for fisheries should also be considered in case that the SRIP diverts 80% water.

4.2.4 Legal Aspects

EPR describes that no person shall cause the emission of waste from any place in contravention of the standards prescribed by the MOPE in Chapter 3 “Prevention and Control of Pollution”, Rule 15. EPR also describes in Rule 17 “Complaints may be lodged in case anyone causes pollution or emits waste.” In other word, VDCs or Municipals can complain about this problem to the Ministry of Industry.

The Ministry, which has right of jurisdiction over any factories in this country, can give mandatory instruction to the paper mills. Furthermore the Ministry can order to remove the pollutants from the effluent according to the EPR.

4.3 Impact on Fishing Community

4.3.1 Social Condition of Fishermen

Sunsari river and Budhi river basins have rich diversity of culture, living style, socio-economic conditions and settlement pattern of various ethnic gropes. The major gropes are Tharu, Yadav, Mehata, Muslim, Jhangadh, Bahun, Chhetri, and Mallah.

Out of these groups, Mallah people who sometimes are called Gudhi, have been engaged in fishery traditionally depending on Sunsari river, Old Sunsari river and sometimes other rivers.

Their communities in the Study area lie in the following VDCs; Ghuski, Ramnagar Bhutaha and Narusimha in the Study area. The number of their household is estimated at around 180 (See **Figure-9**). 17 persons out of 180 fishers are part time fishers. Fishing is a completely male's job and very often observed through the Sunsari river and Old Sunsari river. The fishing is done individually. There are 20, 100 and 60 households in Narusimha VDC, Ramnagar Bhutaha VDC and Ghuski VDC, respectively. The number of Mallah people is estimated at around one thousand.

Generally they are marginal people and many of them are landless. An example is that 50 household out of 60 households in the Ghuski VDC are landless. Even if they have any lands, the area of land in most cases is quite small, less than 0.5 ha.

There is descendent community leader in Vikrampur village, Ghuski VDC and informal leader in Mallahtol village, Ramnagar Bhutaha VDC, they don't have any committees or organizations formed by them though. On the contrary, they have communication with the same Mallah people living in different VDCs and get together for the purpose of religion events etc.

Sometimes they are hired as labors in other's farmland or fishponds. But their incomes mainly rely on fishery in Sunsari river, Old Sunsari, Budhi river and sometimes Koshi river. Their incomes are often insufficient to support their families properly, sometimes compelling them to miss their meals.

4.3.2 Adverse Impacts on the People

The fish population in Sunsari river is likely to be adversely affected due to the decrease of the river flow. It could give significant impacts on the fisher people and could have poor people even now become poorer.

Most of the participants of Farmer Level Consultation meetings were of the opinion that Sunsari river is not a good source of fish and they did not consider fishing as a major problem. On the contrary the fishermen said that Sunsari river is a better source of fish as compared to other rivers in the locality.

Most of the fishermen were of the opinion that irrigation project, though essential, would be beneficial for farmers but would be no use to landless fishermen. They emphasized that their main occupation is fishing. They were of the opinion that downstream releases of the order of 10-20% during lean period are not likely to work due to low velocity and consequently no upward migration of the fishes.

4.3.3 Interaction/Consultation with People

An interaction/consultation meeting was organized on August 14, 2002 with the fishermen of Ramnagar Bhutaha VDC ward no. 8 in their locality. 42 fishermen from the village took part in the discussion. Their opinions, suggestions and comments were found to be as follows:

- Most of them were of the opinion that Irrigation project, though essential, would be

beneficial for farmers but would be of no use to landless fishermen,

- They emphasized that their main occupation is fishing,
- Irrigate the proposed Study area of SRIP from SMIP and do not disturb Sunsari river,
- In contrary to the statement of most of the participants of Farmer Level Consultation Workshops some of them said that Sunsari river is a better source of fishes as compared to other rivers in the locality,
- They suggested fish culture in community ponds as an alternative managed by their own organization. When asked about their contribution in making these ponds they said that they would contribute to the extent possible,
- Those with some lands agreed that they would be benefited through irrigation by growing vegetables, etc.
- They were of the opinion that downstream releases of the order of 10-20% during lean period are not likely to work due to low velocity and consequently no upward migration of the fishes,
- Most of them did not accept the idea of earning by working as farm labor, simply by saying that they are not used to it. They prefer to go for fishing irrespective of getting good catch or not,
- They said that fish population in Sunsari river was constantly decreasing after the paper mills started operating. They were of the opinion that the mills should not be allowed to release the untreated effluents in the river,
- Regarding fishing in Mariya Dhar, at present many people claim the land within the Dhar as private. They expressed doubts whether the land that people are claiming as private is really private. Quite often there are conflicts that are generally settled by giving half of the catch. In their opinion resolution of the ownership problem and a weir/bund for pond construction about one meter depth of water in it (Dhar) would be the most appropriate alternative to them. When asked whether VDC can resolve the ownership issue, they answered in negative and indicated towards some higher levels of HMG/N.

The participants were given a questionnaire related to fishing. 20 of them were returned to the Study Team duly filled. Their answers are categorized under different sections as below:

- Major source of income

  fishing – 100%

  fishing as well as farming – 20%

  fishing as well as working as farm labor – 20%

- Fishing time (months/year)

  year round – 35%

  9 – 11 months – 10%

  6 – 9 months – 35%

  less than 6 months – 10%

- Family members working partly as farm labor – 50 % of the respondents have mentioned that some of their family members work as farm labor.
- River mostly used for fishing

  Sunsari only – 70%

  Sunsari and Mariya Dhar – 25%

  Sunsari, Koshi and Mariya Dhar – 10%
- Maximum catch on an average – 6 kg/day during October – December
- Minimum catch on an average – 1/2 kg/day during July – August
- Conflicts with the people during fishing who claim that they have land inside the Mariya Dhar

  usually – 55%

  sometimes – 45%

  never – 0%
- Is it necessary to implement SRIP?

  yes – 30%

  no – 55%
- To what extent fish catches in Sunsari river will be adversely affected by SRIP?

  no effect – 10%

  decrease in catch by half - 20%

  decrease in catch by more than half - 40%
- After SRIP can you fish in the canals instead of in Sunsari river?

  yes – 5%

  no – 75%

  yes but less fish in the canal than in the river – 20%

4.3.4 Compensation for Fisheries

1) Introduction of Aquaculture

Though the headwork will release a regulatory flow to the downstream reaches to keep the biodiversity in Sunsari river, there will be adverse effect on the fisheries due to the decrease of the flow. In reality, the two paper factories have already affected the fisheries to certain extent. Taking into account the present situation already deteriorating and also their social status, the Project should actively undertake a measure to promote fish culture for the fishermen.

A program funded by UNDP, "Park and people" program has promoted various projects including fish culture since 1995. The staffs facilitated them to organize "functional

groups"[*1] and provided various trainings to them, and also fishponds. DADO also has been in charged of fish culture promotion, the staffs have sufficient experience, which can serve benefit for inland fishery encouragement. Therefore, it can be concluded inland fishery promotion could be an option as compensations for the fish population decrease.

It is recommendable that fishers establish some groups for the inland fishery promotion. In turn proper trainings relevant to aquaculture, namely, production, harvest, processing and marketing also should be provided to the people.

Besides, there are three public sector fish hatcheries with the Eastern Development Region (near the proposed project area) as listed below. Required number of fish seed could be supplied from one of these hatcheries.

- Fisheries Research Center – Tarahara, Sunsari District
- Fisheries Development Center – Fattepur, Saptari District
- Fisheries Development Center – Lahan, Siraha District

Given the situation fishermen are landless at most case, it is difficult to construct for fishponds in their land. Besides, sandy soil which prevailing in the Study area is not suitable for construction of fishpond. Therefore utilization of Mariya Dhar (Old Sunsari river), where silt and clay soil are partly ranged, for fish culture activities will be useful.

There are three systems of aquaculture in Nepal, namely, extensive, semi-intensive and intensive culture (see **Table 4.3.1**). Supposing 0.2ha semi-intensive fishpond per a household is installed, it can compensate for decrease of fish population in the river as shown in **Table 4.3.2**. Taking into consideration their skill, land acquisition and feasibility, semi-intensive culture is applicable in the area. The number of fishers' households is 180 at present, so that 36ha lands for fishpond is required in case introduction of semi-intensive culture.

Table 4.3.1 Systems of fish culture in Nepal

	Extensive culture	Semi-Intensive culture	Intensive culture
Feeding	Nothing	**Nothing**	Applied
Fertilizer	Nothing	**Applied**	Applied
Liming	Applied	**Applied**	Applied

Table 4.3.2 The Comparison of Incomes from Fishery and Fish Culture (Rs/yr)

	Present fishery per household	Extensive culture per 0.3ha	Semi-Intensive culture per 0.2ha	Intensive culture per 0.2ha
Operation Cost	0	5,100	**5,295**	13,255
Gross Income	25,200	24,150	**31,500**	49,000
Net income	25,200	19,050	**26,205**	35,745

Resource: Agriculture Diary 2002, Agriculture Information and Communication Centre

Basic data for calculation is described in Table-8 and Table-9 in Attachment.

[*1] The functional groups are composed of 10 members. Each group wrestles various activities such as irrigation promotion, fishery development, etc. The funds for the activities are supplied as a credit of interest-free by the program.

Fishpond construction cost per hectare is around Rs.200,000 and if purchase of land is necessary, the cost is estimated at about Rs.300,000 according to DADO. On the contrary the cost of area along Mariya Dhar is lower accounting Rs.100,000. Landholding situation along the Mariya Dhar, however, is partly registered and ensured as mentioned in **Chapter 4.3.5** below. Some parts of the area might belong to not government but individuals, it is uncertain at present though.

2) Farmland provision

In addition to above measures, another countermeasure, namely farmland provision to fishers can be examined as compensation. The fishers have not cultivated their farming skill, so that it is very difficult for them to grow any kind of crops. Therefore, the Team proposes an idea of farmland shared. Supposing the people can gain farmlands, they can lease the lands to farmers aiming at acquisition of rental fee. In addition to that the fishers can be employed as labor forces, taking advantage of vacant time.

3) Cost estimation of compensations

It is common that rental fee of farmland is a half of net income in Southeast and South Asian countries. However, the Team supposes the benefits from the farming not to be shared, but entirely given to a fisher when the costs are estimated herein. It is because that the lands have high potential to generate much more net incomes by the project. In that case the area of 108 ha is required to compensate the people, the expense of land purchase is arrived at Rs.32,400,000 as shown below.

In turn provided inland fishery targeting all 180 fishers are applied, cost estimation of the fishery, which balance for their present incomes, are arrived around Rs.30,000,000 as follows:

Table 4.3.3 The Case Study for Cost estimation of Compensation measures (Rs)

Case	Case1 Semi-Intensive aquaculture (in Mariya Dhar)	Case2 Semi-Intensive aquaculture (in farmland)	Case3 Intensive aquaculture (in Mariya Dhar)	Case4 Farmland
(1) Whole required area*	43.2ha	43.2ha	32.4ha	108.0ha
(2) Land acquisition	4,320,000	12,960,000	3,240,000	32,400,000
(3) Constructions	8,640,000	8,640,000	6,480,000	-
(4) Initial cost for operation	1,143,720	1,143,720	2,147,310	-
Sub-total	14,103,720	22,743,720	11,867,310	32,400,000
(5) Extension service cost for 3 years	15,756,000	15,756,000	15,756,000	-
Grand Total	**29,859,720**	**38,499,720**	**27,623,310**	**32,400,000**

*Actual required area is 36 ha for fish culture, it additionally accompanies 20% of that as levee.

4.3.5 Possible Development of Mariya Dhar

On the one hand some of the participants of the district level as well as farmer level consultation meetings suggested that Mariya Dhar could be developed as a compensatory

measure for fish culture. At the same time, on the other hand some of them raised doubts about the possible development of the Dhar as an alternate fishery option. They said that most of the land within it is private, either registered or people are using it and paying tax to VDC.

The Study Team in an attempt to find the status of the land within the Dhar contacted District Survey Office, Land Revenue Office and Land Reforms Office etc., in Inaruwa. But almost no information was obtained. The only information the Team could obtain was that the land within the Dhar was distributed to landless people by different Commissions at different times. Some of them were already given the ownership certificate (Lal Purja). Others are yet to be given. The papers prepared by the latest Commission are sealed after it was disbanded about a year ago.

Now a new committee has been formed under the chairmanship of C.D.O. with a mandate to finalize the task within six months for cases already decided by the Commission. The cadastral maps of the Dhar showed a number of small plots with plot number. But, whether the ownership certificates have been distributed to all those plots or not was not clear. The record on the Survey Office only had a remark saying "Plotting as obtained form the High Level Commission". The maps of Ramnagar Bhutaha ward No.1 and 2 showed that in some locations the Dhar had no right of way. All the above offices were of the same opinion that real status of the lands could only be obtained through field verification and enquiry.

Suggested approach:

- Differentiate private and public land within the Dhar,
- Calculate the amount of compensation to be given to private land,
- Evaluate the techno-economic viability of the proposal,
- Identify a workable and agreeable mode of management of the proposed fish culture in the Dhar and
- Finally, explore whether the proposal is socially acceptable.

4.4 Water Use along Sunsari river

Often seen is pump irrigation from Sunsari river. Practice of extracting water includes pumping of water into a circular earthen bund. Small earthen canals carry the water from the pool of water collected into the circular bund to the fields. However, such canals irrigate fields only up to 200 m from the bank of rivers, as irrigating land at a distance more than that becomes economically unfeasible. Thus, farmers generally use shallow tube well for irrigating their fields that are more than 200 m away from the river bank.

A total of 266 pumping locations of the type mentioned above were observed in May 2002 at the downstream of the bridge of East-West highway to the border with India. Approximately 230 ha of land is being served by the 266 pumping stations along the Sunsari river. By considering pumping capacity of 20 l/s and number of pumps available in nearby villages which is about 20 according to interview, the total water extraction at maximum during dry season from Sunsari river is calculated below:

Total water drawn from Sunsari river = 20 X 20 = 400 l/s 0.40 m^3/s (at maximum)

Note: this is regarded as maximum value since all the 20 pumps are supposed to operate simultaneously.

SRIP is to release 50% water, which is 1.8 m^3/s, to downstream during winter season, so that the pump irrigation requiring 0.4 m^3/s at maximum would not be affected. At a latter stage, SRIP is expected to divert 80% water, on condition that the paper factories abide by Nepal Standard. 80% diversion means 0.7 m^3/s release to downstream, which is still more than the total pump irrigation requirement. Therefore, the SRIP is not expected to take any compensation measure for the pump irrigation along the river. Noted here is that the pump irrigation should be alternated to shallow tube well since the water is already heavily polluted. The government should facilitate the farmers to stop pumping up the polluted water and shift to shallow tube wells irrigation.

4.5 Aquatic Biodiversity of Sunsari river

So many and various aquaculture from microorganism to large-size fish like eels or catfishes range in the river. They are affected each other in the river and they have quite closed relationship. If the environment surrounding them is changed, they will receive serious adverse effects. Based on these understandings the Team conducted a study of present aquatic biodiversity in Sunsari river and impact assessment of the project on aquaculture. The summaries of results are followings, and details such as aquaculture list in Sunsari river are shown in **Figure-7** in Attachment.

4.5.1 Present Conditions

1) Planktons

Aquatic invertebrates are the most important resources, which are the link in the production process in aquatic ecosystem, because they are primary consumers and carnivores. They form the natural food source for several fishes. Altogether thirty-five species of phytoplankton belonging to cynophyceae bacillariophyceae, chlorophyceae and pyrrophyceae were recorded during investigation period (during May 2001). Zooplanktons were found only rotifers, copepods and cladocerans. During this study, rotifers were found to be more abundant than copepods and cladocera.

2) Larger Invertebrates

Altogether thirty-five groups of macro invertebrates belonging to seven orders of arthropods are identified. Two types of animal (temporary and permanent fauna) are found in the fresh water environment. Temporary fauna spend only a part of their life whereas permanent fauna spend their entire life in the ecosystem.

3) Fish Species Diversity

The fish species of Sunsari river are forty-eight, which is shown in Attachment. These River supports biological diverse species like carps, catfishes, loaches and minnow. These collections represent from upstream and downstream of proposed and existing headwork axis of Sunsari respectively. The principal fish species of Sunsari river are grouped as follows:

Carps	:	River carp (*Lebeo rohita, L. gonius, L. dero, L. pangusia, Catla-catla, Cirrhina mrigal*) and other species like *Crossocheilus latius, Chagunius chagunio*, etc.
Cat fishes	:	*Clupisoma garua*, *Mystus spp*.
Loaches	:	Stone loach (*Noemacheilus beavani, N. botia, Lepidvcephalichthys guntea, L. nepalensis, heteropneustes fossils*.
Eels	:	Swamp *eel (Amphipnous Cuchia, Mastacembelus pancalus, Macrognothus aculatus*) fresh water eel (*Anguilla bengalensis*).
Barbs	:	*Puntius sophore, P.ticto, P.titius, P.sarana, Chanda nama, Colisa patius, Sicamugil cascasia.*
Minnows	:	Barilius shacra, B, barna, Essomus dandricus, Rasbora daniconius etc.

4.5.2 Adverse impacts on Aquatic Biodiversity in Sunsari river

1) Loss of aquatic invertebrates

Dewatering below the headwork for a stretch of about 26 km in Sunsari river will have the serious impacts on micro flora and aquatic invertebrates. Mainly three groups of fauna, Plecoptera, Ephemeroptera and Tricoptera will get more affected by the headwork on the river. These faunal groups have a narrow range of tolerance to changes in the nature of environmental factors such as temperature, dissolved oxygen, pH and carbon dioxide levels.

The number of abundant groups of the fauna, Baetidae, Heptageniidae, *Simulium (Simulium) himalayense Simulium (Simulium)* sp. will be decreased drastically due to new environment by the river impoundment. Rare faunal groups e.g. Leptophlebidae, Tricorythidae and Lepidostomidae may be disappeared from the river due to changes in the environmental conditions of the river. These groups of animals may be replaced by other groups of fauna. Macro-invertebrates are considered as the major food resources of fishes. Therefore, some groups of the fishes may either disappear from the river or change their feeding habit.

2) Impacts on fish

The fish species which have ecologically adapted to a flowing conditions will find the new condition in the Sunsari river untenable, while species which in the river system are restricted to pools, would adapt to the new conditions. Changes in the composition and abundance of both the planktonic and benthic communities resulting from the reservoir formation would also affect the food supply of many species of fish, some adversely, some favorably. This factor will eventually influence the species composition in the fish population.

It is therefore possible to predict, before the formation of the Sunsari headwork that the fish population will be dominated by pool dwellers and species unselective in their choice of habitat. Likewise the species, which for various reasons require a riverine environment, would decrease in number. List of major fishes, which require flowing condition and pool dwellers, are presented below:

Table 4.5.1 List of Major Types of Fishes (Pool Dwellers and Flowing Water)

Pool Dweller Fishes	Flowing Water Fishes
Channa marulius	*Catla catla*
C. panctatus	*Labeo rohita*
C. striatus	*Noemacheilus spp.*
Clarius batrachus	*Puntius spp.*
Heteropneustes fossilis	*Barrilius spp.*
Macrognathus aculeatus	*Mystus spp.*
Mastacemblus puncalus	*Wallago attu*
Labeo gonius	*Anguilla bengalensis*
Cirrhinus rewa	*Xenentodol concila*
Oxygaster bacaila	
Cirrhinus mrigala	

After water diversion from the river, at least 10% of the average flow in dry season should be released based on general practice in this Country. Usually compensation water provision is within 10-20% of long-term average flow according to Struthers, 1991 (Scotland). The Team has a plan to design headwork accompanied with fish path to conserve fish species, together with 20-50% downstream release.

4.6 Public Consultation

The Study Team made a number of visits to the Study area to inform the local people about the scope of work under the project and to solicit their opinions, to have a first-hand look of the canal system, and to observe the natural ecosystem, especially aquaculture condition. On such occasions discussions were made regarding the environmental issues related to the project and their opinions collected. Apart from this one district level and four farmer level consultation meetings were organized on 1st, 5th, 7th, 9th and 11th of August 2002. For the farmer level meetings the 13 VDCs of the Study area were divided in four groups as shown in the table below:

Table 4.6.1 Schedule of Farmer Level Consultation Meetings

S. No.	Date	Venue	VDCs	No. of participants
1	August 5, 2002	Primary Teachers' Training Centre, Inaruwa	Narsingh, Babiya and Jalpapur	56
2	August 7, 2002	Krishna Secondary School, Bhutaha	Ramnagar, Bhutaha, Gautampur and Basantpur	70
3	August 9, 2002	Harinahara Higher Secondary School	Harinagara, Madhya Harsahi and Rajganj Sinwari	71
4	August 11, 2002	Kaptanganj Higher Secondary School	Kaptanganj, Devanganj, Ghuski and Sahebganj	85

The main opinions, suggestions and comments obtained during the consultation meetings are summarized below:

Positive impacts:

- Silt carried by the canal water can act as fertilizer, increase in cropping intensity, increase

in productivity and production, construction of access roads, more employment opportunities in agriculture sector etc. and in an overall sense betterment in the living conditions of the people.

Negative impacts

- Water quality downstream of the headwork needs attention especially in the context of reduced flow in the river during winter and spring season and release of the effluents from the paper mills.
- Existing downstream use (for lift irrigation, cattle watering etc.) may be impaired. When asked about the minimum release in the river for environmental considerations, a compromise between irrigation and ecology during lean period, they suggested 10-25% of the flow.
- Compensatory fish culture in Mariya Dhar might be a better alternative if the ownership issue of the land can be resolved.
- Inundation is a problem in some part of the project area and might get worse.
- The erosion problem exists and might continue.

Other comments:

- VDCs would make some land available for making ponds for community fish culture.
- Fishermen, these days, take private ponds in contract and are also engaged as middle men in fish trade.
- The river is fed by spring source. Some of the participants expressed doubts about the water from spring after construction of deep cutoffs in the headwork.
- Some of them raised doubts about the possible development of Mariya Dhar as an alternate fishery option. They said that most of the land within the Dhar is private either registered in somebody's name or in the sense that people are using it and paying tax to VDC.
- Sunsari is not a good source of fish and fishing in it is not a major problem, fishermen can fish in canal and also act as farm labor. They can also fish in the upstream of headwork [*2].

4.7 Environmental Monitoring Plan

Based on the activities and adverse impacts in **Table 4.1.2**, the following indicators are proposed to monitor the changes of environment due to the construction and operation of the project and to check the effectiveness of the mitigation measures planned. Monitoring provides necessary information for decision makers to evaluate the situation and to take additional measures to minimize the adverse impacts, which might be bigger in magnitude and larger in extent than originally thought.

[*2] This comment from a farmer is just opposite to that of fishers' shown in Chapter 4.3.3. It may come from farmer's misunderstanding about fisheries, it is not clear though.

Table. 4.7.1 Environmental Monitoring Plan

Indicators	Schedule	Method	Main Actor(s)	Sampling Points	Particulars
Preparation Stage					
- Incorporation of mitigation measures in the design and tender document	During approval	Review process	Project and MOWR	-	-
- Production, water consumption and environmental management of Baba Paper Mill	Once a month	Observation and inquiry	Project	-	-
- Construction of ETP at Baba and Arvind Paper Mills	-	-	The Paper Mills	-	-
- Water Quality of Sunsari River, discharge from Baba and Arvind Paper Mills and groundwater around Baba Paper Mill	Once a month in lean season	On-site check	Project	See Figure 4.7.1	pH, EC, COD and DO
	Once in monsoon season	On-site check	Project	Ditto	Ditto
	Once in three months	Laboratory test	Project	Ditto	A*
Construction Stage					
- Water Quality of Sunsari River, discharge from Baba and Arvind Paper Mills and groundwater around Baba Paper Mill	Once a month	On-site check	Project	See Figure 4.7.1	pH, EC, COD and DO
	Once in three months	Laboratory test	Project	Ditto	A*
- Condition of woods	Once in three months	Observation and inquiry	Project	Around the camp(s)	Density and species of plants
- Health and sanitation facilities at work and labor camp(s)	Once in three months, or if required	Observation and inquiry	Project	At the camp(s)	Water works and sewerage
- Heavy traffic, noise, social disharmony etc.	Twice a year or if any complaints	Public hearing	Project	At east-west highway bridge	Any complaints
Operational Stage					
- Water Quality of Sunsari River, discharge from Baba and Arvind Paper Mills	Once a month	On-site check	Project	See Figure 4.7.1	pH, EC, COD and DO
	Once in three months	Laboratory test	Project	Ditto	A*
- Flow in Sunsari River	Everyday	Measurement	Project	See Figure 4.7.1	Flow
- Fishes in Sunsari River	Once in each monsoon and lean season	Observation and inquiry	Project	See Figure 4.7.1	Identification of the fish species
- Grass along Sunsari River	Once in each monsoon and lean season	Observation and inquiry	Project	See Figure 4.7.1	Identification of the grass species
- Water use by pump irrigation along Sunsari River	Once in lean season	Observation and inquiry	Project	Along the Sunsari river	The number of pump station
- Water use by hand-pump wells along Sunsari River	Once in lean season	Observation and inquiry	Project	Ditto	Ditto
- Compensatory fish culture	Once in lean season	Inquiry	Project	At three VDCs See Figure 9 in attachment	Cost and income of aquaculture
- Downstream erosion at the initial stage	Once in lean season	Observation and inquiry	Project	Just downstream of the headworks	Erosion
- Silt load in Sunsari River	Once in lean season	On-site check	Project	See Figure 4.7.1	Suspended solid of the river
- Silt deposit in the canals	Once a year	Observation	WUC	See Figure 4.7.1	The depth of silt in the canals
- Plantation on the spoil banks and its management	Once in monsoon season	Observation	WUC	At the banks	The density of plants
- Vector-borne diseases	Once after and before monsoon	Public hearing, Inquiry	Project	At hospitals	The number of patients
- Plantation of catchments area and its management	Twice a year	Plantation and management	Project, WUC	At catchments	The density of plants

A* The parameters of water quality test in laboratory are COD, BOD, Iron, Arsenic, Chromium and Manganese.

CHAPTER 5 PLANNING ASSESSMNET

Alternative analysis has been done as a planning assessment in terms of command area, amount of intake, location of the intake, intake design and water sources. The alternative of canal alignment was not included because the two canals of the Project, which are Suksena Canal and Shankarpur Canal, were constructed by SMIP and already exist in the area. Also the do-nothing alternative was not considered because the command area of the Project was already the command area of SMIP and the irrigation project has been there since 1964.

5.1 Alternatives of Command Area

The canal water cannot flow to the 397 ha of land in Kaptanganj VDC by gravity because of the higher elevation of the area, so that the Study Team proposes shallow tube wells for this area from technical and economic feasibility.

5.2 Alternatives of Amount of Intake

Although the flow of Sunsari river is not enough for full irrigation of the command area, some amount of water shall remain in the river for water quality, fishes, downstream water users and vegetation etc. Especially, the water quality of Sunsari river is already a big problem because of two paper mills, so that no water can be taken from the river unless the two paper mills construct an effluent treatment plant.

5.3 Alternatives of Intake Site

Sunsari District Irrigation Office originally proposed the intake site location at downstream of the outlets of Arvind and Baba Paper Mills. However, the proposed site was moved to 600m downstream of E-W highway, and upstream of the outlets of paper mills. The advantage of the new location is that irrigation water will not be affected by the discharge of two paper mills, which are not suitable for irrigation. Also the new location is on a relatively straight reach of the river. A site upstream of the E-W highway was also ruled out based on techno-economic ground.

5.4 Alternatives of the Intake Design

The Study Team has decided to choose an intake design with fish passage to reduce the impact to fishes.

5.5 Alternatives of Water Sources

Since the flow of Sunsari river at lean season is less than the required amount for irrigation, alternative water sources of SMIP water, groundwater as well as preventive irrigation, which requires less water were considered.

5.6 Comparison of Alternatives

Two alternatives regarding command area, three alternatives regarding amount of intake, two alternatives regarding intake site, and four alternatives regarding water sources are compared in adverse impacts.

Table 5.6.1 Alternatives and Likely Adverse Impacts

Alternatives	Adverse Impacts
(1) Alternative of Command Area	
1) To include all the Study area	1) Need tube wells and fuels. 2) No benefit for the people who cannot get irrigation water.
2) To exclude the 397ha of Kaptanganj	
(2) Alternative of Amount of Intake	
1) To take 50% of the water in Sunsari river in lean season	1) Less likely to have severe water pollution in Sunsari river, as long as the two paper mills construct ETP. Possible water use conflicts due to very limited water supply.
2) To take 80% of the water in Sunsari river in lean season	2) Less likely to have severe water pollution in Sunsari river as far as discharge of the two paper mills is below the Nepali Standard (COD discharge: 250 mg/l) and any compensation are taken and agreed with fishers.
3) To take 90% of the water in Sunsari river in lean season	3) Likely to have more severe water pollution problem, even if the discharge of the two paper mills is below the Nepali Standard (COD discharge: 250 mg/l). Also fishes cannot migrate in the leanest season.
(3) Alternative of Intake Site	
1) Downstream of the outlets of two paper mills	1) Not likely suitable for irrigation water due to the discharge of the two paper mills.
2) Downstream of E-W highway and upstream of the outlets of two paper mills	2) No impact from the discharge of the two paper mills.
(4) Alternative of Intake Design	
1) Weir + under sluices	1) Likely to have more adverse impacts on fishes.
2) Barrage + under sluices + fish passage	2) Likely to have less adverse impacts on fishes.
(5) Alternative of Water Sources	
1) Sunsari river only	1) Possible water use conflicts due to very limited water supply.
2) Sunsari river + SMIP water	2) Possible water use conflicts among canals.
3) Sunsari river + deep wells	3) Need electricity. Possible lowering groundwater table and possible ground water pollution in long-term.
4) Sunsari river + shallow wells	4) Possible lowering groundwater table and impact on the villagers who are using shallow wells.

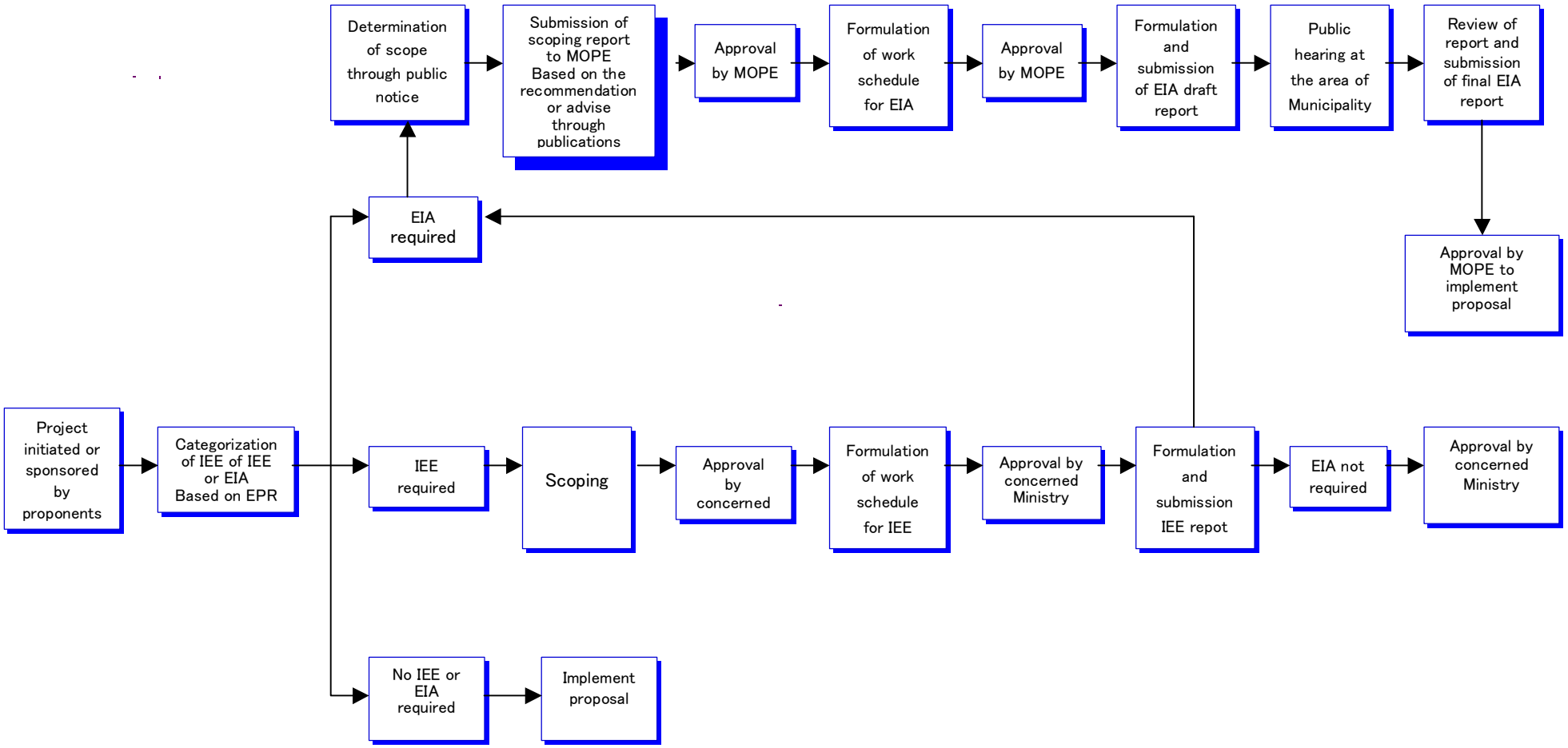


Figure-1 Procedure of IEE and EIA (made based on EPR)

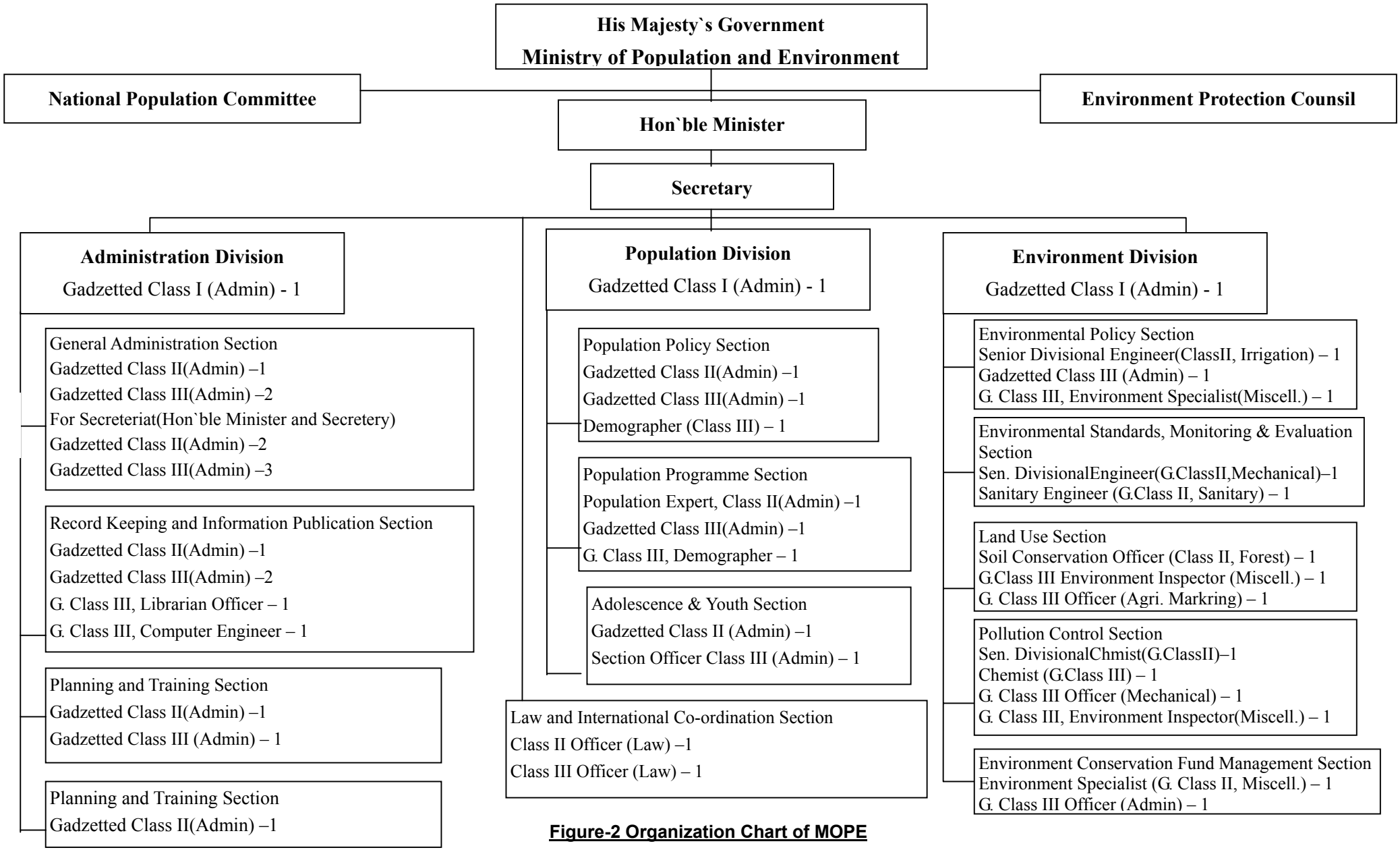


Figure-2 Organization Chart of MOPE

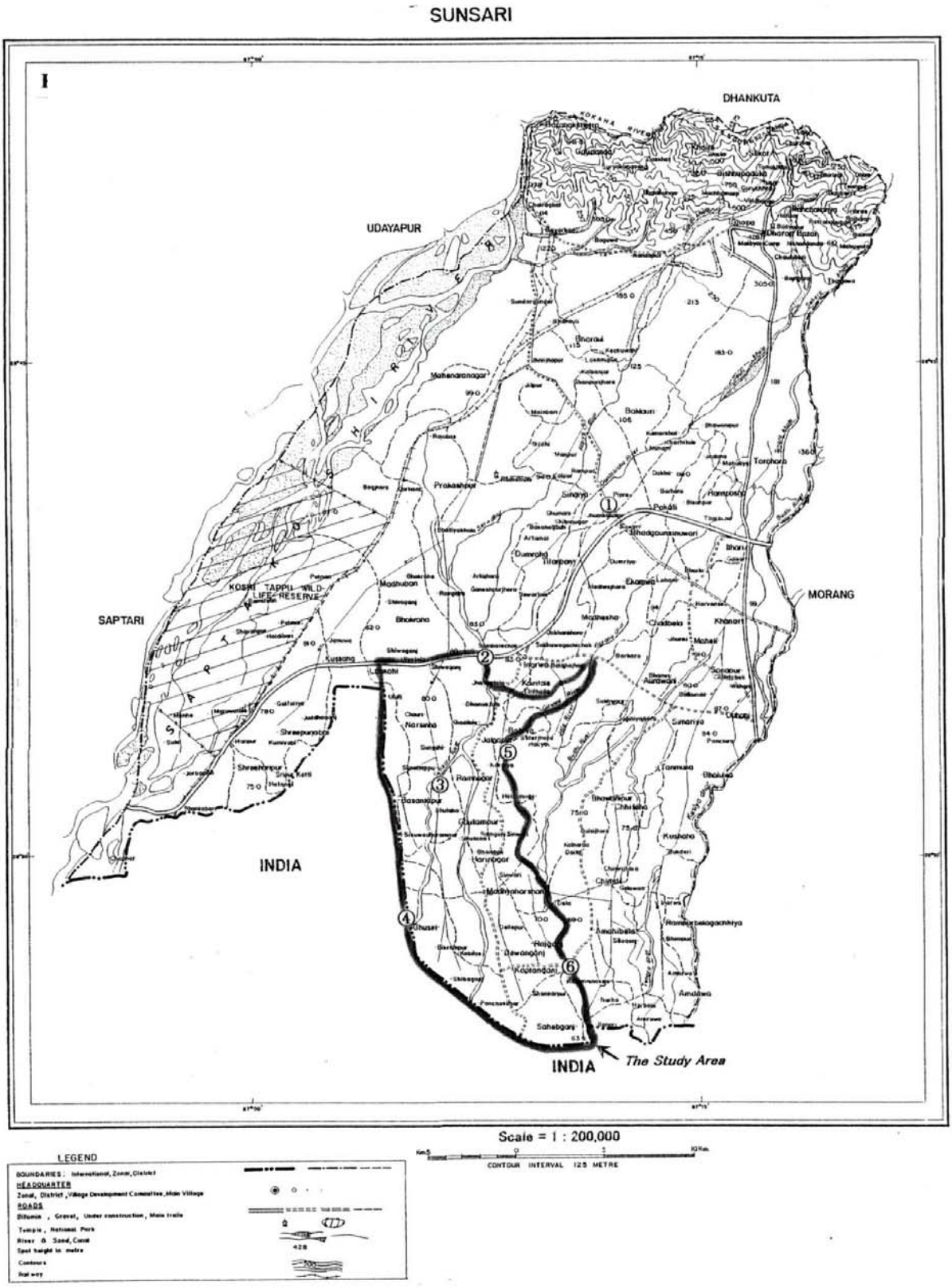
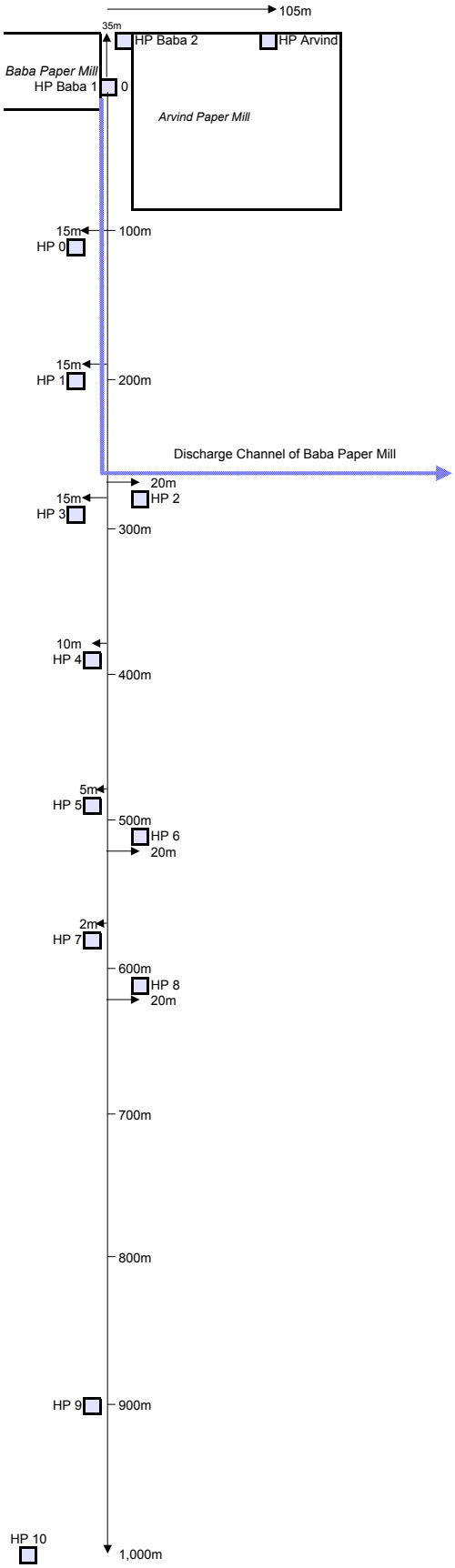


Figure-3 Location Map of sampling for surface water quality check



EC Data of Hand-pump Wells near Paper Mills

Identification of the Hand-pump Wells	Depth [feet]	Material of Tube	Approx. Distance [m]	EC [mS/m)λ18°C				
				04-Aug-	06-Aug-	08-Aug-	14-Aug-	16-Aug-
HP Baba 1(In Front of the Gate)	25	Polyethelene	0	39.44	38.96	39.39	40.84	40.62
HP Baba 2(In Front of Tea Shop)	25	Polyethelene	37		47.23	47.51	47.91	47.38
HP Arvind		Polyethelene	109			35.87	35.79	35.36
HP 0 (Basiruddin)	25	Polyethelene	112		41.37	40.60		39.54
HP 1 (Safeed I)	25	Polyethelene	194	40.62	39.95	40.58		40.52
HP 2 (Saefeed II, the Other Side)	26	Polyethelene	281	42.82	42.45	42.91		43.58
HP 3 (Allauddin Ansari)	18	Galvanized Iron	293	45.09	45.28	44.48		44.25
HP 4 (Allauddin Mansuri)	30	Galvanized Iron	389		65.13	65.06		62.66
HP 5 (Kishan Lal)	25	Polyethelene	490		49.64	52.84		53.58
HP 6 (Sukh Deb, the Other Side)	25	Polyethelene	509		69.04	71.39		68.12
HP 7 (Indra Lal Urao)	35	Polyethelene	581		42.86	42.72		38.08
HP 8 (Taiyub Ansari, the Other Sid	20	Polyethelene	612		55.87	54.13		47.66
HP 9 (Usman Mansuri)		Polyethelene	900		50.09	51.08		52.75
HP 10 (Paltu Ram, 1 km Down)	25	Polyethelene	1000		45.44	45.30		45.41

Salinity Data of Hand-pump Wells near Paper Mills

Identification of the Hand-pump Wells	Depth [feet]	Material of Tube	Approx. Distance [m]	Salinity [mg/L]				
				04-Aug-	06-Aug-	08-Aug-	14-Aug-	16-Aug-
HP Baba 1(In Front of the Gate)	25	Polyethelene	0	0.01	0.02	0.01	0.02	0.02
HP Baba 2(In Front of Tea Shop)	25	Polyethelene	37		0.02	0.02	0.02	0.02
HP Arvind		Polyethelene	109			0.01	0.01	0.01
HP 0 (Basiruddin)	25	Polyethelene	112		0.02	0.02		0.02
HP 1 (Safeed I)	25	Polyethelene	194	0.01	0.01	0.02		0.02
HP 2 (Saefeed II, the Other Side)	26	Polyethelene	281	0.02	0.02	0.02		0.02
HP 3 (Allauddin Ansari)	18	Galvanized Iron	293	0.02	0.02	0.02		0.02
HP 4 (Allauddin Mansuri)	30	Galvanized Iron	389		0.03	0.03		0.03
HP 5 (Kishan Lal)	25	Polyethelene	490		0.02	0.02		0.03
HP 6 (Sukh Deb, the Other Side)	25	Polyethelene	509		0.03	0.04		0.04
HP 7 (Indra Lal Urao)	35	Polyethelene	581		0.02	0.02		0.02
HP 8 (Taiyub Ansari, the Other Sid	20	Polyethelene	612		0.03	0.02		0.02
HP 9 (Usman Mansuri)		Polyethelene	900		0.02	0.02		0.02
HP 10 (Paltu Ram, 1 km Down)	25	Polyethelene	1000		0.02	0.02		0.02

pH Data of Hand-pump Wells near Paper Mills

Identification of the Hand-pump Wells	Depth [feet]	Material of Tube	Approx. Distance [m]	pH [pH]				
				04-Aug-	06-Aug-	08-Aug-	14-Aug-	16-Aug-
HP Baba 1(In Front of the Gate)	25	Polyethelene	0	6.93	6.83	6.88	7.14	7.03
HP Baba 2(In Front of Tea Shop)	25	Polyethelene	37		6.68	6.75	6.92	7.02
HP Arvind		Polyethelene	109			7.07	7.34	7.17
HP 0 (Basiruddin)	25	Polyethelene	112		6.99	7.01		7.13
HP 1 (Safeed I)	25	Polyethelene	194	6.95	7.07	7.04		7.19
HP 2 (Saefeed II, the Other Side)	26	Polyethelene	281	6.86	6.98	7.05		7.07
HP 3 (Allauddin Ansari)	18	Galvanized Iron	293	7.03	6.95	7.01		7.09
HP 4 (Allauddin Mansuri)	30	Galvanized Iron	389		6.82	7.02		7.08
HP 5 (Kishan Lal)	25	Polyethelene	490		6.94	6.97		7.05
HP 6 (Sukh Deb, the Other Side)	25	Polyethelene	509		6.83	6.91		7.05
HP 7 (Indra Lal Urao)	35	Polyethelene	581		6.96	7.08		7.28
HP 8 (Taiyub Ansari, the Other Sid	20	Polyethelene	612		6.79	6.90		7.01
HP 9 (Usman Mansuri)		Polyethelene	900		7.04	7.05		7.12
HP 10 (Paltu Ram, 1 km Down)	25	Polyethelene	1000		7.17	7.21		7.26

DO Data of Hand-pump Wells near Paper Mills

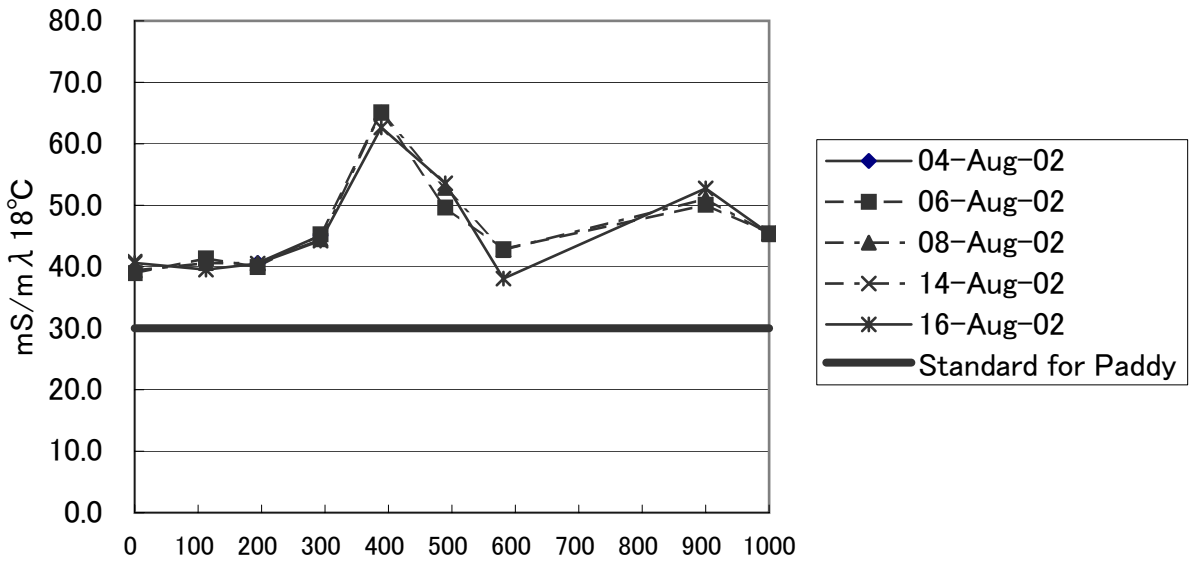
Identification of the Hand-pump Wells	Depth [feet]	Material of Tube	Approx. Distance [m]	DO [mg/L]				
				04-Aug-	06-Aug-	08-Aug-	14-Aug-	16-Aug-
HP Baba 1(In Front of the Gate)	25	Polyethelene	0	2.01	1.36	0.94	1.70	1.55
HP Baba 2(In Front of Tea Shop)	25	Polyethelene	37		0.83	2.17	0.94	1.57
HP Arvind		Polyethelene	109			1.30	1.87	1.88
HP 0 (Basiruddin)	25	Polyethelene	112		0.98	1.90		1.62
HP 1 (Safeed I)	25	Polyethelene	194	1.20	1.44	1.60		1.65
HP 2 (Saefeed II, the Other Side)	26	Polyethelene	281	1.40	1.45	2.04		0.82
HP 3 (Allauddin Ansari)	18	Galvanized Iron	293	1.72	1.64	2.00		1.63
HP 4 (Allauddin Mansuri)	30	Galvanized Iron	389		0.98	2.13		2.06
HP 5 (Kishan Lal)	25	Polyethelene	490		1.64	1.74		2.35
HP 6 (Sukh Deb, the Other Side)	25	Polyethelene	509		1.07	1.70		1.70
HP 7 (Indra Lal Urao)	35	Polyethelene	581		1.12	2.21		2.40
HP 8 (Taiyub Ansari, the Other Sid	20	Polyethelene	612		0.84	0.80		0.88
HP 9 (Usman Mansuri)		Polyethelene	900		1.94	1.84		0.98
HP 10 (Paltu Ram, 1 km Down)	25	Polyethelene	1000		0.98	1.65		0.89

Temperature Data of Hand-pump Wells near Paper Mills

Identification of the Hand-pump Wells	Depth [feet]	Material of Tube	Approx. Distance [m]	Temperature [°C]				
				04-Aug-	06-Aug-	08-Aug-	14-Aug-	16-Aug-
HP Baba 1(In Front of the Gate)	25	Polyethelene	0	26.4	26.9	26.8	25.9	26.3
HP Baba 2(In Front of Tea Shop)	25	Polyethelene	37		26.2	26.1	25.9	26.0
HP Arvind		Polyethelene	109			25.8	25.5	25.7
HP 0 (Basiruddin)	25	Polyethelene	112		26.3	26.4		26.2
HP 1 (Safeed I)	25	Polyethelene	194	25.6	26.3	25.9		25.7
HP 2 (Saefeed II, the Other Side)	26	Polyethelene	281	26.1	26.3	26.5		26.5
HP 3 (Allauddin Ansari)	18	Galvanized Iron	293	25.7	25.2	25.8		25.7
HP 4 (Allauddin Mansuri)	30	Galvanized Iron	389		25.6	25.2		25.2
HP 5 (Kishan Lal)	25	Polyethelene	490		26.0	26.0		26.4
HP 6 (Sukh Deb, the Other Side)	25	Polyethelene	509		27.1	26.2		25.9
HP 7 (Indra Lal Urao)	35	Polyethelene	581		25.9	25.7		26.7
HP 8 (Taiyub Ansari, the Other Sid	20	Polyethelene	612		25.8	26.3		26.7
HP 9 (Usman Mansuri)		Polyethelene	900		26.4	26.2		25.6
HP 10 (Paltu Ram, 1 km Down)	25	Polyethelene	1000		26.0	25.9		25.8

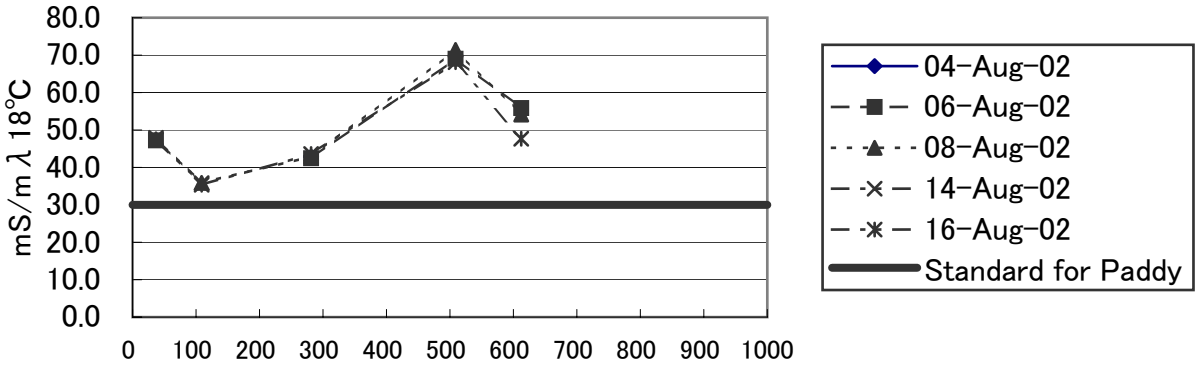
Figure-4 Location Map and Data of Sampling for Ground Water Quality Check

EC (Electric Conductivity) of Handpump Wells Near Baba Paper Mill

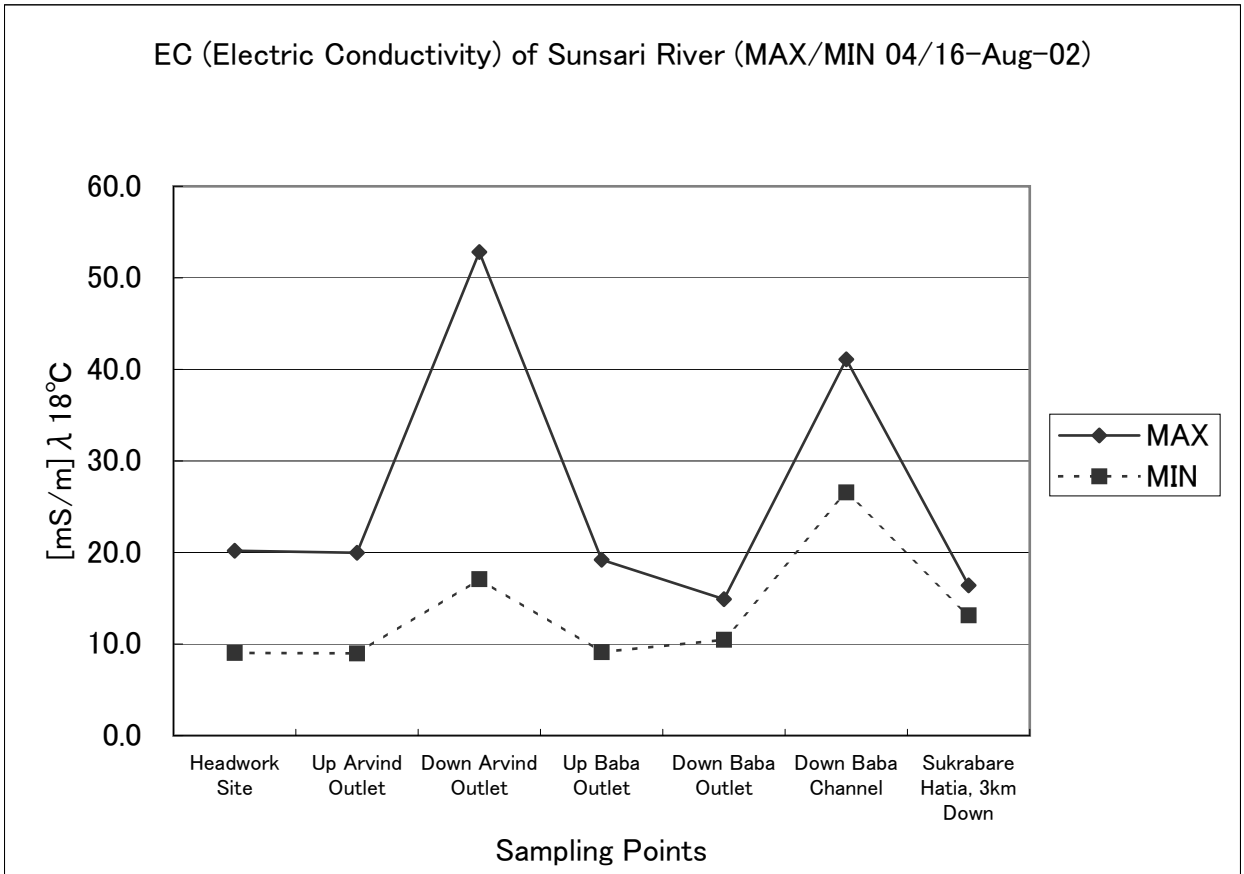


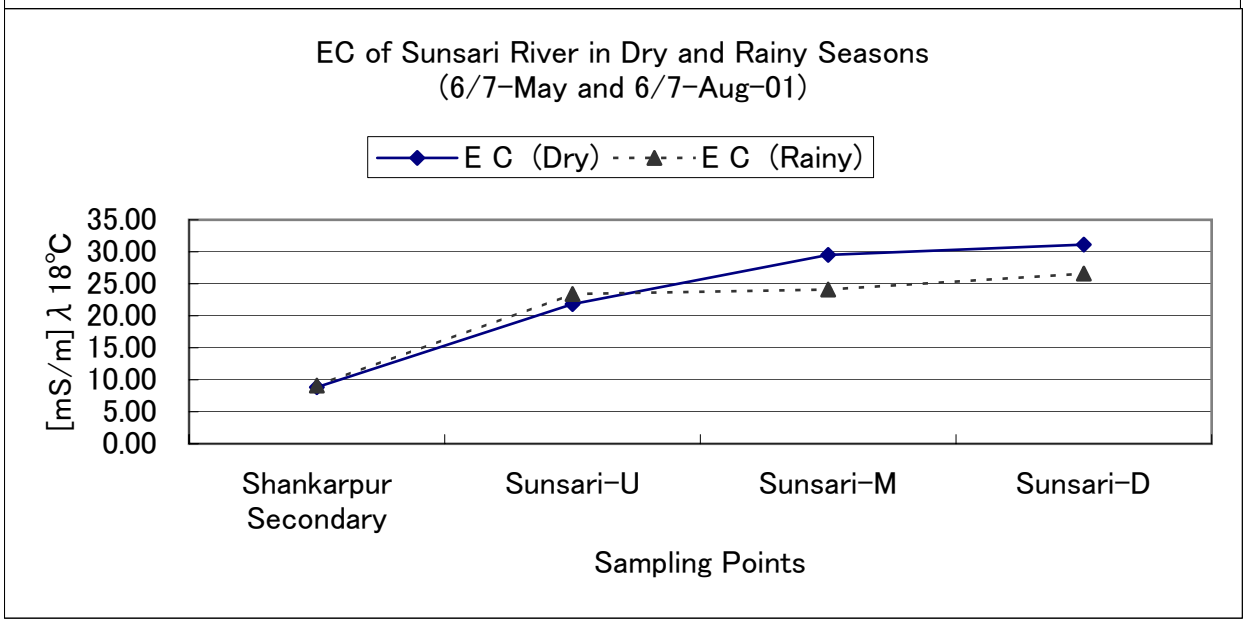
m from Baba Paper Mill (9 Handpump Wells on the Same Side of Baba Paper Mill)

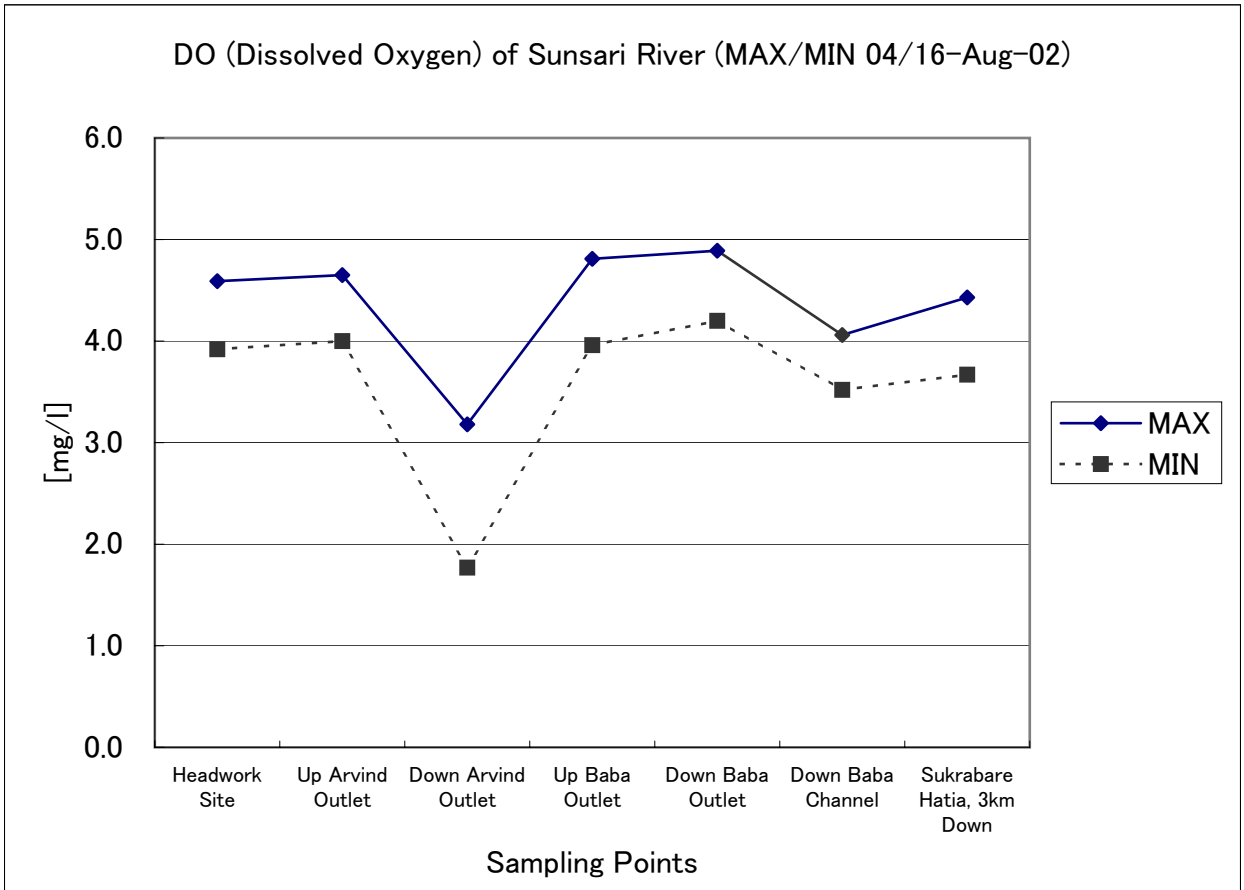
EC (Electric Conductivity) of Handpump Wells Near Baba Paper Mill

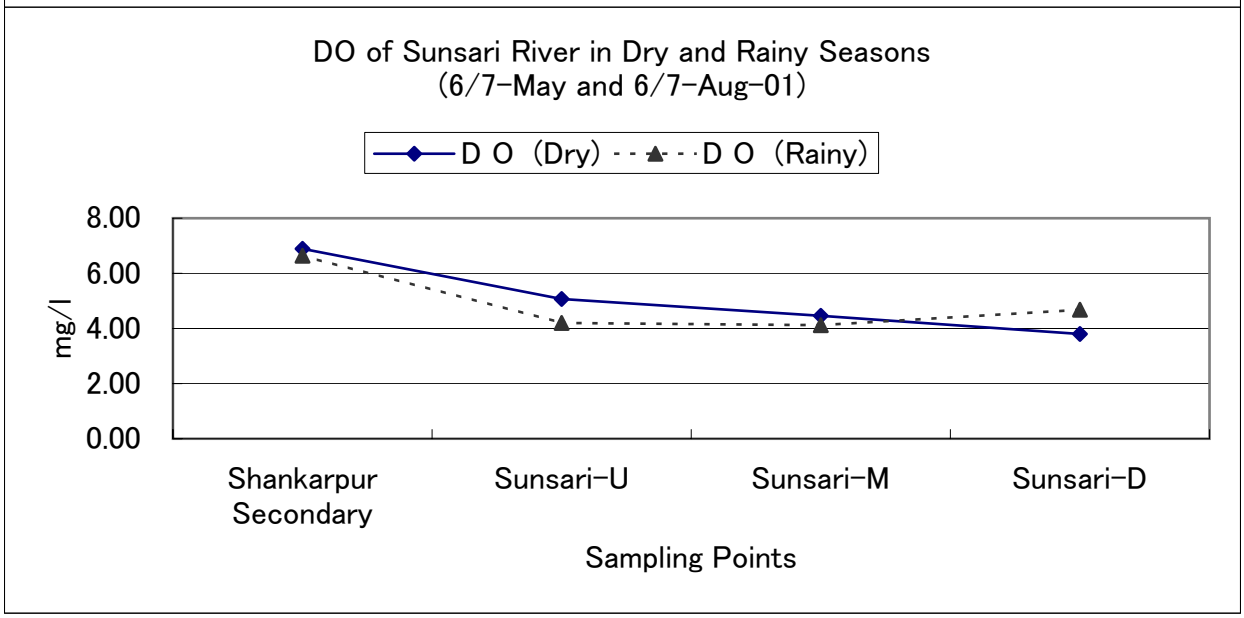


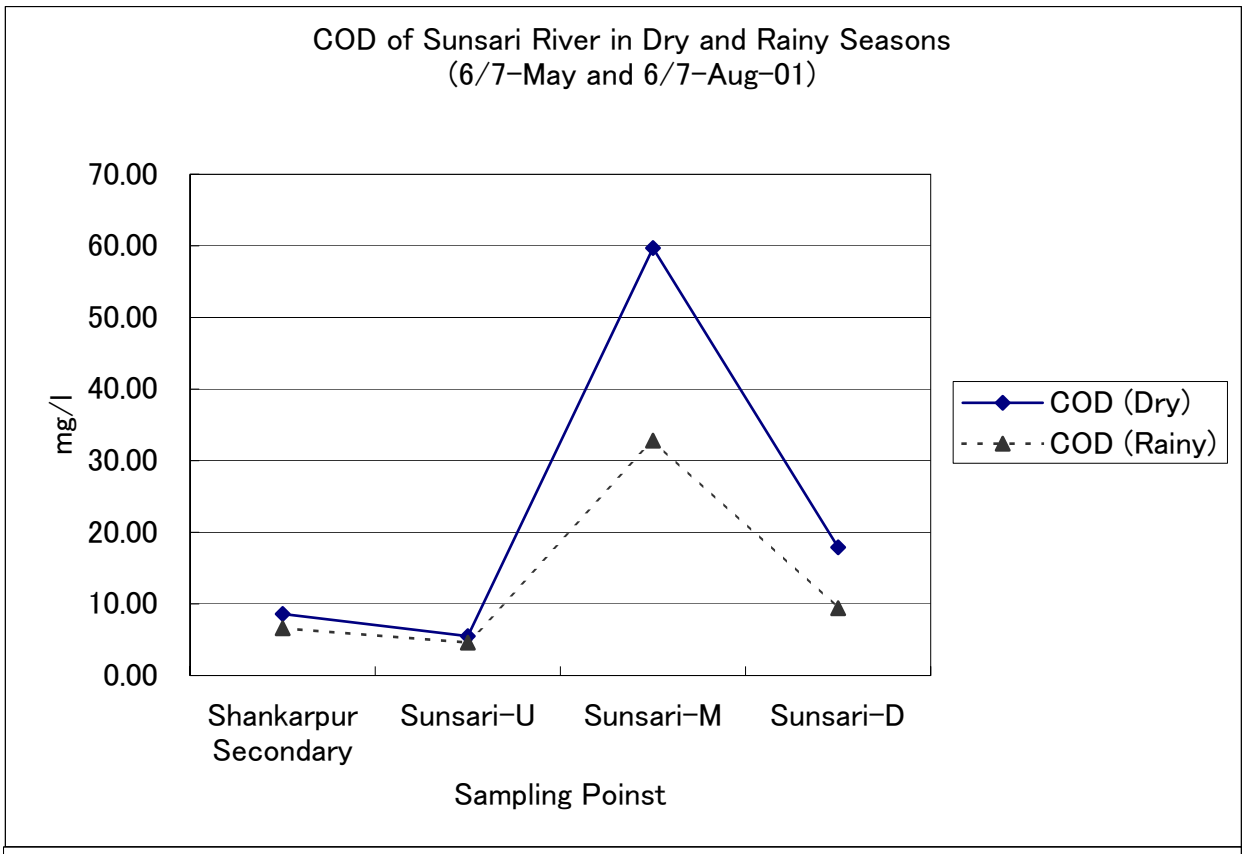
m from Baba Paper Mill (5 Handpump Wells on the Other Side of Baba Paper Mill toword Sunsari River)

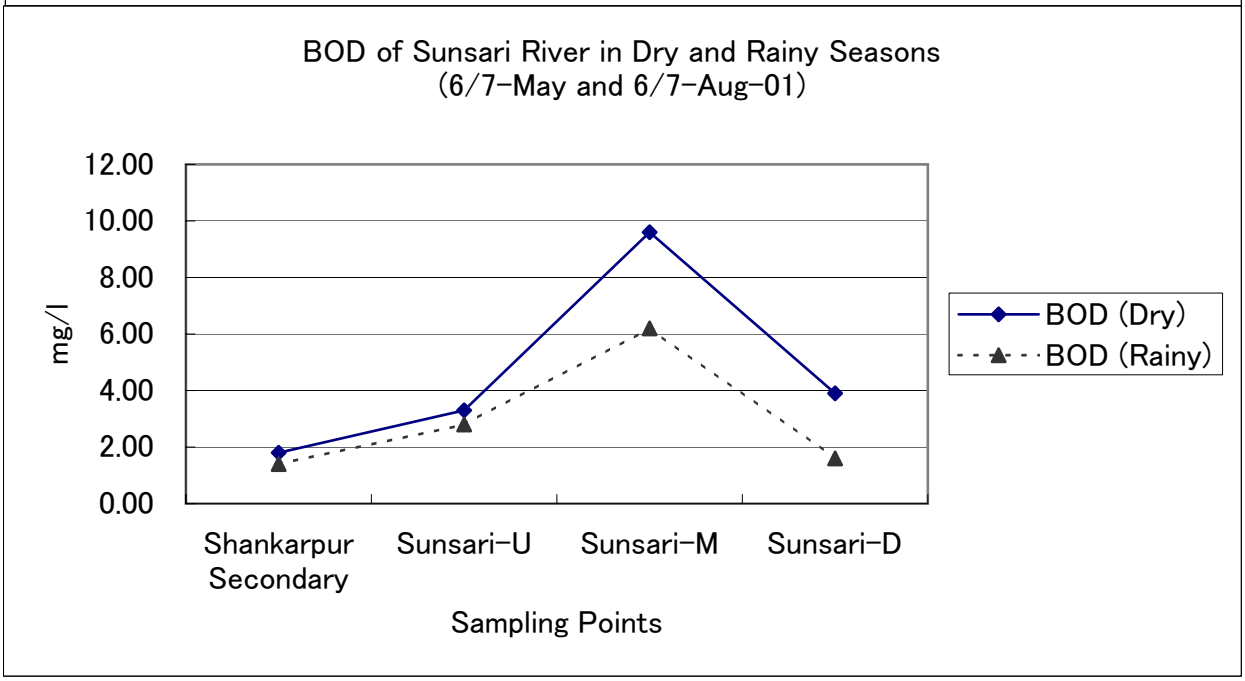

EC (Electric Conductivity) of Sunsari River (MAX/MIN 04/16-Aug-02)
60.0
50.0
40.0
30.0
20.0
10.0
0.0
[mS/m] λ 18℃
MAX
MIN
Headwork Site
Up Arvind Outlet
Down Arvind Outlet
Up Baba Outlet
Down Baba Outlet
Down Baba Channel
Sukrabare Hatia, 3km Down
Sampling Points


EC of Sunsari River in Dry and Rainy Seasons
(6/7-May and 6/7-Aug-01)
E C (Dry)
E C (Rainy)
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
[mS/m] λ 18℃
Shankarpur Secondary
Sunsari-U
Sunsari-M
Sunsari-D
Sampling Points


DO (Dissolved Oxygen) of Sunsari River (MAX/MIN 04/16-Aug-02)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
[mg/l]
MAX
MIN
Headwork Site
Up Arvind Outlet
Down Arvind Outlet
Up Baba Outlet
Down Baba Outlet
Down Baba Channel
Sukrabare Hatia, 3km Down
Sampling Points


DO of Sunsari River in Dry and Rainy Seasons
(6/7-May and 6/7-Aug-01)
D O (Dry)
D O (Rainy)
8.00
6.00
4.00
2.00
0.00
mg/l
Shankarpur Secondary
Sunsari-U
Sunsari-M
Sunsari-D
Sampling Points


COD of Sunsari River in Dry and Rainy Seasons
(6/7-May and 6/7-Aug-01)
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
mg/l
Shankarpur Secondary
Sunsari-U
Sunsari-M
Sunsari-D
Sampling Poinst
COD (Dry)
COD (Rainy)


BOD of Sunsari River in Dry and Rainy Seasons
(6/7-May and 6/7-Aug-01)
12.00
10.00
8.00
6.00
4.00
2.00
0.00
mg/l
Shankarpur Secondary
Sunsari-U
Sunsari-M
Sunsari-D
Sampling Points
BOD (Dry)
BOD (Rainy)

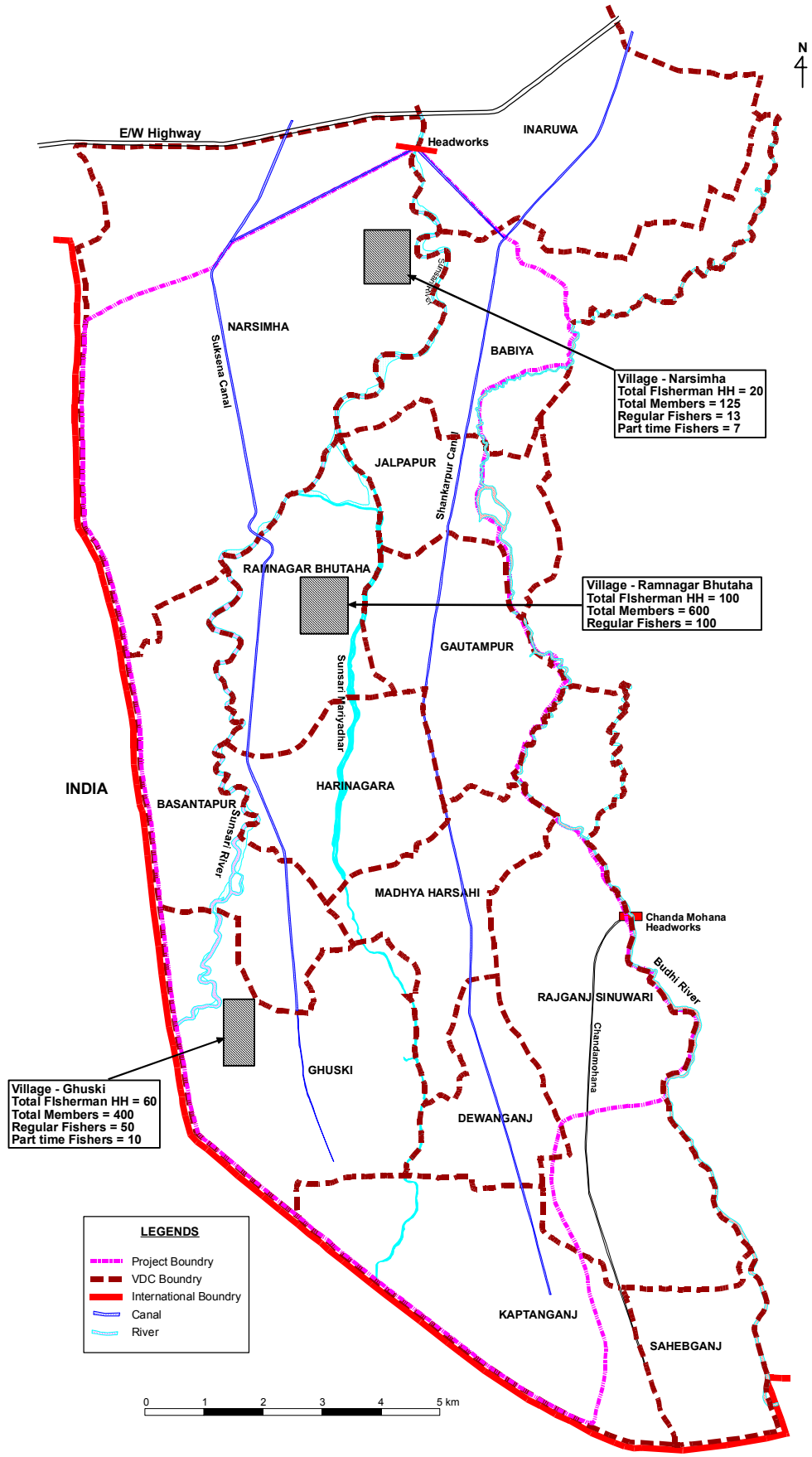


Figure-9 The location of fishers' villages and the number of households

Table-1 (1) Result of Water Quality Test on the Observation River (Dry Season)

for The Feasibility Study on The Sunsari River Irrigation Project in The Kingdom of Nepal

JICA Study team: SANYU CONSULTANTS INC. **6-7/05/2001**

Sample		In-site-test							Laboratory test																			Remarks
									Nutrient salty materials [mg/l]				Soluble ion [mg/l]							BOD [mg/l]	COD [mg/l]	T.N inTSS [mg/l]	T.C inTSS [mg/l]	$KMnO_4^+$ [mg/l]	As [mg/l]	Fe [mg/l]	Mn [mg/l]	
No.	Name	Temp. [°C] t	pH [pH]	EC [mS/m] λ18	DO [mg/l]	Col. [n/100ml]	Total c. [n/10ml]	ORP [m/V]	NO_3^-	NO_2^-	NH_4^-	PO_4^-	Ca^+	Mg^+	K^+	Na^+	Cl^-	SO_4^{2-}	HCO_3^-									
1	Shankarpur-Secondary	26.2	8.04	8.84	6.89	68	a lot	+ 222	0.02	0.02	0.48	>0.01	10.00	2.00	2.70	4.90	9.30	12.00	43.00	1.80	8.60	0.12	23.43	3.70	<0.01	0.02	0.03	Chatara Main Canal
2	Sunsari-U	31.0	7.92	21.83	5.07	44	37	+ 228	0.03	0.01	0.08	0.04	32.00	13.00	3.60	11.20	3.70	5.00	190.00	3.30	5.50	0.07	2.03	3.60	<0.01	<0.01	<0.01	Sunsari river
3	Sunsari-M	27.8	8.24	29.51	4.46	a lot	a lot	+ 258	0.41	0.02	0.36	0.01	32.00	14.00	4.90	18.90	9.30	16.00	195.00	9.60	59.70	0.23	4.63	7.90	<0.01	0.01	0.03	Sunsari river
4	Sunsari-D	28.2	7.81	31.12	3.80	36	a lot	+ 261	0.06	0.07	0.12	0.05	36.00	12.00	3.90	11.30	3.70	8.00	186.00	3.90	17.90	0.21	3.35	5.90	<0.01	<0.01	0.02	Sunsari river
5	Garaun Khola	28.0	7.00	16.72	4.17	10	Nil	+ 216	0.02	>0.01	0.10	>0.01	12.00	6.00	2.40	8.90	5.60	7.00	78.00	3.60	7.20	0.40	2.50	4.00	<0.01	<0.01	0.02	Garaun Khola
6	Budi-D	26.2	7.47	28.84	4.36	a lot	a lot	+ 234	0.03	0.08	0.08	0.02	20.00	12.00	2.90	12.70	3.70	5.00	152.00	2.00	3.10	0.70	13.73	2.40	<0.01	<0.01	<0.01	Budhi river
WHO		-	-	-	-	-	-	-	50	3	1.5	-			-	200	250	250	-	-	-	-	-	-	0.01	-	0.50	Desirable Level (Tap Water)
England		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	5.00	0.20	for water used on soil
Japan		-	6.0-7.5	<30.00	>5.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<6.00	-	-	-	0.005	-	-	
FAO		-	6.5 - 8.4	<75.00	-	-	-	-	<5.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.00	0.20	

Sampling ; 6 May. - 7 May. 2001 except DO on 5th Feb.

In-site-test [MODEL : D-24T, HORIBA, Ltd.]
Temp. : Water temperature [°C]
pH : Hydrogen ion concentration [pH]
EC : Electric conductivity [mS/m]
[$\lambda_{18}=\lambda t\{1+\alpha(18-t)\}$
λt ; test value, t ; Water temperature
$\alpha = 0.02$
DO : Dissolved Oxygen [mg/l]
Col. : Colon bacillus colony number [n/10(; Coliform group
Total c. : Total colonies [n/10ml] ; extra item
ORP : Oxidation-Reduction Potential [m/V]
[=E+206-0.7(t-25)] E; test value, t; W. temperature

Laboratory test [GWRDP-Kathmandu]
Nutrient salty materials : **(NO3, NO2, NH4, PO4)** [mg/l]
Sediment **(Carbon, Nitrogen)** [mg/l] ; Trilliner Plotting, SAR
Soluble ion **(Ca, Mg, K, Na, Cl, SO4, HCO3)** [mg/l]
BOD : Biological Oxygen Demand [mg/l]
COD : Chemical Oxygen Demand [mg/l]
KMnO4 has substituted **DOC** : Dissolved Organic Carbon [mg/l]
As : Arsenic [mg/l]
Fe : Iron [mg/l] ; treat a sample with HN3 [5ml/l] in site.
Mn : Manganese ; treat a sample with HN3 [5ml/l] in site.

WHO ; International Standards for Drinking Water Quality (1995).
FAO ; Recommended maximum concentrations of trace in irrigation water (1985).
* Coliform Bacteria
1. Coliform bacteria should not be present in 100ml of any two consecutive sample of drinking water;
2. No sample should contain more than 10 coliform becteria per 100ml;
3. Throughout any year, 95 percent samples should not contain any coliform bacteria in 100ml;
4. No 100 sample should contain E. coli;

Japan ; Agriculture Irrigation Standard for Paddy
England Recommended Maximum Concentration of Trace Elements in Irrigation Water

Table-1(2) Result of Water Quality Test on the Observation River (Rainy Season)

for The Feasibility Study on The Sunsari River Irrigation Project in The Kingdom of Nepal

JICA Study team: SANYU CONSULTANTS INC. **6-7/05/2001**

Sample		In-site-test							Laboratory test																			Remarks
									Nutrient salty materials [mg/l]				Soluble ion [mg/l]							BOD	COD	T.N	T.C in	$KMnO_4^+$	As	Fe	Mn	
No.	Name	Temp. [℃] t	pH [pH]	EC [mS/m] λ18	DO* [mg/l]	Col. [n/100ml]	Total c. [n/10ml]	ORP [m/V]	NO_3^-	NO_2^-	NH_4^-	PO_4^-	Ca^+	Mg^+	K^+	Na^+	Cl^-	SO_4^{2-}	HCO_3^-	[mg/l]	[mg/l]	TSS [mg/l]	TSS [mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	
1	Shankarpur-Secondary	24.6	8.46	9.10	0.04	a lot	2	+ 62	0.30	>0.01	0.81	0.30	17.00	1.00	2.78	2.98	3.70	9.00	52.00	1.40	6.60	0.24	32.40	4.20	<0.01	0.02	0.03	Chatara Main Canal
2	Sunsari-U	31.0	7.82	23.40	0.24	no	no	+ 14	0.30	0.04	0.73	0.20	28.00	10.00	3.41	8.35	3.70	6.00	143.00	2.80	4.60	3.26	264.30	3.60	<0.01	<0.01	<0.01	Sunsari river
3	Sunsari-M	30.0	7.86	24.10	0.01	no	a lot	+ 32	0.20	0.15	0.29	0.13	34.00	11.00	3.76	8.95	11.20	6.00	156.00	6.20	32.80	1.83	77.20	18.80	<0.01	0.01	0.03	Sunsari river
4	Sunsari-D	29.8	8.02	26.60	0.15	no	a lot	+ 36	0.29	0.13	0.37	0.15	34.00	12.00	4.41	10.90	9.30	9.00	156.00	1.60	9.40	2.08	64.30	6.40	<0.01	<0.01	0.02	Sunsari river
5	Garaun Khola	28.6	7.48	13.10	0.12	no	no	+ 50	0.39	0.16	0.27	0.10	11.00	5.00	2.29	9.15	5.60	3.00	78.00	3.00	6.60	2.43	110.30	4.50	<0.01	<0.01	0.02	Garaun Khola
6	Budi-D	28.4	6.84	21.30	0.15	no	few	+ 32	0.22	0.03	0.14	0.08	23.00	8.00	2.94	11.10	3.70	3.00	139.00	1.80	2.60	0.43	42.30	2.30	<0.01	<0.01	<0.01	Budhi river
WHO		-	-	-	-	-	-	-	50	3	1.5	-			-	200	250	250	-	-	-	-	-	-	0.01	-	0.50	Desirable Level (Tap Water)
England		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	5.00	0.20	for water used on soil
Japan		-	6.0-7.5	<30.00	>5.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<6.00	-	-	-	0.005	-	-	
FAO		-	6.5 - 8.4	<75.00	-	-	-	-	<5.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.00	0.20	

Sampling ; 6 August. - 7 August. 2001.

In-site-test [MODEL : D-24T, HORIBA, Ltd.]
Temp. : Water temperature [℃]
pH : Hydrogen ion concentration [pH]
EC : Electric conductivity [mS/m]
[λ 18 =λt{ 1+ α (18-t) }
λt ; test value, t ; Water temperature
α = 0.02
DO* : Dissolved Oxygen [mg/l]
The value of DO are quetionable and they are about 1/100 of those in dyr season. Reexamination was done in 2002. (See the small table.)
Col. : Colon bacillus colony number [n/10(; Coliform group
Total c. : Total colonies [n/10ml] ; extra item
ORP : Oxidation-Reduction Potential [m/V]
[=E+206-0.7(t-25)] E; test value, t; W. temperature

Laboratory test [GWRDP-Kathmandu]
Nutrient salty materials : **(NO3, NO2, NH4, PO4)** [mg/l]
Sediment **(Carbon, Nitrogen)** [mg/l] ; Trilliner Plotting, SAR
Soluble ion **(Ca, Mg, K, Na, Cl, SO4, HCO3)** [mg/l]
BOD : Biological Oxygen Demand [mg/l]
COD : Chemical Oxygen Demand [mg/l]
KMnO4 has substituted **DOC** : Dissolved Organic Carbon [mg/l]
As : Arsenic [mg/l]
Fe : Iron [mg/l] ; treat a sample with HN3 [5ml/l] in site.
Mn : Manganese [; treat a sample with HN3 [5ml/l] in site.

WHO ; International Standards for Drinking Water Quality (1995).
FAO ; Recommended maximum concentrations of trace in irrigation water (1985).
* Coliform Bacteria
1. Coliform bacteria should not be present in 100ml of any two consecutive sample of drinking water;
2. No sample should contain more than 10 coliform becteria per 100ml;
3. Throughout any year, 95 percent samples should not contain any coliform bacteria in 100ml;
4. No 100 sample should contain E. coli;

England Recommended Maximum Concentration of Trace Elements in Irrigation Water

Sample		In-site-test					
		Temp. [℃]	pH [pH]	EC [mS/m] λ18℃	DO [mg/l]	Turb. [NTU]	Salinity [%]
No.	Name						
1	Shankarpur-Secondary	24.3	8.45	7.08	6.64	>999	0.00
2	Sunsari-U	28.8	7.89	17.17	4.25	426	0.00
3	Sunsari-M	28.8	7.62	24.15	4.12	443	0.01
4	Sunsari-D	27.1	7.79	19.14	4.68	306	0.00
5	Garaun Khola	27.8	7.43	9.17	3.04	112	0.00
6	Budi-D	26.6	7.28	15.98	4.27	129	0.00

Sampling : 12 August - 13 August 2002

Table-2 Guidelines FAO for Interpretation of water quality for irrigation

Potential Irrigation Problem	Units	Degree of restriction on use		
		None	Slightly Moderate	Severe
Salinity (affects crop water availability)				
EC or	dS/m	< 0.75	0.75 – 0.3	> 3.0
TDS	mg/l	< 450	450 – 2000	> 2000
Infiltration (affects infiltration rate of water into the soil, evaluate using EC and SAR together				
SAR = 0.30	–	> 0.7	0.7 – 0.2	< 0.2
SAR = 3.60	–	> 1.2	1.2 – 0.3	< 0.3
SAR = 6.12	–	> 1.9	1.9 – 0.5	< 0.5
SAR = 12.20	–	> 2.9	2.9 – 1.3	< 1.3
SAR = 20.40	–	> 5.0	5.0 – 2.9	< 2.9
Specific ion toxicity (affects sensitive crops)				
Sodium (Na): Surface Irrigation	SAR	< 3.0	3.0 – 9.0	> 9.0
Sprinkler Irrigation	mg/l	< 69.0	> 69.0	
Chloride (Cl): Surface Irrigation	mg/l	< 141.8	141.8 – 354.6	> 354.6
Sprinkler Irrigation	mg/l	< 106.4	> 106.4	
Boron (B)	mg/l	< 0.7	0.7 – 3.0	> 3.0
Miscellaneous effects (affects susceptible crops)				
Nitrate–Nitrogen (NO_3–N)	mg/l	< 5.0	5.0 – 30.0	> 30.0
Bicarbonate (HCO_3)	mg/l	< 91.5	91.5 – 537.0	> 537.0
pH	–	Normal Range (6.5–8.4)		

Source: Water quality for agriculture, FAO Irrigation and Drainage Paper 29, Rev.1, FAO Rome, 1985

EC = Electrical Conductivity, TDS = Total Dissolved Solids, SAR = Sodium Absorption Ratio,
dS/m = desi Simen/meter

Table - 3 Water quality results of discharge from paper factories and Tolerance limit for industrial effluents discharge into inland surface water

Parameters	Results *1 (Phase 1)		Results*2 (Phase 2)	NS*3	Units
	ARBINDA	BABA	BABA		
PH (field)	7.15	7.29	6.76	5.5– 9.0	–
PH (Lab)	6.38	6.35	6.46		–
Electric Conductivity (field)	804	5,905	2,110		λ s/cm
Electric Conductivity (lab)	795	5,510	2,130		λ s/cm
Field Temp.	29.8	33.6	29.7	< 40	ºC
Lab. Temp.	30.8	30.8	26.8		ºC
Turbidity	269	999	> 460		NTU
Dissolved Oxygen	0.30	< 0.01	< 0.01		mg/l
Salinity	0.03	0.31	-		%
T. Suspended Solids	1,634.6	1445.9	436.9	30 – 200	mg/l
T. Volatile S. Solids	351.9	585.0	289.4		mg/l
T. Dissolved Solids	395.0	2,750.1	1,070.5	–	mg/l
T. Alkalinity	64	611	776	–	mg/l as $CaCO_3$
Bicarbonate (HCO_3)	78	745	986	–	mg/l as HCO_3
Carbonate (CO_3)	< 1	< 1	< 1	–	mg/l as CO_3^{-2}
Hydroxide (OH)	< 1	< 1	< 1	–	mg/l as OH
Nitrate (NO_3)	0.20	33.25	12.96	–	mg/l as N
Nitrite (NO_2)	0.32	48.2	16.00	–	mg/l as N
Ammonia (NH_3)	1.64	133.00	25.57	< 50	mg/l as N
T. Phosphate (PO_4)	0.05	0.65	1.50	–	mg/l as P
Chloride (Cl)	139.5	744	198.4	–	mg/l
Iron (Fe)	3.35	4.00	2.92	–	mg/l
Lead (Pb)	0.06	0.17	0.12	< 0.1	mg/l
Zinc (Zn)	0.24	0.62	0.74	< 5	mg/l
Copper (Cu)	0.04	0.08	0.03	< 3	mg/l
Cadmium (Cd)	< 0.01	< 0.01	< 0.01	< 2.0	mg/l
Chromium (Cr)	0.08	0.26	0.13	< 0.1	mg/l
Sodium (Na)	25	1104	828.0	–	mg/l
Potassium (K)	7	172	112.5	–	mg/l
Arsenic (As)	0.07	0.15	< 0.1	< 0.2	mg/l
Mercury (Hg)	< 0.01	< 0.01	< 0.01	< 0.01	mg/l
Cyanide (CN)	< 0.1	< 0.1	< 0.1	< 0.2	mg/l
C.O.D.	252	2,965	2,570	< 250	mg/l
B.O.D.	168	2,025	1,416	30– 100	mg/l
Oil & Grease	1.14	2.98	2.12	< 10	mg/l
Phenolic Compounds	0.244	0.723	0.43	< 1.000	mg/l as phenol
Floride	0.16	0.43	0.18	< 2.0	mg/l

*1: Sampling on My 2001

*2 Sampling on July 2002

*3: NS = Nepal Bureau of Standards and Metrology (Ne. Gu. Na. 229 – 2047)

Table-4 Comparison effluent discharge standards in several countries

Physical properties and chemical constituents (mg/l)	Germany				Belgium				France		Great Britain				
	Discharge into water course			To a treatment plant				Discharge into sewer	Discharge Depending on treatment level	Metal Finishing industries	Examples of river discharge				Sewer Discharge
	a	b	c		1	2*	3				1	2	3	4	
Temperature in ^0C	20	20 – 28	28	35	30	30		45	30		26	32			
PH	6.9	5 – 10	5 – 10	6.5 – 9.5	6.5–8.5	–		6.5 – 8.5	5.5 – 8.5		6 – 9	5 – 9			
Suspended solids (mg/l)	20				100		1000	20 – 100			30	30			
BOD_5 (average over 2 h)	25				15	30	50		20 – 40		20				
COD (average over 2 h)	80					500			80 – 150						
$KmnO_4$ Oxidisability	18	18 – 40	40												
N (Kjeldahl)						10			7 – 80		10				
Fluoride										15		10		10	
Chlorides	150	150 – 300	350												
Sulfides									0			1			
Sulfates					400	2000						1200	1200		
Cyanides						0.5				0.1 – 1	0.1				
Arsenic										0					
Barium															
Cadmium										3					
										0.5 – 1	0.5				
Iron	0.5	0.5 – 1.5	1.5			2					4			0.3	
Manganese	0.25	0.25 – 0.5	0.5			1									
Mercury									0		0.01				
Nickel				5											
Lead			3			1				1	0.1				
Copper															
Zinc			5		100	5									
Cd+Cr+Cu+Ni+Zn+Fe										15					
Oil & Grease	0	Trace	Trace	20– 100				500			4	4	50	50	500
Hydrocarbons				5 – 15					5 – 20		0.5 – 1			0.01	
Phenols	0.005	0.005–1	0.1	100					0.5 – 1		0.5				
Organic solvents									0		0	0	0	0	
Active Chlorines (mg Cl/l)											0.5	1	1		
Remarks & reference					* Degree of 3/8/76: Discharge of waste water from Iron & Steel Industry						Regional Regulations (examples)				
	Galvonotechnic(1971, 62, No.12 L'ultima acqua, A.Canuti, 1974, AFEE 2482/2				Degree of 26/5/71 Law of 26/5/71 La Technique de l'eau(1974)				Official Gazette Brochures		Water Act 1973, Protection HandBook of Pollution Control, P. Sutton, 1975, Publ. A. Osborne.				

Table- 5 Recommended Maximum Concentration of Trace Elements in Irrigation Water*

Elements	For water used continuously on soil (mg/l)	For use up to 20 years on fine textured soil of pH 6.0 to 8.5 (mg/l)
Aluminum (Al)	5.0	20.0
Arsenic (As)	0.1	2.0
Beryllium (Be)	0.1	0.5
Cadmium (Cd)	-**	2.0
Chromium (Cr)	0.01	0.05
Cobalt (Co)	0.2	5.0
Copper (Cu)	1.0	5.0
Fluoride (F)	1.0	15.0
Iron (Fe)	5.0	20.0
Lead (Pb)	5.0	10.0
Lithium (Li)	2.5	2.5
Manganese (Mn)	0.2	10.0
Molybdenum (Mo)	0.01	0.05***
Nickel (Ni)	0.2	0.02
Selenium (Se)	0.02	0.02
Vanadium (V)	0.1	1.0
Zinc (Zn)	2.0	10.0

Source: Environmental Studies Board, National Academy of England. "Water Quality Criteria."1972

* These levels normally do not affect plants and soil. No data are available for Hg, Ag, Sn, Ti and W.

** No problem when Cd content is less than 0.57 mg/l; increasing problem when it is between 0.75 and 2.0 mg/l; and severe problem when it is more than 2.0 mg/l.

*** For only acid fine textured soils and acid soils with high iron oxide content.

Table-6 (1) Water Quality Data

04-Aug-2002	Temperature [℃]	pH [pH]	EC [mS/m] λ 18℃	DO [mg/l]	Turbidity [NTU]	Salinity [%]
Sunsari River						
Sunsari River (Headwork Site)	28.2	7.40	17.35	4.10	361	0.00
Sunsari River (Up Arvind Outlet)	28.1	7.34	17.32	4.07	351	0.00
Sunsari River (Up Baba Outlet)	29.1	7.56	17.43	3.94	474	0.00
Sunsari River (Down Baba Outlet)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Sunsari River (Sukrabare Hatia, 3km Down)	30.2	7.20	16.41	3.67	335	0.00
Sunsari River (Saiphon Bridge, 7km Down))	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Arvind Paper Mill						
Arvind Outlet to Sunsari River	29.2	7.02	58.12	1.70	>999	0.03
Arvind Channel (10m up Outlet)	29.4	7.00	57.67	1.91	>999	0.03
Arvind Discharge Near the Fence (Bottom)	28.8	7.05	59.90	1.27	980	0.03
Arvind Discharge Near the Fence (Surface)	28.8	7.18	58.80	6.18	912	0.03
Arvind Agro-based Process (Bottom)	27.7	6.64	78.18	6.66	945	0.04
Arvind Agro-based Process (Surface)	27.9	7.39	79.40	6.45	>999	0.04
Arvind Inlet to Tank	31.6	7.50	52.42	6.70	>999	0.03
Arvinc Outlet from Tank	31.7	6.99	51.91	6.53	969	0.03
Baba Paper Mill						
Baba Reservoir2	34.3	6.88	221.75	0.20	624	0.16
Baba Reservoir1	34.4	7.08	174.72	0.22	588	0.13
Baba End of Canal (150m Down)	32.9	6.90	247.10	0.07	>999	0.18
Baba Discharge (In Front of the Gate)	32.8	6.90	244.29	0.44	>999	0.17
Handpump Wells						
HP Well (Sukrabare Hatia)	25.6	6.40	10.52	1.15	2	0.00
HP Well Baba 1(In Front of the Gate)	26.4	6.93	39.44	2.01	3	0.01
HP Well 1 (Safeed I)	25.6	6.95	40.62	1.20	3	0.01
HP Well 2 (Safeed II, the Other Side)	26.1	6.86	42.82	1.40	3	0.02
HP Well 3 (Allauddin Ansari)	25.7	7.03	45.09	1.72	3	0.02
Others						
Suksena Canal (Narsingh Bridge)	33.3	7.69	6.87	5.54	230	0.00
Runoff from Jute Field	33.9	7.09	5.12	0.38	52	0.00
Suksena Canal (Down Narsingh Bridge)	35.0	7.14	4.62	3.08	49	0.00
Runoff from Paddy Field	33.0	6.97	2.73	4.45	208	0.00

Table-6 (2) Water Quality Data

06-Aug-2002	Temperature [℃]	pH [pH]	EC [mS/m] λ 18℃	DO [mg/l]	Turbidity [NTU]	Salinity [%]
Sunsari River						
Sunsari River (Headwork Site)	31.2	7.58	14.72	3.92	784	0.00
Sunsari River (Up Arvind Outlet)	31.3	7.52	14.53	4.00	822	0.00
Sunsari River (Down Arvind Outlet)	30.0	7.14	52.82	1.77	743	0.03
Sunsari River (Up Baba Outlet)	31.3	7.46	14.90	3.96	802	0.00
Sunsari River (Down Baba Pipe Outlet)	31.3	7.58	14.90	4.20	885	0.00
Sunsari River (Sukrabare Hatia, 3km Down	29.0	7.33	16.22	3.95	>999	0.00
Sunsari River (Saiphon Bridge, 7km Down)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Arvind Paper Mill						
Arvind Channel (10m up Outlet)	29.9	7.17	51.59	2.00	689	0.03
Arvind Discharge Near the Fence (Bottom	29.2	6.23	64.25	4.60	820	0.03
Arvind Discharge Near the Fence (Surface	29.3	7.12	57.66	6.06	988	0.03
Arvind Agro-based Process	27.6	6.75	55.43	6.58	>999	0.02
Arvind Inlet to Tank	31.3	6.82	59.82	6.47	>999	0.03
Arvinc Outlet from Tank	31.1	6.78	59.19	5.46	>999	0.03
Baba Paper Mill						
Baba Reservoir2	37.2	6.87	184.18	0.08	413	0.15
Baba Reservoir1	35.1	7.05	153.31	0.42	395	0.11
Baba End of Canal (150m Down)	30.6	7.08	222.16	1.90	861	0.14
Baba Discharge (In Front of the Gate)	30.4	6.89	246.66	4.50	833	0.16
Handpump Wells						
HP Well (Sukrabare Hatia)	26.2	6.54	10.45	1.18	2	0.00
HP Well Baba 2(In Front of Tea Shop)	26.2	6.68	47.23	0.83	6	0.02
HP Well Baba 1(In Front of the Gate)	26.9	6.83	38.96	1.36	8	0.02
HP Well 0 (Basiruddin)	26.3	6.99	41.37	0.98	2	0.02
HP Well 1 (Safeed I)	26.3	7.07	39.95	1.44	0	0.01
HP Well 2 (Saefeed II, the Other Side)	26.3	6.98	42.45	1.45	0	0.02
HP Well 3 (Allauddin Ansari)	25.2	6.95	45.28	1.64	0	0.02
HP Well 4 (Allauddin Mansuri)	25.6	6.82	65.13	0.98	0	0.03
HP Well 5 (Kishan Lal)	26.0	6.94	49.64	1.64	0	0.02
HP Well 6 (Sukh Deb, the Other Side)	27.1	6.83	69.04	1.07	0	0.03
HP Well 7 (Indra Lal Urao)	25.9	6.96	42.86	1.12	2	0.02
HP Well 8 (Taiyub Ansari, the Other Side)	25.8	6.79	55.87	0.84	0	0.03
HP Well 9 (Usman Mansuri)	26.4	7.04	50.09	1.94	0	0.02
HP Well 10 (Paltu Ram, 1 km Down)	26.0	7.17	45.44	0.98	0	0.02

Table-6 (3) Water Quality Data

08-Aug-2002	Temperature [℃]	pH [pH]	EC [mS/m] λ 18℃	DO [mg/l]	Turbidity [NTU]	Salinity [%]
Sunsari River						
Sunsari River (Headwork Site)	29.4	7.76	9.03	4.59	>999	0.00
Sunsari River (Up Arvind Outlet)	29.3	7.75	8.98	4.65	>999	0.00
Sunsari River (Down Arvind Outlet)	29.5	7.48	17.09	3.18	>999	0.00
Sunsari River (Up Baba Outlet)	29.7	7.76	9.12	4.53	>999	0.00
Sunsari River (Down Baba Pipe Outlet)	29.5	7.70	10.47	4.89	>999	0.00
Sunsari River (Down Baba Channel)	29.6	7.49	26.57	4.06	>999	0.01
Sunsari River (Sukrabare Hatia, 3km Down	27.7	7.55	13.14	4.43	>999	0.00
Sunsari River (Saiphon Bridge, 7km Down)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Arvind Paper Mill						
Arvind Channel (10m up Outlet)	30.9	7.12	41.85	0.61	278	0.02
Arvind Discharge Near the Fence	29.3	7.31	44.27	2.49	242	0.02
Arvind Agro-based Process	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Arvind Inlet to Tank	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Arvinc Outlet from Tank	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Baba Paper Mill						
Baba Reservoir2	35.2	6.95	283.39	0.07	>999	0.25
Baba Reservoir1	35.1	7.00	329.00	0.07	>999	0.26
Baba End of Canal (150m Down)	32.3	7.25	221.34	0.71	>999	0.15
Baba Discharge (In Front of the Gate)	31.9	7.19	220.21	1.39	>999	0.15
Handpump Wells						
HP Well (Sukrabare Hatia)	26.8	6.66	10.30	0.93	0	0.00
HP Well (Kishen Urao, Narsingh-1)	25.7	7.44	31.05	1.08	1	0.01
HP Well (Sifagam Urao, Narsingh-1)	25.3	7.34	35.70	0.94	0	0.01
HP Well Arvind	25.8	7.07	35.87	1.30	2	0.01
HP Well Baba 2(In Front of Tea Shop)	26.1	6.75	47.51	2.17	0	0.02
HP Well Baba 1(In Front of the Gate)	26.8	6.88	39.39	0.94	0	0.01
HP Well 0 (Basiruddin)	26.4	7.01	40.60	1.90	0	0.02
HP Well 1 (Safeed I)	25.9	7.04	40.58	1.60	0	0.02
HP Well 2 (Saefeed II, the Other Side)	26.5	7.05	42.91	2.04	0	0.02
HP Well 3 (Allauddin Ansari)	25.8	7.01	44.48	2.00	0	0.02
HP Well 4 (Allauddin Mansuri)	25.2	7.02	65.06	2.13	0	0.03
HP Well 5 (Kishan Lal)	26.0	6.97	52.84	1.74	15	0.02
HP Well 6 (Sukh Deb, the Other Side)	26.2	6.91	71.39	1.70	2	0.04
HP Well 7 (Indra Lal Urao)	25.7	7.08	42.72	2.21	0	0.02
HP Well 8 (Taiyub Ansari, the Other Side)	26.3	6.90	54.13	0.80	0	0.02
HP Well 9 (Usman Mansuri)	26.2	7.05	51.08	1.84	4	0.02
HP Well 10 (Paltu Ram, 1 km Down)	25.9	7.21	45.30	1.65	0	0.02
Runoff from Paddy Field	37.8	8.00	1.63	5.46	64	0.00

Table-6 (4) Water Quality Data

14-Aug-2002	Temperature [℃]	pH [pH]	EC [mS/m] λ 18℃	DO [mg/l]	Turbidity [NTU]	Salinity [%]
Sunsari River						
Sunsari River (Headwork Site)	26.8	7.58	20.19	4.18	191	0.00
Sunsari River (Up Arvind Outlet)	26.9	7.61	19.97	4.37	194	0.00
Sunsari River (Down Arvind Outlet)	28.3	7.42	44.15	2.56	839	0.02
Sunsari River (Up Baba Outlet)	28.8	7.70	19.21	4.81	213	0.00
Sunsari River (Down Baba Pipe Outlet)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Sunsari River (Down Baba Channel)	26.9	7.57	41.10	3.67	341	0.02
Sunsari River (Sukrabare Hatia, 3km Down	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Sunsari River (Saiphon Bridge, 7km Down)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Arvind Paper Mill						
Arvind Channel (10m up Outlet)	28.2	7.46	43.30	2.88	680	0.02
Arvind Discharge Near the Fence	28.0	7.37	51.28	4.80	662	0.02
Arvind Agro-based Process	27.0	7.46	43.79	6.33	526	0.02
Arvind Inlet to Tank	29.1	7.19	53.99	6.85	772	0.03
Arvind Outlet from Tank	28.8	7.22	55.04	6.79	746	0.03
Baba Paper Mill						
Baba Reservoir2	31.9	7.14	285.19	0.05	>999	0.20
Baba Reservoir1	31.3	7.27	263.51	0.14	908	0.18
Baba End of Canal (150m Down)	31.3	7.49	255.43	0.07	>999	0.17
Baba Discharge (In Front of the Gate)	30.9	7.67	224.08	0.97	>999	0.15
Handpump Wells						
HP Well (Sukrabare Hatia)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
HP Well (Ramnagar Bhutaha-1)	26.0	7.30	49.14	0.82	1	0.02
HP Well (Ramnagar Bhutaha-2)	26.6	7.31	55.72	1.10	1	0.02
HP Well Arvind	25.5	7.34	35.79	1.87	3	0.01
HP Well Baba 2(In Front of Tea Shop)	25.9	6.92	47.91	0.94	0	0.02
HP Well Baba 1(In Front of the Gate)	25.9	7.14	40.84	1.70	2	0.02
HP Well 0 (Basiruddin)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
HP Well 1 (Safeed I)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
HP Well 2 (Saefeed II, the Other Side)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
HP Well 3 (Allauddin Ansari)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
HP Well 4 (Allauddin Mansuri)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
HP Well 5 (Kishan Lal)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
HP Well 6 (Sukh Deb, the Other Side)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
HP Well 7 (Indra Lal Urao)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
HP Well 8 (Taiyub Ansari, the Other Side)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
HP Well 9 (Usman Mansuri)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
HP Well 10 (Paltu Ram, 1 km Down)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Jute Water in Ghuski-1	28.4	5.96	72.86	0.19	340	0.04
Jute Water in Ghuski-2	28.7	5.87	41.42	0.17	427	0.02

Table-6 (5) Water Quality Data

16-Aug-2002	Temperature [℃]	pH [pH]	EC [mS/m] λ 18℃	DO [mg/l]	Turbidity [NTU]	Salinity [%]
Sunsari River						
Sunsari River (Headwork Site)	28.2	7.69	18.39	4.15	206	0.00
Sunsari River (Up Arvind Outlet)	28.2	7.77	18.31	4.14	215	0.00
Sunsari River (Down Arvind Outlet)	29.4	7.42	54.43	2.05	777	0.03
Sunsari River (Up Baba Outlet)	27.6	7.71	18.99	4.01	184	0.00
Sunsari River (Down Baba Pipe Outlet)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Sunsari River (Down Baba Channel)	27.7	7.62	34.01	3.52	222	0.01
Sunsari River (Sukrabare Hatia, 3km Down	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Sunsari River (Saiphon Bridge, 7km Down)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Arvind Paper Mill						
Arvind Channel (10m up Outlet)	29.6	7.35	56.52	2.45	804	0.03
Arvind Discharge Near the Fence	28.4	7.40	56.71	5.98	687	0.03
Arvind Agro-based Process	27.4	7.52	52.21	6.01	298	0.03
Arvind Inlet to Tank	29.3	7.29	59.60	6.40	>999	0.03
Arvind Outlet from Tank	29.4	7.36	58.98	5.63	>999	0.03
Baba Paper Mill						
Baba Reservoir2	31.2	7.11	169.28	0.43	274	0.11
Baba Reservoir1	31.3	7.35	325.16	0.35	862	0.23
Baba End of Canal (150m Down)	31.0	7.43	245.68	0.10	>999	0.16
Baba Discharge (In Front of the Gate)	31.5	7.37	256.23	0.60	>999	0.17
Handpump Wells						
HP Well (Sukrabare Hatia)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
HP Well	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
HP Well	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
HP Well Arvind	25.7	7.17	35.36	1.88	6	0.01
HP Well Baba 2(In Front of Tea Shop)	26.0	7.02	47.38	1.57	0	0.02
HP Well Baba 1(In Front of the Gate)	26.3	7.03	40.62	1.55	2	0.02
HP Well 0 (Basiruddin)	26.2	7.13	39.54	1.62	0	0.02
HP Well 1 (Safeed I)	25.7	7.19	40.52	1.65	1	0.02
HP Well 2 (Saefeed II, the Other Side)	26.5	7.07	43.58	0.82	2	0.02
HP Well 3 (Allauddin Ansari)	25.7	7.09	44.25	1.63	2	0.02
HP Well 4 (Allauddin Mansuri)	25.2	7.08	62.66	2.06	2	0.03
HP Well 5 (Kishan Lal)	26.4	7.05	53.58	2.35	3	0.03
HP Well 6 (Sukh Deb, the Other Side)	25.9	7.05	68.12	1.70	4	0.04
HP Well 7 (Indra Lal Urao)	26.7	7.28	38.08	2.40	17	0.02
HP Well 8 (Taiyub Ansari, the Other Side)	26.7	7.01	47.66	0.88	2	0.02
HP Well 9 (Usman Mansuri)	25.6	7.12	52.75	0.98	1	0.02
HP Well 10 (Paltu Ram, 1 km Down)	25.8	7.26	45.41	0.89	0	0.02

Table-7 List of fishes of Sunsari with their Migratory Status, Economic Value and Special Status in Totality

SN	Scientific Name	Local Name	Migratory Status	Economic Value	Special Status in Totality
1	Catla catla (Ham)	Bhakur	MD	F	C
2	Chagunius chagunio (Ham)	Khaisala	RE	F	V
3	Cirrhinus mrigala (Ham)	Naini	MD	F	C
4	Cirrhinus rewa (Ham)	Rewa	RE	F	C
5	Labeo dero (Ham)	Gurdi	SD	F	C
6	Labeo gonius (Ham)	Kursa	SD	F	C
7	Labeo pangusia (Ham)	Termassa	SD	F	I
8	Labeo rohita (Ham)	Rohu	MD	F	C
9	Puntius chola (Ham)	Pothi	RE	F	R
10	Puntius conchonius (Ham)	Pothia	RE	F	C
11	Puntius sarana (Ham)	Pothia	RE	F	C
12	Puntius sophore (Ham)	Pothi,Sidre	RE	F	C
13	Puntius ticto (Ham)	Vittae	RE	F	C
14	Puntius titius (Ham)	Sidre	RE	F	I
15	Barilis barna (Ham)	Fageta	RE	F1	C
16	Barilius shacra (Ham)	Fageta	RE	F1	C
17	Barilis jalkapoori (Shrestha	Jalkpoor	RE	F1	V
18	Esomus dandricus (Ham)	Dhedawa	RE	F1	C
19	Rasbora dandricus (Ham)	Darai	RE	F1	C
20	Oxygaster bacaila (Ham)	Chalwa	RE	F	C
21	Oxygaster gora (Ham)	Darai	RE	F1	C
22	Crossocheilus latius (Ham)	Petfora	RE	F1	C
23	Lepidocephalichthys guntea (Ham)	Nakata	RE	F	C
24	Lepidocephalichthys nepalensis (Shrestha)	Letani	RE	F	R
25	Somileptes gongota (Ham)	Baglata	RE	F	O
26	Noemacheilus beavani (Ham)	Gadila	RE	F	C
27	Noemacheilus botia (Ham)	Baghilata	RE	F	C
28	Mystus cavasius (Ham)	Tengra	SD	F	C
29	Mystus seenghala (Sykes)	Tengra	SD	F	C
30	Mystus tengra (Ham)	Tengri	SD	F	C
31	Mystus vittatus (Bloch}	Tengra	SD	F	C
32	Wallago attu (Schneicler)	Bohari	SD	F	C
33	Clupisoma garua (Ham)	Jalkapoor	LD	FS	C
34	Gagata veridescens (Ham)	Baglata	RE	F1	C
35	Heteropneustes fossilis (Bloch)	Singhi	RE	M	C
36	Clarias batrachus (Linnaeus)	Mungri	SD	F	C
37	Anguilla benglanensis (Gray & Hard)	Rajbam	LD	FS	V
38	Xenentodon concila (Ham)	Chuchebam	SD	FS	C
39	Channa marulus (Ham)	Saura	SD	F	C
40	Channa punctatus (Bloch)	Garahi	SD	F	C
41	Channa striatus (Bloch)	Saura	SD	F	O
42	Amphipnous cuchia (Ham)	Bam	SD	F	O
43	Chanda nama (Ham)	Chanda	SD	F	C
44	Colisa latius (Ham)	Kotri	SD	F	I
45	Glossogobius Giuris (Ham)	Bhulla	RE	F	C
46	Macrognathus aculeatus (Bloch)	Gainchi	SD	F	C
47	Mastacembelus pancalus (Ham)	Kathgainchi	SD	F	C
48	Sicamugil cascasia (Ham)	Rewa	SD	F	R

Legend:

RE	Resident	F	Food value	O	Occasional
SD	Short distance	S	Sport value	C	Common
MD	Mid range	M	Medicinal value	V	Vulnerable
LD	Long distance	R	Rare	I	Intermediate
				IK	Insufficiently Known

Table- 8 List of Zooplankton Recorded in Sunsari and Budhi Rivers

S.No.	Species	Sunsari River							Marya Dhar
		1	2	3	4	5	6	7	
A	**Rotifera**								
1	Ascomorpha saltans	132			66			66	
2	Heraella brehmi	99	132					33	
3	Trichoscerca cylindrica	33		33			66		
4	Keratella cochlearis	66	66	33					33
5	Gastropus hyptopus		99		33	33			
6	Brachionus bidentata		66						
7	Brachionus calyciflorus	33		33			33	33	33
8	Philodina roseola		33				33	33	66
9	Pompholyx szilcata	66		66			33		66
10	Pleurotrocha petromyzon		132				33		66
11	Proales sp.		99				165		
12	Asplanchana priodonta			99				33	33
13	Monostyla lunaris	66							33
14	Lepadella acuminata	33							33
B	**Clodacera**								
1	Alona intermedia	198	165	99	132	33	66	66	33
2	Bosmina sp.	33	66	33			66		33
3	Moinodophina macleayii	33	33					66	
4	Chydorus ovalis						132		66
C	**Copepoda**								
1	Mesocyolops leuckarti								33
2	Cyclops vicinus	99			33	33	33		
3	Nauplius			33		33	66		33

Sampling : 3-11 May 2001

Table-9 List of Aquatic Insect Collected in the Study Area during Field Survey of Sunsari river and Mariya Dhar

S.No.	Species	Sunsari River							Mariya Dhar
		1	2	3	4	5	6	7	
A	**Ephemeroptera**								
1	Beatis sp.		✓	✓	✓		✓	✓	
2	Stenonema sp.				✓	✓			
3	Ephemerlla sp.					✓			
4	Potamanthus sp.							✓	
5	Ameletus sp.	✓		✓					✓
B	**Odonata**								
1	Leucorrhinia sp.					✓			
2	Sympetrum sp.	✓	✓	✓					
3	Enallagma sp.		✓				✓		
4	Libellula sp.			✓					
5	Amphiagrion sp.			✓					
C	**Plecoptera**								
1	Nemoura Venosa		✓						
2	Acroneuria sp.				✓				
3	Isogenus sp.		✓						✓
4	Peltoperia sp.								✓
D	**Hemiptera**								
1	Abedus sp.		✓						
2	Belostoma fluminea		✓						
3	Nepa sp.			✓	✓			✓	
4	Notonecta				✓				
5	Hesperocorixa						✓		
6	Pelocoris						✓		
7	Rhigovelia sp.								✓
8	Plea sp.								
E	**Coleoptera**								
1	Dytiscus sp.	✓		✓				✓	
2	Hydrophilus sp.	✓	✓	✓			✓	✓	
3	Dineutus sp.	✓	✓		✓				✓
4	Promoresia sp.					✓			
5	Psephenus sp.							✓	✓
F	**Trichoptera**								
1	Leptocella albida					✓			
2	Blossosoma sp.								✓
G	**Diptera**								
1	Eucorethra sp.	✓	✓						
2	Dasyhelea sp.	✓							
3	Culex sp.	✓							
4	Anophelos sp.		✓						
5	Tanypus sp.					✓		✓	
6	Chironomus sp.								
H	**Molusca**								
1	Goniobasis varginica	✓							
2	Pleurocera acula		✓						
3	Compeloma sp.								
I	**Amphiba**								
1	Tedpole	✓							

Sampling : 3-11 May 2001

Table- 10 List of Phytoplankton Recorded in Sunsari river and Mariya Dhar

(nos. per liter)

S.No.	Species	Sunsari River							Mariya Dhar
		1	2	3	4	5	6	7	
A	**Cynophyta**								
1.	Merismopedia glauca	250	750		250		250	750	250
2.	Lyngbya major	250		250		500			
3.	Stichosiphon sansibaricus								
4.	Spirulina sp.	250			250		250		500
5.	Chroococcus sp.								
B	**Bacillariophyta**								
1.	Fargilaria capucina	1000	1250	1000	750	250	250	500	750
2.	Cymbella cistula	750	500	500	750			500	750
3.	Cymbella Naviculiformis		250		250				
4.	Synedra ulna	500	750	250	500	250	500		500
5.	Synedra Affinis		250	250					
6.	Melosira granulata	1250	500			250			250
7.	Melosira italica	250	250		500	250			
8.	Navicula veridula		250	250			500		
9.	Navicula Radiosa	250	250	500	250	500			250
10.	Navicula cryptocephala	250		250					250
11.	Amphora ovalis	500		250			250	250	500
12.	Pinnularia macilenta	250	500	250	500				250
13.	Pinnularia Braunii	250	250	250		250		250	
14.	Gyrosigma kutzingii	750	500		500				
15.	Stauroneis acuta			500			500		750
16.	Gomphonema geminatum	750							
17.	Rhopalodia gibba								
18.	Cymatopleura solea	750	1000	500	750			500	1250
19.	Surirella sp.		500	750	250			250	250
20.	Asterionella sp.	250		250					250
21.	Achnanthes inflata		250						
22.	Nitzschia Acicularis								
C	**Chlorophyta**								
1.	Spirogyra sp.	750	500	500	250			250	500
2.	Closterium Moniliferum		500	500		250		250	250
3.	Cosmarium acquale	250	500	500	250				
4.	Cosmarium reinforme	250		250	500				500
5.	Pediastrum boryanum						500		500
6.	Spirotaenia condensata	500	250	500	250				250
7.	Closterium parvulum	1250		250					500
8.	Scenedasmus brasiliensis	500	250	250					
9.	Zygnema insigne	500		500					
10.	Sirogonum scicticum	750	500						
11.	Volvox aurens				250				250
12.	Hydrodictyon reticufatum	250							
13.	Schizogomum nurate	250	250	-					
D	**Pyrrophyta**								
1.	Peridinium umbomatum	500	750		500			250	500
2.	Peridinium pipes			250					

Sampling: 3-11 May 2001

Table - 11 Statement of Recommended Material and Estimated Production for Different Variety Fish Production System

Fish Production System	Production Material per hectare			Lime kg/ha	Nitrogen kg/ha	Phosphorusk g/ha	Grains kg/ha	Production (t/ha)	Production Average [4] (t/ha)
	Toadfish Stocking Size (gm) Number								
	Fry [1]	Fingerling [2]	Advanced Fingerling [3]						
Fish farming in pond									
1. Extensive	**7,000**			**500**				**0.8-1.5**	**1.15**
2. Semi-Intensive	**1,000**	**700**		**500**	**220**	**345**		**1.5-3.0**	**2.25**
3. Intensive	**15,000**	**10,000**		**500**	**220**	**345**	**2,850**	**>3**	**3.50**
4. Commercial									
4.1. Variety Fish Farming			8,000	500	220	345	2,850	4.0-5.0	
4.2. Local variety Major carp Fish farming			7,000	500	220	345	2,850	4.0-5.0	
4.3. Local variety fish farming and integrated fish farming			8,000	500	220	345	2,850	4.0-5.0	
Fish farming on paddy field		8,000		500	220	345	6,662	3.5-4	
Fish farming on other water reservoir	5,000							0.3-0.5	
Fish farming in cage	7,000								
1. General		$10/m^3$							
2. Commercial			$20/m^3$						
Fish farming in enclosure		7,000							

Resource: Agriculture Diary 2002, Agri. Information and Communication Centre for input quantity

1) Fry: Size 2.5cm & weight $1.0g/m^3$

2) Fingering: Size 5-8 cm & weight $1.5g/m^3$

3) Advanced Fingerling Size 5-8 cm & weight $25g/m^3$

4) This cell is add in original table

Table - 12 Operation Cost and Income of Fish Culture

per year, hectare

Input	Unit Price (Rs/kg)	1. Extensive		2. Semi-Intensive		3. Intensive	
		Quantity (kg)	Cost (Rs.)	Quantity (kg)	Cost (Rs.)	Quantity (kg)	Cost (Rs.)
Pond Cleaning	5,000	-	5,000	-	5,000	-	5,000
Fry (Rs/kg)	1.0	7,000	7,000	1,000	1,000	15,000	15,000
Fingerling (Rs/kg)	1.0	0	0	7,000	7,000	10,000	10,000
Lime (Rs/kg)	10.0	500	5,000	500	5,000	500	5,000
Nitorgen (Rs/kg)	15.0	0	0	220	3,300	220	3,300
Phosphorusk (Rs/kg)	15.0	0	0	345	5,175	345	5,175
Grain (Rs/kg)	8.0	0	0	0	0	2,850	22,800
Total Cost (Rs/ha/yr)			**17,000**		**26,475**		**66,275**
Gross Income (Rs/ha/yr)	70	1,150	**80,500**	2,250	**157,500**	3,500	**245,000**
Net Income(Rs/ha/yr)			**63,500**		**131,025**		**178,725**

Resource: Agriculture Diary 2002, Agri. Information and Communication Centre for Input quantity
Interview to District Agri. Development Office for Unit price

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5) Fattepur Irrigation Sub-Project, Environmental Impact Assessment Final Repot, May, 2000, His Majesty's Government of Nepal, Ministry of Water Resources, Department of Irrigation, Mid Western Development Region, European Union

HIS MAJESTY'S GOVERNMENT OF NEPAL
MINISTRY OF WATER RESOURCES
DEPARTMENT OF IRRIGATION

SUNSARI RIVER IRRIGATION PROJECT

ENVIRONMENTAL IMPACT ASSESSMENT

DRAFT FINAL REPORT

November, 2002

Proponent

Department of Irrigation
Jawalakhel, Lalitpur
Nepal

Tel. No : 535382, 526768

EXECUTIVE SUMMARY

Introduction

1. His Majesty's Government of Nepal (HMGN) has continued to accord high priority in agriculture development and to promote the development of irrigation sector. As a part of this, HMGN is implementing Sunsari and Morang Irrigatino Project (SMIP) to supply irrigation water to farmlands covering 63,925 ha in Morang and Sunsari districts. However, the design unit water requirement was not enough to cover the entire farmlands in the southern part of the Sunsari district – the area as covered by SMIP – as planned owing to certain areas of very sandy soil. Although SMIP was rehabilitated, only about 80 ha, out of 10,000 ha of its southern part are irrigated through Shankarpur and Suksena irrigation canals. Therefore, most of the farmers in the project area are relying on rainfall or meet their irrigation water demand through pumping shallow groundwater particularly for winter crops because paddy usually cannot bear the pumping cost (diesel). About 53 percent of households in the project area have inadequate food for more than nine months. Furthermore, about 63 percent of the total households (having less than 0.5 ha of land holdings) cannot supply food even for 3 months from their own land.

2. With this in consideration, HMGN requested the Government of Japan (GOJ) to develop this Sunsari River Irrigation Project (SRIP) to provide irrigation facility to a net command area of 10,147 ha, and the GOJ through Japan International Cooperation Agency (JICA) has provided funding for necessary studies including the environmental study for the development of this irrigation project. JICA has almost finalised the feasibility study report. The project will be implemented within in two stages within seven years and the total cost will be about US$ 17.78 million (tentative). The EIRR ranges from 17 to 24 percent in different cases.

3. As this level of project requires environmental impact assessment (EIA) based on Nepal's legal regime on the environment, this EIA report has been prepared based on the Scoping Document and the Terms of Reference approved legally by the Ministry of Population and Environment on … November 2002, and it also complies all legal requirements. The SRIP of the Department of Irrigation, Ministry of Water Resources is the proponent for this proposal.

Project location

4. The project is located at 26^0 24' N to 26^0 30' N and 87^0 04' E to 87^0 12' E. The command area of this project (SRIP) is located in the middle and lower reaches of the Shankarpur Branch Canal and the Suksena Branch Canal in the Sunsari District. The study area covers 168.2 km^2 which occupies about 13 percent of the total area of the district. The cultivable area is estimated at 125.3 km^2, i.e., 74 percent of the total study area. It is a part of 63,925 ha of command area of the SMIP. The Project area consists of 13 Village Development Committees (VDCs) inhabited by about 98,000 people. The gross command area (GCA) and authenticated area (land revenue paid) within the command of 13 VDCs totals to 16818.8 ha and 12530.4 ha respectively.

Project Components

5. Major facilities of this project are headwork, conveyance canal (main canal), distribution canals (secondary and tertiary canals), and controlling and regulating gates. The design criteria are based on the criteria of the Department of Irrigation including of Japanese standard design criteria for headwork wherever applicable. The high flood discharge will be designed for 650 m^3/sec and about 1.8 m^3/sec (50 percent of minimum P 80 percent) will be released for river maintenance. A fish pass will be constructed on both sides of the headwork. The maximum design discharge at intake will be from 8.05 m^3/sec. The minimum block size will be 20 ha.

6. The headwork will be constructed at 600 m downstream from the East-West (E-W) highway just above the effluent discharge points of the Arvind and Baba Paper Mills to avoid mixing of untreated effluent in the canal water. Weir type will be fully movable (all gate type). The sediment volume entering into canal system is estimated at 189,000 m^3/year (equivalent to 0.2m depth of sediment in canals) as the Sunsari River has the annual water volume of 161 MCM. As the amount of sediment is not so high, farmers will themselves remove the accumulated sediment as necessary. It is expected that proposed flushing channel will solve the predicted sediment deposition.

7. This Project aims to build on the successes of SMIP and other irrigation schemes implemented in Nepal. The length of the main canal will be 35.83 km, followed by 60.52 km secondary canal and 172.41 km long tertiary canal. During the canal construction period, almost all of the existing roads including the canal maintenance road will be used as right of way (ROW) for temporary roads. Some temporary roads will be added. At least about 6.8 km of the existing road will be improved. The Water User Association (WUAs) will be requested to construct small feeder road from their field to the nearby tertiary or secondary by themselves (utilising their own labour).

8. In order to ensure proper distribution of water, the main canal adapts conventional check regulating system together with drops as required based on the topographic condition. No gated regulation within secondary canal block will be applied.

9. As 397 ha of the southern most part of the study area will not receive gravity irrigation water from this Project due to its high elevation, it will be irrigated through groundwater development by 80 nos. of shallow tube-wells.

10. Total length of proposed drains in Shankarpur area (right bank) is 27.250 kms and Suksena area (left bank) is 37.650 kms. Major drainage systems are Sunsari River, Old Sunsari River Course (Mariya Dhar) and Budhi River. The drainage system has been designed for the capacity of 4.3 lps/ha. In addition, river training works will be implemented to minimise the damage of flood and submergence. Bearing in mind the impacts of inundation, the areas prone to flood and inundation are proposed to plant paddy and/or jute as most farmers are already practicing.

11. Along the headwork site, the volume of excavation and backfill materials for construction are estimated at 39,000m^3 and 19,000 m^3 respectively. About 20,000 m^3 will be used to construct flood embankment in the headwork vicinity and road construction. Therefore, a separate spoil disposal site will not be required. About 36,700 m^3 of aggregate, 19,100 m^3 of sand and 10,600 m^3 of timber will be required to construct the headwork and canal system and these materials will be collected from the riverbank around the construction site.

12. It is expected that most of the construction workers will be the local people. Based on the volume of work, about 2000 unskilled workers will be employed during the dry season for earthwork activities, and about 460 unskilled workers for concrete works. In case the contractor has some permanent labours in their payroll, a labour camp will be operated during the construction stage with necessary service facilities such as drinking water, heath, sanitation, and solid waste management.

13. The project will assist in setting up of new farmers' organisation and cater agricultural supporting services as a part of extension services including appropriate application of chemical fertiliser and pesticides with due consideration on toxicity and residual effect and so on.

Objective of the EIA Study

14. The main objective of this study is to assess and mitigate the potential impacts of the SRIP on the environment and make the project environmentally sound and sustainable. This study has assessed the likely impacts, examines their significance, recommends environment protection measures, and proposes environmental management plan including environmental monitoring and auditing including associated costs.

Methodology

15. During the preparation of this EIA report, necessary information was collected through primary and secondary sources including maps interpretation. They were analysed by following the methods and techniques as included in the EIA Training Manual for Professionals and Managers. Questionnaires and checklists were extensively used and series of consultation programmes were organised to solicit people's concerns including of fishermen. Soil and water samples were analysed at the laboratory. All data were processed, summarised, tabulated and interpreted at appropriate place in this report. Ad hoc and checklist were used to identify impacts. Impacts were predicted based on subjective judgement and evaluated through Delphi method. Significance of the impacts is also evaluated through expert judgement and they have been presented in the form of summary impact matrix.

16. After the preparation of the draft report, a public hearing was conducted at ……. (place) on … (date). About …….. participants attended the meeting and raised a number of issues relevant to the project activities and possible impacts on the environment. Base on the inputs received during the public hearing, this final report has been prepared.

Policies, Laws, Guidelines and Institutions

17. Relevant policies and strategies have been reviewed on the environment right from the initiation of EIA in Nepal including the Irrigation Policy 1992 (revised 1997), Hydropower Development Policy 2001, agriculture policy and Agriculture Perspective Plan, Water Resources Strategy 2002, and National Biodiversity Strategy, 2002.

18. Relevant laws on the environment, particularly the *Environment Protection Act (EPA) 1996* and *Environment Protection Rules (EPR) 1997* have been extensively reviewed. In addition, the *Water Resources Act, 1992* and its Rules 1993, Irrigation Rules, 1998 (amendment 2000), *Land Acquisition Act, 1977*, *Local Self-Governance Act 1999* and its Rules 2000, and the *Aquatic Life Protection Act 1961* and its Rules 2000 were extensively reviewed and provisions related to this project have been enumerated. The conventions related to biodiversity conservation, wetland management and desertification were also reviewed.

19. While conducting the study, the methods and procedures included in the environmental assessment guidelines including the National EIA guidelines 1993 and sectoral guidelines for Industry Sector 1995 and draft EIA guidelines for Water Resources Sector 1996 were extensively reviewed. Furthermore, existing environmental standards on industrial effluents have been documented so as to propose effluent treatment plants for the paper mills. In order to seek the inputs of various organisations at local, district and central levels during the project construction, major responsibilities of the concerned agencies have been reviewed.

20. This review indicates that this Project can be implemented smoothly to provide year-round water facility to irrigate the command area as envisaged within the framework of the existing policies, laws, strategies, standards and institutions on the environment, agriculture and water resources sectors, and make the project environmentally sound and sustainable.

Existing Environmental Conditions

Physical Environment

21. The Project area located at the eastern bank of the Sapta Koshi River and is rectangular in shape ranging from 64 meters to 80 meters above the mean sea level. The western and southern part of the project area is bordered with India. It is dominated by sandy soils having low to moderate water holding capacity. The climate in the project area is sub-tropical with mean daily maximum temperature of about 34^0C and annual average rainfall of 1,867mm between 1970 and 1993. The catchment area of the source river is about 300 km^2. It is relatively disturbed, erosion potential is high and resultant effect is the sedimentation in the riverbed and the farmland.

22. The prospective water resources for the project area are; 1) Sunsari River, 2) groundwater either shallow or deep, 3) water release from SMIP if extra water available is in the Chatra main canal, and 4) other rivers such as Budhi and its tributaries. The Sunsari River – the source river for the irrigation project – flows southwest through the central part of the study area. The flow and water quantity in the river is less than the irrigation requirements during winter and spring seasons surface. Geologically, the surrounding areas of the project have alluvial formation and Siwalik Group of rocks. This formation is irregular with alternating beds of silt, sand and gravel. The unconsolidated sediment deposits are mostly pervious and make an excellent aquifer.

23. Soil analysis indicated pH ranging from 5.7 to 7.2, organic matter 0.7 to 9.7 percent, nitrogen 0.03 to 0.28 percent, phosphorus 189 to 969 kg/ha, and potassium 591 to 836 kg/ha along with higher amounts of micronutrients such as boron, zinc, iron, copper etc.

24. Crop water consumption varies according to the crop growth stage. The potential evapo-transpiration is calculated as the minimum of 2.3 mm/day for December, the maximum of 7.2 mm/day in April and the annual total is 1,679 mm**.** Being the soil sandy, percolation loss was also considered to estimate paddy water requirement by conducting 42 field tests. The result ranges

from 9.9 mm/day to as much as 38.7 mm/day with the overall average of 17.26 mm/day which is higher than that of the SMIP (3.00 mm/day in Suksena area).

25. Out of the total agricultural land in the study area, currently irrigated (fully and partially irrigated) land occupies only 17 percent. Remaining area is cultivated under the rain-fed condition, and 91 percent of sample households cultivate winter crops by using shallow tube wells (STWs).

26. Based on water quality test of various parameters, the surface water is suitable for irrigation purposes as long as the headwork is constructed upstream of two paper mills to avoid entry of wastewater of these paper mills in the canal water. In case of ground water, Arsenic exceeds in some samples than WHO limits for drinking water but still permissible for irrigation purposes. However, DO in most of the samples analysed do not satisfy the Japanese irrigation standard which is more than 5 mg/l. No air quality degradation and high noise level was noticed.

27. When the Sunsari River discharge reaches more than 250 m^3/s, and/or precipitation in the study area exceeds 150 to 200 mm/day, the study area experiences flooding problems, and a total of 1,950 ha of land are frequently flooded due to precipitation and/or river discharge. About 8 VDCs out of 13 VDCs experience either flood or submergence problem.

Biological Environment

28. The project area has no forest area, and hence the area is not a habitat for wild fauna, particularly the mammals and forest birds. However, the Sunsari River and Budhi River is rich in the diversity of fish species. About 48 species of carps, catfishes, loaches, eels, barbs and minnow have been identified. The fish species indicates diversity in aquatic plants, particularly in phytoplankton and zooplanktons. No ecologically sensitive area was identified in the study area and the ecologically vulnerable area – the Siwaliks – lies above the proposed headwork site.

Socio-economic Environment

29. Based on the 2001 Census, the total population of the study area has 97,700 with 16,187 households and male/female ratio of 1:0.94. The family size was 6.0 with population density 581 persons/km^2. The annual growth rate from 1991 to 2001 was 2.5 percent, which is less than district population growth rate of 3.0 percent. Hill-terai and international migration is not significant in the study area. About 60 percent of the people are illiterate. Disparity of education status by sex increases as the grade goes higher. There are around 30 sub-castes mixed in the Study area. In fact, Muslim (Miya) population is the majority as 23.4 percent, followed by Meheta (Hindu) 19.25 percent, and Yadav (Hindu) 10.7 percent. Majority of the settlements are clustered and densely populated with possibility of higher number of local workforce for the construction of the project.

30. Most of the people are engaged in agriculture and earn living from being land owner, tenant and farm labour. Women are mostly engaged in agricultural labour. Livestock rearing, fishing in rivers and fishponds is also a source of income, especially of the landless people. A total of 202 households with 1,250 people are engaged in fishing activities and they are mostly the landless. Of them 175 households are considered regular fishermen. About 48 percent of the total population are categorised as landholder with less than 1 bigha (0.67 ha).

31. Major crops in the Study area are monsoon paddy, wheat, potato, oilseeds, pulses, vegetables, jute and sugarcane. Cropping is done in spring, monsoon and winter seasons. The overall cropping intensity is about 164 percent. The Study area is well known for potato and early cauliflower. Sugarcane and jute as well as potato and vegetables are important cash crops. Jute occupies almost 20 percent of the overall agricultural land during spring/monsoon season. However, jute and sugarcane suffer from sharp fluctuations in price as compared with vegetables. Cropping intensity of monsoon paddy in the study area is lower than that of other SMIP command areas. Paddy and wheat are the dominant cereals. Once the irrigation facility is provided cropping intensity will reach to about 200 percent. At present the average yield rate of wheat is 1.95 t/ha, and that of paddy is 2 t/ha. It is estimated that the total production of cereals is about 28,850 MT (paddy – 16,514 MT, and what – 12, 335 MT). The area faces about 18,000 MT of cereals deficit at present and about 53 percent of the total households live with inadequate food for more than nine months. In order to increase cereal production, local people also use fertilisers and chemicals although in low quantity.

32. Based on the household survey, average gross income was around 121,000 Rs/year. Of this income, 67 percent is from agriculture product, 8.5 percent from livestock, selling fish and forestry product (bamboo), and around 12.0 percent from employment including farm labour. The average expenditure is 110,000 Rs/year and highest expenditure is on agriculture followed by food. About 10 percent of the respondent has savings of 2,000 – 100,000 Rs/year. Income level corresponds to land holding size, and the income of the farmer with more than 4ha is more than 4 times higher than the farmers with less than 1 ha of land. The agricultural product in the study area is mostly self-consumed and some surplus is sold at the local markets.

33. The project area has education, health and drinking water facilities at different locations. Most of the people depend on tube wells for drinking water. Farm products are brought to the local market by using bicycle, cattle cart and tractor. The road network is established in the study area. Four jute-processing factories, 7 rice mills, 3 flour mills and 4 vegetable oil refining factories are operated along Biratnagar – Dharan road. In addition, two sugar mills are operated around the study area.

34. A number of line agencies particularly of agriculture and irrigation sectors also exist in and nearby the study area. The study area is also facilitated with 15 agriculture extension centres. At present, Local Governance Programme (LGP) funded by UNDP, Decentralized Planning for Child Programme (DPCP) by UNICEF, Sunsari-Morang Programme by PLAN International, and Nepal Participatory Learning and Advisory Project (NPLAP) funded by DFID are under implementation. In addition, there are 11 NGOs considered to be somehow active in the study area.

Alternative Analysis

35. Two alternatives – do-nothing and implementation of the proposed project – were analysed to evaluate crop production in "with and without" project scenario. If the project is not implemented, the crop yield will not increase. Implementation of the project will likely increase yield rate of various crops. Within project scenario, command area alternative, amount of water in the intake, and alternatives to the intake site, intake design and water source were analysed and the best alternative will be to construct the intake at upstream of the effluent discharge site of the paper mills and downstream of the E-W highway. Diversion of about 50 to 80 percent of the water of the Sunsari River into the canal would be the appropriate option along with the construction of the fish passages in the intake.

Environmental Impacts and Protection Measures

Beneficial Impacts and Augmentation Measures

36. During the construction stage, the project will provide employment to about 2020 unskilled labour man/day for earthworks and 460 man/day for concrete works for 3 working season including for about 80 skilled labours. Construction workers will likely use the local materials and products and it may promote trade and business in the project area. Income generated will likely improve health, education and other social service sector including community development activities. In order to augment this beneficial impact, the project will adopt a policy of involving over 80 percent of the total construction workers to the local people. The Project will encourage the project officials and the workers to maximise the use of local goods, products and services.

37. Local people will be employed in the headwork and canal construction. The Project will offer them practical training to upgrade their skill, and organise training programme on construction supervision, operation and maintenance of the canals and to strengthen local institutions.

38. Increase in per capita income of the local people will likely promote investment on social service facilities particularly in developing and/or upgrading health and sanitation, and drinking water facilities. The Project will also assist in strengthening the existing health posts by providing additional medicines if the health posts are involved in providing medicines and primary health care to the construction works. Similarly physical facilities of the local schools will be improved if the children of the outside construction workers are enrolled in the local schools.

39. During the operation stage, the cropping intensity will be increased from existing 165 percent to about 200 percent. It will promote crop diversification, enhance soil fertility, and increase overall production of cereals. It is expected that the paddy, jute, wheat, potato and sugarcane will increase from existing 2.5 to 4.2 t/ha, 1.9 to 2.5 t/ha, 2.2 to 3.5 t/ha, 17.9 to 22 t/ha, and 44 to 80

t/ha respectively. In order to maximise this impact, the Project will avoid or minimise leakage of irrigation water in the canal system, provide necessary information and training on the appropriate seeds, fertilisers and agro-chemicals, including IPM and IPNM and agriculture services.

40. The year-round irrigation facility will also increase the land value. However, the Project will encourage the landowners not to change the land use.

41. This Project follows the joint management policy, i.e., the Project and WUAs. The Project beneficiaries and/or the member of the WUAs will receive necessary training to augment the benefits. The beneficial impacts and proposed augmentation measures are presented in the summary impact matrix (Table 5.1).

Adverse Impacts and Mitigation Measures

42. During the pre-construction stage, a total of 372.3 ha of land should be acquired for the construction of canal system. Of this 5.6 ha of land will be used for headwork construction, and 19.8 ha will be occupied by conveyance canal. A total of 32.5 ha and 115.9 ha of land will be used for the construction of secondary and tertiary canals respectively. Similarly, the Project has estimated to use about 154.6 ha for on-farm development (water course) and 0.7 ha for road improvement to maintain 1.5 km long road. Furthermore, about 43.2 ha of the land will be developed as fishpond, as a part of environmental mitigation measures. Almost all the land of the main canal is already acquired by the SMIP. This Project will encourage the farmers, particularly the fishermen community to raise fish as the main sources of subsistence living. As this is a joint management project (Project and farmers), compensatory environmental protection measures (EPMs) will be limited for the construction of headwork only. For other land, local people will be compensated as per the prevailing laws. In case of road, local people will extend their cooperation to provide necessary farmland or other categories of land. Some land will be required for work camp, labour camp and spoil disposal. This will be for temporary use and be leased for the project duration through necessary compensation.

43. Most of the construction related impacts are temporary in nature. The volume of excavation and backfill for headwork construction are 39,000m^3 and 19,000 m^3 respectively. Remaining 20,000 m^3 is planned to spread to level the field around the construction site, and for embankment construction in the river training works. Hence, no spoil disposal area is located for operation. Furthermore, impact of earthwork is evaluated insignificant and no mitigation measure is proposed.

44. The Project will require about 36,700 m^3 of aggregate, 19,100 m^3 of sand and 10,600 m^3 of timber for the construction of headwork and canals which shall be collected from the riverbank around the construction site without disturbing the morphology of the area concerned. In order to minimise impacts associated with quarry operation and collection of aggregates, boulders and sand, the Project will take into consideration the river course, materials deposition trend, and manual extraction of the construction materials along the river course. The unused materials will be disposed off safely nearby the headwork site without damaging the river course, and landform.

45. Construction activities will be undertaken during the dry seasons, and it will likely generate dust and gaseous emission particularly at the headwork and canal excavation site. Plying of heavy vehicles will also emit gaseous emission and create noise. Cement slurry, mobile, diesel etc. may be leaked into the water bodies thereby causing water pollution. Operation of the labour camp and work camp is likely to create environmental pollution due to the solid wastes and wastes water. In order minimise environmental pollution, and its effect on local people and construction workers, the Project will instruct the supervising consultant and the contractor to spray water at regular interval to arrest the dust, maintain vehicles to minimise gaseous emission, prohibit the use of pressure horn particularly along the settlement, hospitals and health posts and school areas, erect adequate no horn and safety signs in these areas, and keep vehicle speed breakers at appropriate places. The Project will avoid the leakage of cement slurry, mobile or diesel into the water bodies to the extent possible along with the provision of sanitary latrines and solid waste management in the labour camps and work camps.

46. In order to minimise impacts related to stockpiling of construction materials, the contract document will have specific clauses to regulate Contractor's activities including for compensation for the loss of agriculture production. Other impacts identified and predicted in the physical environment are evaluated as insignificant.

47. As there is no forest in the project area, impacts are evaluated only on the aquatic life, particularly the fish population. High demand for fish by the construction workers and project officials will likely affect its population and in the worse condition, the species itself. In order to minimise it, the Project has planned, inter alia, to release water to maintain aquatic habit, and proposed to instruct Arvind and Baba paper mills to operate effluent treatment plants (ETPs). Furthermore, a special package of fish culture has been developed to about 180 households of fishermen in Mariya Dhar area. The Project will provide training to fishermen on raising the fish and harvesting technique as appropriate. A fish passage will be constructed in the headwork site to conserve migratory fishes.

48. About 270 ha of agricultural land will be affected due to construction of tertiary canals and the watercourse. Farmers loosing over 50 percent of the total land through land acquisition process will be adequately compensated considering them as the Severely Project Affected Families (SPAFs) by following the existing regulatory provisions.

49. High number of construction workers including outside labourers will exert pressure particularly on social service facilities. In order minimise it, the Project will provide drinking water facility to the outside labourers. It will also provide medicines for health posts, and physical facilities for schools if the construction workers and their families are provided with these facilities. Furthermore, provisions for health and sanitation, and drinking water facilities will be the pre-requisite for labour camp operation. If severe health injuries are noted due to Project activities, the Project will bear the cost for medication. Necessary information on occupational health and safety along with the provisions for primary health care facilities, and health cost for treatment elsewhere will also be provided.

50. Law and order impact is considered minor and insignificant, and no mitigation measure is proposed. However, conflicts and malpractices, if noticed, will be reported to the nearest security official and the Project will also take actions to expel the workers involved in such practices.

51. Demand for food items and other consumables will likely increase due to high cash flow. This impact is natural and has been evaluated insignificant. Hence, no mitigation measure is proposed. The construction of irrigation system will not affect any religious and/or cultural sites, and cultural practice of the project area.

52. During the operational stage, about 0.2m depth of silt will likely be deposited in the canal system which will ultimately reduce soil fertility and crop production. In order to mitigate it, the Project will construct spillway and proposes removal of silt periodically by the farmers. Therefore, a separate sedimentation basin has not been proposed. If the water carries over 5,000 ppm of silt in the River during the rainy season, it is recommended to close the canal gate.

53. As mentioned before, discharge of untreated effluents from Arvind and Baba paper mills will increase pollution load particularly BOD and COD during the lean flow in the river below the proposed headwork. There is a possibility that the factories construct effluent treatment plant (ETP) under the assistance from DANIDA. The project has also estimated the pollution load in 80 and 90 percent water diversion during the lean period. On condition that the factories install and ETP reducing the effluent to 20 percent, the SRIP may take Sunsari water up to 50 percent of water. If the SRIP intends to divert 80 percent of water, HMGN should enforce the factories to comply with the Nepal's environmental standard.

54. Feasibility study has identified flood prone and possible inundation area at eight locations. In order to drain out the irrigated water from the field, extensive drainage development has been proposed as an integral part of the project. In addition, the canal embankment running along the Sunsari River will be strengthened to protect the possible breach.

55. The Project activities will pose impacts on certain groups of fish species and this impact is evaluated significant. It is also predicted that the construction of barrage in the Sunsari River may result to the disappearance of some species, and emergence of new species. There is possibility on the decline of the population of some fish species – the flowing water lover, and pool-dwellers. After water diversion, pool habitat will be maintained in selected areas, and if so 9 species of flowing water fish will be greatly affected. Furthermore, the long-distance migratory fish species such as eel may be affected due to barrage construction. In order to minimise this impact, the Project will construct fish passage in the headwork, and discharge at least 0.7 m^3/s even if 80

percent of the flow is diverted for irrigation purposes to improve aquatic habitat. This comes to about 20 percent of the river water flow and complies with the standard as stipulated in the Hydropower Development Policy, 2002. Furthermore, operation of the ETPs and compliance of the environmental standards by the paper mills will also improve fish habitat. In addition, the Project will launch fish culture programme to benefit the fishermen which are likely to be affected by the Project activities.

56. Loss of fish population is evaluated as most significant impact and this could be lowered down by encouraging the fishermen in raising fishes in the fishponds. In order to develop fishponds and promote fish culture, the land available in the Mariya Dhar (old Sunsari River) will be considered initially by solving its ownership problem. As about 180 households are now engaged in fishing in the study area, development of about 43 ha of land as fishponds would be sufficient for the introduction of semi-intensive fish culture as compensation.

57. The project will not pose significant impact on pump irrigation. A total of 266 pumping stations were observed in May 2002 at the downstream of the East-West Highway to the border with India irrigating about 230 ha of land (maximum diversion of about 0.4 m^3/s will be sufficient for the operation of these pumping stations). Even if the project divert up to 80 percent of the water after ETP operation, the required water will be released for pump irrigation.

58. Impact related to the use of more agro-chemicals like chemical fertilisers, insecticides and pesticides is evaluated moderate, the the Project under the agricultural extension programmes will encourage the local people to use of green manure and adopt integrated plant nutrients and adopt integrated pest management.

59. Impact on women through year-round facility for irrigation water is considered to be moderate as they are involved in planting, weeding, harvesting, threshing and storing of the farm products. The Project will disseminate information on possible implications of additional workload to women in the area, and encourage men as well to reduce such workload. A summary matrix of the adverse environmental impacts and recommended mitigation measures is given in Table 5.2.

60. Considering the nature, magnitude, extent and duration, impacts have been evaluated as significant, moderate and insignificant using the values as given in the National EIA Guidelines 1993 and preventive, corrective, and compensatory measures have been proposed accordingly. Impacts evaluated as significant are in the areas of employment generation, land acquisition, water pollution, and aquatic invertebrates including migratory fish species. The Project will emphasise to involve the local people as construction workers by even providing technical skills, strengthening WUAs, compensating land acquired, and also involving the fishermen in fish raising.

Environmental Management Plan

Plan for EPMs Implementation

61. In order to ensure the implementation of the environment protection measures (EPMs) as proposed above, this environmental management plan (EMP) has been proposed following the POSDCORB concept. Major EPMs have been identified, and implementation activities have been proposed with due consideration on location, timing, and method. The responsible agency for EPMs implementation has been proposed and necessary cost has also been estimated. The EPMs will be implemented within the project area and the responsibility is either given to project administration (project, consultant, supervisor or contractor) or the users – the WUAs – for pre-construction, construction, and operational and maintenance stages.

Environmental Monitoring

62. In order to know the compliance of the implementation of EPMs and their effectiveness, a plan for environmental monitoring has been developed with due consideration on the Schedule 6 of the EPR 1997. Indicators for compliance and impact monitoring, location of monitoring, method, schedules and responsibilities have been proposed. The Project will monitor the compliance of the technical specifications as an in-built process. The Project has planned to carryout the impact monitoring study at the middle of the project construction phase and after the project completion so as to provide input for environmental auditing. An inter-ministerial committee with representation from DOI Environmental Unit, MoWR, MoPE and MoAC has been proposed to form for environmental impact monitoring study.

Environmental Auditing

63. With due consideration on the Rule 14 of the EPR, 1997 (amendment 1999), and the National EIA Guidelines 1993, the project impact auditing has been recommended to evaluate the environmental changes as a result of project implementation. The DOI will carry out environmental auditing in its interest for obtaining feedback for integrating environmental aspects in future irrigation projects. The proposed auditing parameters include, inter alia, downstream water release during lean period, water quality, quantity and quality of effluents from paper mills, fish population, water logging, socio-economic changes, crop production, and functioning of fish passage. A team of experts will carry out auditing by employing methods as used in impact identification and prediction to minimise method-based errors.

Institutional Arrangement

64. The Project will have the overall responsibility for ensuring EPMs implementation, conduction of environmental monitoring, and for making the Project environment-friendly and sustainable. As an in-built mechanism, the Project will establish an Environment Unit to ensure the integration and implementation of EPMs including environmental monitoring. The Unit will have environmentalist, irrigation engineer, fishery expert, agriculture economist and sociologist and necessary support staff. Most of the EU staff will be located at the project site and an Environmentalist will station at Project Management Office and conduct frequent field visit. An organisation chart has been proposed.

Directives and Coordination

65. In view of the nature of the project and its location, the irrigation project will be developed smoothly. However, coordination should be established with the Ministry of Land Reform and Management to facilitate land registration process in the Mariya Dhar area so that fish culture could be developed. The Project will ensure coordination with a number of central and local level institutions including the fishery development, district agriculture, WUAs and local NGOs as and when needed. Necessary directive should be issued to operate ETP by paper mills and comply with the Nepalese environmental standard.

Reporting Requirements

66. The Environmental Unit will prepare necessary reports about the implementation of the EPMs and monitoring results at regular interval and disseminate them through the Project Management Office. The EU will also prepare an annual report and project completion report including environmental performance, and make them public.

Estimated Budget

67. Most of the costs for EPMs will be included in the Project cost. A total of NRs. 34,320,000 has been estimated as an additional costs proposed for the implementation of the selected EPMs. For environmental monitoring activities that will be carried out by an Environmental Unit, a total of NRs. 8,958,180/ has been estimated. In addition, an amount of Rs. 200,000/ will be allocated for the impact monitoring by the proposed inter-ministerial committee. As the Project also intends to carry out environmental auditing to judge its environmental performance, a total of Rs. 2,517,000/ has been estimated. In sum, the total cost for the implementation of the EPMs, environmental monitoring and environmental auditing is estimated at NRs. 45,996,080/ and this cost will be borne by the Project.

Conclusions and Recommendations

68. The SRIP will provide irrigation facility to about 10,147 ha net command area of 13 VDCs on the southern part of SMIP. In view of the nature and scale of the Project, impacts identified predicted and evaluated, and existing relevant policies and laws this Project can be implemented by minimising the adverse environmental impacts through coordinated effort and joint management concept. It is concluded that the beneficial impacts outweighs the adverse impacts. But, the two paper factories located at the down stream of the proposed headworks site have been polluting the water of Sunsari river by discharging untreated effluent, which is not permissible according to the law. Abstraction of water for the purpose of irrigation will reduced the flow in the river and water quality will be further deteriorated. Hence, this study recommends to implementing the project as designed with the assurance that the proposed mitigation measures are implemented effectively, and environmental monitoring is conducted during project construction and operational stages with allocation of necessary budget.

69. This study recommends to solve landownership problem in the Mariya Dhar area to promote fish culture. It is urged to enforce legal provisions for Arvind and Baba Paper Mills to operate ETPs and comply with the environmental standards. It is also recommended to perform surveillance monitoring from the central level organization, preferably by the inter-ministerial committee.

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ABBREBIATION

APP	Agriculture Perspective Plan
BOD	Biological Oxygen Demand
CA	Command Area
CBD	Convention on Biological Diversity
CCD	UN Convention to Combat Desertification
CMC	Central Main Canal
COD	Chemical Oxygen Demand
CP	Cleaner Production
DADO	District Agricultrue Development Office
DANIDA	Danish International Development Agency
DDC	District Development Committee
DOI	Department of Irrigation
DTW	Deep Tube Well
EA	Environmental Assessment
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPA	Enviornment Protection Act
EPM	Environmental Protection Measure
EPR	Environment Protection Rules
ESPS	Environment Sector Programme Support
ETP	Effluent Treatment Plant
EU	Environmental Unit of SRIP
FAO	Food and Agriculture Organisation
GCA	Gross Command Area
GOJ	Government of Japan
HMGN	His Majesty's Government of Nepal
IPM	Integrated Pest Management
IPNM	Integrated Plant Nutrient Management
JICA	Japan International Cooperation Agency
LGP	Local Government Programme
MOAC	Ministry of Agriculture and Co-operatives
MOPE	Ministry of Population and Environment
NGO	Non-Governmental Organisation
NPC	National Planning Commission
NPLAP	Nepal Participatory Learning and Advisory Project
O/M	Organisation and Management
PDSP	Planning and Design Strengthening Project
PETo	Potential Evapo-Transpiration
PRA	Participatory Rural Appraisal
ROW	Right-of-Way
SEA	Strategic Environmental Assessment
SMIP	Sunsari – Morang Irrigation Project
SRIP	Sunsari River Irrigation Project
STW	Shallow Tube Well
TOR	Terms of Reference
TSS	Total Suspended Solids
UNDP	United Nations Development Programme
VDC	Village Development Committee
WECS	Water and Energy Commission Secretariat
WUA	Water Users Association

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CHAPTER

1 INTRODUCTION

1. INTRODUCTION

1.1. Background

The past development plans of His Majesty's Government of Nepal (HMGN) as well as Tenth Plan (2002-2007) have accorded high priority to reduce poverty, increase agricultural production and incomes, and create employment especially in rural areas (NPC, 2002). HMGN has implemented the Agricultural Prospective Plan (APP, 1994/95-2014/15) since 1997 linking it with the Ninth Plan (1997-2002). This Plan places strong emphasis on increasing agricultural production through the development of irrigation facilities. The Tenth Plan (2002-2007) continues to support groundwater development as well as small and medium scale surface water projects.

Agriculture, which is largely rain fed, dominates the country's economy. It accounts for about 40 percent of the gross development product (GDP) and provides employment to about 80 percent of the economically active population. Crop yields are generally low, but could be increased considerably with effective irrigation, usage of improved seeds, proper applications of fertilizer and pesticides and improved farming methods.

HMGN is also promoting the involvement of user groups in the development, rehabilitation and maintenance of irrigation schemes through the implementation of the Irrigation Policy, 1992 (first revision 1997). This Policy calls for the development of environment-friendly irrigation system by integrating environmental aspects right from the project formulation stage.

As water is one of the key pre-requisites for agriculture production, HMGN has accorded priority to develop irrigation facilities. A total of about 1.1 million ha of farmland is provided with irrigation facility during the last four and half decades and/or by the end of the Ninth Plan (2002) and has planned to irrigate 1.4 million ha by the end of the Tenth Plan (NPC, 2002). It clearly indicates that over 65 per cent of the total farmland requires irrigation facility for increasing agricultural production even by promoting cropping intensity. Although, the previous Plans have placed adequate emphasis for the development of this sector, increase in the area of irrigated land and consequent increase in yield rate of major crops is at the slow pace. It demands the urgent need for expanding irrigation coverage, i.e., year-round irrigation facility to increase farm production and also to attain the goals of poverty reductions.

In line with the spirit of the Agricultural Perspective Plan, the Tenth Plan has continued the placing of agriculture development in the first priority and has made target to provide irrigation facility to 1.417 million ha of arable land by the end of 2007. The Tenth Plan aims to increase annual economic growth rate by 6.2 per cent with the growth rate of agricultural sector at 4.1 per cent. This target could be achieved by providing additional agri-inputs including the irrigation facility. One of the basics of increasing the farm production is to increase the coverage of year-round irrigable area.

The Sapta Koshi River, flowing along the eastern part of Nepal, is one of the biggest rivers in Nepal with a drainage area covering about one-third of the country. This river has been tapped for irrigation purposes. In 1964, the Chatra main canal, which withdrew water from the Sapta Koshi River, was constructed with Indian assistance for irrigating southern parts of Sunsari and Morang districts in the Kosi zone of Nepal. The canal was supposed to supply irrigation water to farmlands covering 63,925 ha in the project area. However, the design unit water requirement was not enough to cover the entire farmlands as planned owing to certain areas of very sandy soil.

A plan was then started to rehabilitate and modernise the irrigation system in a phased manner. The farmlands, the prospective irrigable area, were divided into three stages and a project entitled Sunsari-Morang Irrigation Project (SMIP) was started. It included among others the construction of a new intake

at the Koshi River. Stage I was started in 1978, Stage II in 1986, and Stage III in 2000 which is still ongoing. Though SMIP has been rehabilitated/renewed during those three stages of construction, the average intake discharge, for 9 years from 1990 to 1998, was just 35 m^3/s against the design intake discharge of 60 m^3/s. A measure to supplement the intake deficit is now being sought.

Several rivers are flowing from north to south of the extensive farmlands in the Sunsari District. One of them is the Sunsari River which flows through the western side of the farmlands – the proposed project area. This river is located at around midway between two secondary canals of the Chatara main canal namely the Shankarpur Branch Canal and the Suksena Branch Canal. The Sunsari River is perennial. If a headwork is constructed at the suitable site it could deliver by gravity the water to the both branch canals that have not been able to supply adequate water to their command areas. If so, it could result in the improvement of irrigation service in the area.

Shankarpur and Suksena irrigation canals, which run through the Study area, were constructed with the assistance of the Government of India about 26 years ago. The irrigation facilities are usable only for 80 ha out of about 10,000 ha of the irrigable area. As of August 2001, the Sunsari river has provided irrigation facility to 55 ha (Babiya, Jalpaur, Gautampur VDCs) and 25ha (Narsimha VDC) respectively. Therefore, most of the farmers in the project area are relying on rainfall or meet their irrigation water demand through pumping shallow groundwater. Pump irrigation by shallow tube well is prevalent especially in the southern parts of the Study area. However, the groundwater is not usually used for paddy irrigation except during acute water shortage. However it is used for winter season's crops because paddy usually cannot bear the pumping cost (diesel).


Suksena Canal


Shankarpur Canal

Water for agriculture is absolutely lacking as compared to the requirements. Due to the sandy soils, unit water requirement of paddy crop is very high. Hence improvement of irrigation facilities is necessary. Also inadequate operation and management of the Shankarpur and Suksena irrigation systems has caused damages in the canals, such as sedimentation on canal bed, sliding of side canal slopes, counter current of canal bed inclination, O/M road subsiding, and leakage of canal water. These situations have aggravated current insufficient supply of irrigation water through the above two canals into the Study area.

Furthermore, about 53 percent of households were found having inadequate food for more than nine months. The area is much constrained with food supply in both downstream and upstream reaches of the study area. The data indicates that households who has less than 2 ha of farmland can secure food for not more than half of a year from their own land and 63 percent of the total households (less than 0.5 ha of land holdings) cannot supply food even for 3 months from their own land.

With due consideration on this situation and potentiality for increasing food production through additional irrigation facility, HMGN requested the Government of Japan (GOJ) to develop this Sunsari River Irrigation Project (SRIP) and the GOJ sent a Scope of Work Mission through JICA in November 2000. The HMGN and GOJ agreed on the Scope of Work and singed on 29 November 2000. JICA, on behalf of the GOJ awarded Sanyu Consultants Inc. of Japan to carry out necessary studies including the environmental study for the development of this irrigation project (Sanyu Consultants Inc., 2002). JICA has almost finalised the feasibility study report.

In accordance with the provisions of the Environment Protection Act 1996 and the Environment Protection Rules 1997, the project planned for irrigating more than 2000 ha in the Terai should undergo environmental impact assessment (EIA) process. The proponent has to prepare the EIA report for the implementation of this level of project legally and process for implementation only after the approval of the final EIA report. Hence, this report is prepared based on the Scoping Document and the Terms of Reference approved legally by the Ministry of Population and Environment on … November 2002.

This report complies with all legal requirements on the environment. A Public Hearing was conducted on …….. 2003 and issues raised during the public hearing has been accommodated in this final EIA report. In accordance with the legal provisions, recommendation letter(s) of the Village Development Committee(s) is also annexed in this report.

1.2. The Proponent and Project Area Delineation

The Sunsari River Irrigation Project (SRIP) of the Department of Irrigation, Ministry of Water Resources is the proponent for this proposal. The Government of Japan through JICA has provided technical and financial assistance for carrying out necessary studies. The JICA has awarded Sanyu Consultants Inc. for the preparation of the EIA and its associated reports on behalf of the proponent.

In order to prepare site-specific and focussed EIA report, the physical boundary of the net command area has been considered as the directly affected project area. Baseline information has been collected and analysed for this net command area. However, secondary environmental impacts have been assessed for the nearby project area within the physical boundary of 0.5km from all sides of the command area.

1.3. Project location

The command area of the proposed project, SRIP, is located in the middle and lower reaches of the Shankarpur Branch Canal and the Suksena Branch Canal in the Sunsari District, Koshi Zone, Eastern Development Region. The study area covers 168.2 km^2 which occupies about 13 percent of the total area of the district. Furthermore, the cultivable area is estimated at 125.3 km^2, i.e., 74 percent of the total study area. It is a part of 63,925 hectare (ha) of command area of the Sunsari Morang Irrigation Project (SMIP). As the tail portion of the command area of SMIP is suffering from severe water shortage for producing water-demanding cereal crops, this Project has been designed. The Project area consists of 13 Village Development Committees (VDCs) inhabited by about 98,000 people. The gross command area and authenticated area (land revenue paid) within the command of 13 VDCs are presented in Table 1-1. A VDC comprises of a wards and each ward of the VDC consists of few settlements. Location Map of the Study Area is presented in Figure 1-1. A map of the study area is presented in Figure 1-2.

Table 1-1 : Command Area in 13 Village Development Committees

SN	Name of VDCs	GCA (ha.)	Land revenue paid area (ha.)
1	Sahebgunj	1346.3	1242.6
2	Kaptangunj	1469.0	1362.4
3	Dewangunj	373.9	333.9
4	Ghuski	1450.3	1299.3
5	Rajgunj Sinuwari	1969.1	1852.7
6	Madhya Harsini	627.5	589.0
7	Basantpur	983.0	793.8
8	Harinagar	1089.9	988.8
9	Ramnagar Bhutaha	1317.0	877.0
10	Jaipapur	599.9	543.2
11	Narsinmha	3548.9	767.2
12	Gautampur	817.6	768.3
13	Babiya	1226.2	1112.2
	Total	16818.8	12530.4

Note: GCA = Gross Command Area

Figure 1-1 : Location Map of the Study Area

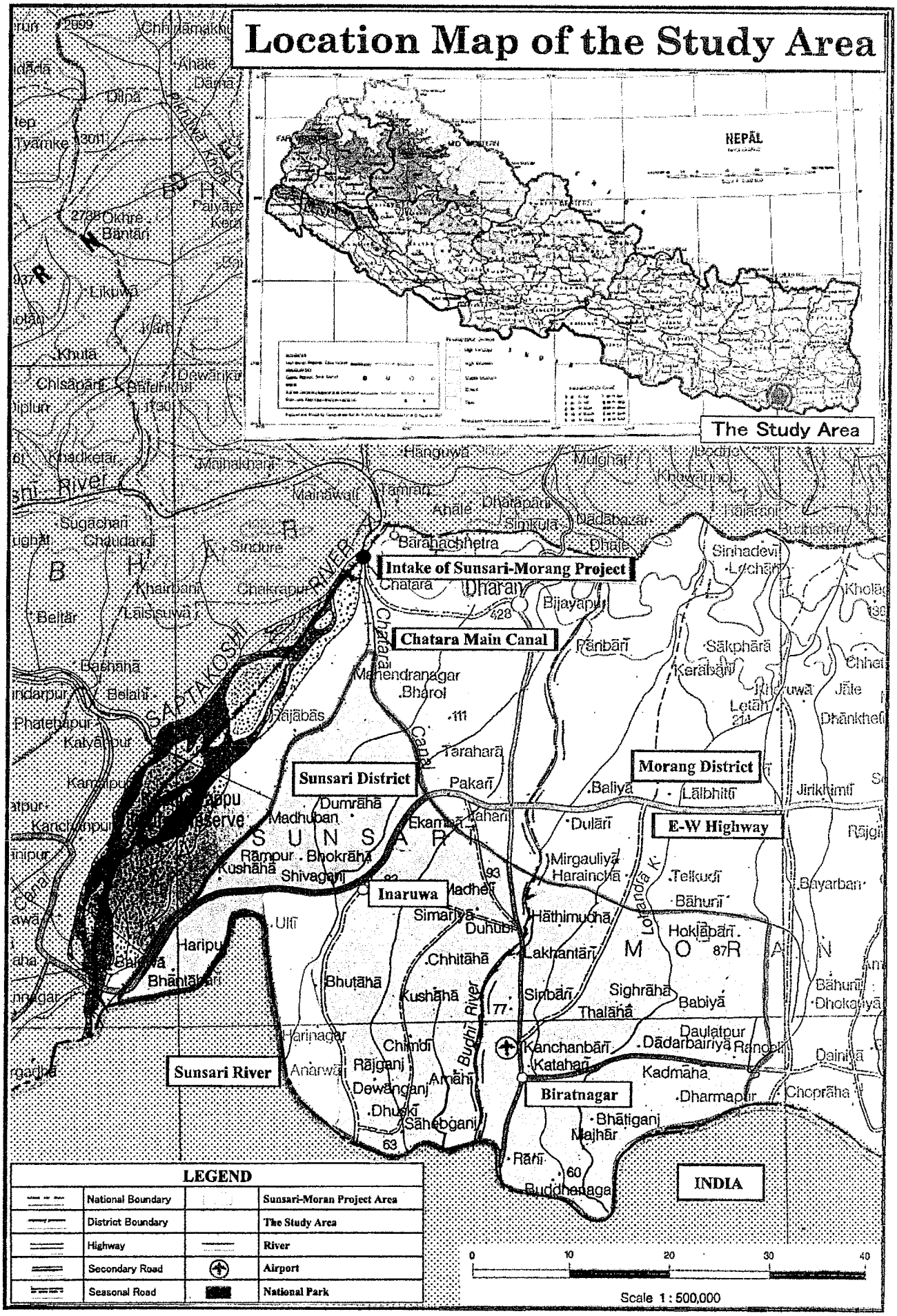
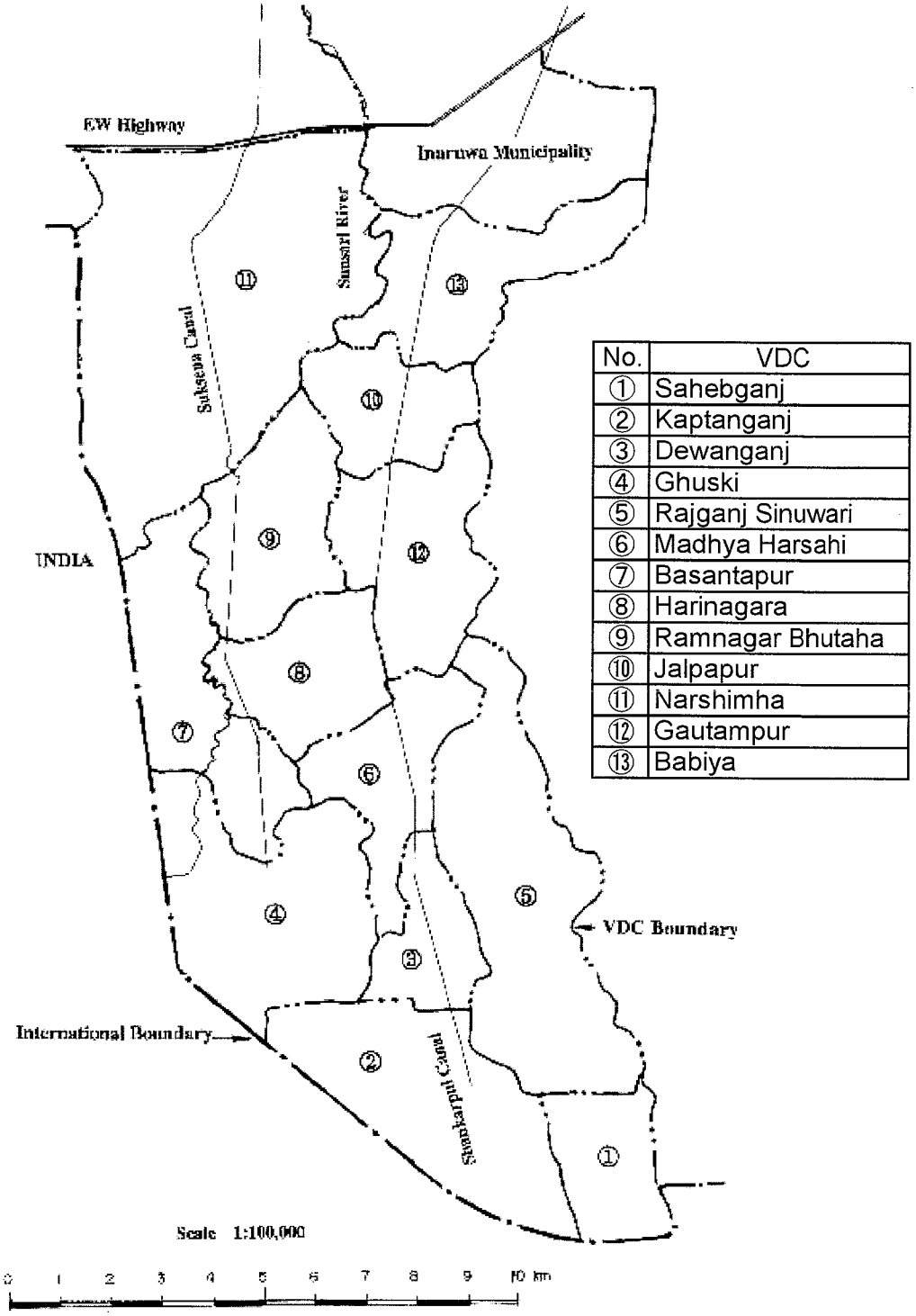


Figure 1-2 : A Map of the Study Area



1.4. Project Components

Construction of irrigation facilities such as headwork and conveyance canals linking Suksena and Shankarpur Canals can contribute to agriculture development and improve the living condition of the people in the area, where crop productivity is limited due to shortage of water. In this Project, major facilities are headwork, conveyance canal (main canal), distribution canals (secondary and tertiary canals), and controlling and regulating gates. The design criteria used in this Study are based on the criteria of the Department of Irrigation, which are given in the "Planning and Design Strengthening Project" (PDSP) manuals. For the design of headwork, this Study refers to "Hydrology and Agro-meteorology Manual (M.3)" and "Headwork, River training Works and Sedimentation Manual (M.7) published by the Food and Agriculture Organisation (FAO). In addition, the Japanese standard design criteria for headwork as well as the views and the experiences of the DOI staff including SMIP have been taken into consideration for the design of this project.

Table 1-2 : Salient Features of the Sunsari River Irrigation Project

1	**Name of the Project**	:	Sunsari Irrigation Project (SRIP)	
2.	**Study Area**			
	Location	:	Latitude 26^0 24' N to 26^0 30' N Longitude 87^0 04' E to 87^0 12' E	
	Project area coverage	:	South western part of Sunsari District covering 13 VDCs	
	Geographical Area	:	168.2 km^2	
3.	**Population**			
	Study Area Population	:	98,000 (16% of the total population of the Sunsari District)	
	Population Density	:	581 people/ km^2	
	Annual Population Growth Rate	:	2.5 percent (1991-2001) census period	
	Average Household Size	:	6.0	
	Literacy Rate	:	40 percent	
4.	**Agriculture Land**			
	Average Land Holding Size	:	1.5 ha.	
	Tenancy	:	29 percent of total HH (Agriculture census of 1991/92)	
5.	**Hydrology and Design Facilities**	**:**		
	Source	:	Sunsari River, perennial	
	Headwork Axis at	:	600 m downstream of East-West Highway bridge	
	Catchment Area	:	300 km^2	
	Average Annual Precipitation	:	1,948 mm	
	Estimated Peak Flow at H/W	:	650 m^3/s	
	Mean Monthly Flow Minimum	:	3.251 m^3/s in March (February 3/3), 2002	
	Mean Monthly Flow Maximum	:	40.84 m^3/s in July (3/3), 2002	
	Total Annual Flow	:	474 Million m^3	
6.	**Proposed Cropping Pattern**	**:**		
	Kari – Paddy	:	60 percent	
	Kari-Upland Crops	:	30 percent	
	Rabi – Wheat	:	50 percent	
	Rabi – Others	:	40 percent	
	Cropping Intensity	:	180 percent	
	Existing Cropping Intensity	:	164 percent	
7.	**Irrigation Efficiency**	**:**	Paddy Field	Upland Field
	Application Efficiency	:	90 percent	70 percent
	Operation Efficiency	:	85 percent	85 percent
	Conveyance Efficiency	:	85 percent	85 percent
	Overall Efficiency	:	65 percent	50 percent

8.	**Existing Yield (t/ha)**			
	Wheat	:	Ave. 2.00t/ha	
	Paddy	:	Ave. 2.30 t/ha	
9.	**Details of Flood Affected Area**	:	(When the river discharge reaches more than 250 m^3/s, or Precipitation > 150 to 200 mm/day)	
	Narsimha VDC	:	300 ha, inundation period for 1 week, depth 1.0 to 1.5 m.	
	Basantpur	:	1,000 ha, inundation period for 10 days, depth 0.3 to 1.0 m.	
	Ghuski and Kaptangunj	:	600 ha, inundation period for 15 days, depth Max 1.5 m.	
10.	**Command Area**			
	Total Command Area	:	16,819 ha.	
	Total Cultivable Area	:	11,338 ha.	
	Net Irrigable Area	:	10,147 ha.	
11.	**Physical Facilities**			
	Headworks	:	1 Barrage with both side off takes	
	Width of headworks	:	72 m	
	Design high flood discharge	:	650 m^3/sec	
	No. of spillways	:	5 nos.	
	No. of Under Sluice Gates	:	4 nos. (on both sides of the headwork)	
	Size of under Sluice Gates	:	6.2 m x 3.85 m	
	Size of Spillway Gates	:	6.2 m x 3.6 m	
	Design Water Intake Discharge	:	16.93 m^3/sec	
	River Maintenance Flow	:	About 1.8 m^3/sec (50% of minimum P 80%)	
	Related Structure	:	Fish pass (on both sides of the headwork)	
	Canal Details	:	Suksena	Shankarpur
	Design Discharge at Intake (m^3/s)	:	8.05 – 0.73	7.64 – 0.81
	Main Canal Length (km)	:	18.5	17.3
	Secondary Canal Length (km)	:	34.7	25.8
	Tertiary Canal Length (km)	:	100	72.4
	Minimum size of block (ha.)	:	20 ha.	
12.	**Time Frame**			
	Mobilization	:	1 Year	
	Detailed Design	:	1 Year	
	Project Implementation	:	3 Years	
13.	**Total Cost (Tentative)**	:	Approximately US $ 18 M (Financial Price excluding tax)	
14.	**EIRR**	:	15.6 % (Case 0, base case) 16.1 % (Case 1) 18.9 % (Case 2) 20.2 % (Case 3)	

1.4.1. Intake

The feasibility study team examined the performance of the intake of the Chatra Main Canal (CMC) with focus on how much water the intake can withdraw according to the water level. Though the original design indicates that the intake can withdraw 60 m^3/s of water all the season (year-round), there might be a difficulty to withdraw that amount of water especially during lean season.

The headwork is proposed at 600 m downstream from the East-West (E-W) highway. The Sunsari River flows in meandering almost all the way and there is a straight and stable reach starting at about 100 m downstream from the E-W Highway. The stable reach is at about 700 m and the headwork will be constructed at a downstream of the stable reach. The site set on the straight reach can well divert the Sunsari River water into both east and west conveyance canals leading to Shankarpur and Suksena canals.

The intake site will be located just above the effluent discharge points of the Arvind and Baba Paper Mills to avoid mixing of untreated effluent in the canal water. Two paper factories are located right beside Sunsari River at about 700 m downstream from E-W highway, discharging effluent into the Sunsari River. The dimensions of the proposed headwork are as followed:

- Position of headwork — 600m downstream from E-W High Way
- Type of headwork — Barrage (fully movable type using gates)
- Catchment Area — 300 km^2
- Design High Flood Discharge — 650 m^3/sec
- Width of headwork — 72 m
- Number of Spillways — 5 Nos.
- Number of Under Sluices — 4Nos. (on both sides of the headwork)
- Size of Under Sluice Gates — 6.2m x 3.85m
- Size of Spillway Gates — 6.2m x 3.60m
- Design Water Intake Discharge — 16.93 m^3/sec
- River Maintenance Flow — about 1.8 m^3/s (50% of minimum P80%)
- Related Structure — Fish Pass (on both sides of the headwork)

As per the design flood discharge, this Study refers to empirical formulas employed in Nepal under 50 years probability, and probable passing flow under the E-W highway bridge with due consideration on the following flood discharge. Though the recorded discharge is 680 m^3/s, the biggest value, this was augmented due to the bigger catchment area of about 70 percent more than the Sunsari catchment area. This Study takes 650 m^3/s as the design flood discharge taking into account the probable passing flow.

Table 1-3 : Design Flood Discharge

Method	Particular	Discharge (m^3/s)	Remarks
1. Modified Dickens Formula	Empirical	568～610	
2. WECS Method	Empirical	488	
4. Area Velocity Method (EW Bridge)	Manning	647	= 500 m^3/s (design flood)
5. Sunsari crossing at Eastern Koshi Main Canal (In India)	Recorded	680	CA=500 km^2 (70 percent more than the Sunsari CA of 300 km^2)

Weir type will be fully movable (all gate type). As headwork is so-called river structures, it needs to be stable enough to withstand floods. At the same time it will not be a serious obstacle disturbing the flow of the floods. Fully movable type of weir can pass the high flood through to downstream safely by its full open operation. Therefore, this Study designs all gate type weirs as the headwork type.

In addition to above, fixed type weir may give unbalance of supply and demand of the riverbed materials between upstream and downstream across the headwork. Riverbed materials are deposited in front of the fixed weir. Consequently, retrogression of the downstream riverbed takes place. Adopting the fully movable type (all gate type) can head off this problem. The foundation structure at the proposed headwork site is given in the figure together with the result of standard penetration test.

The designs foundation levels for the proposed headwork site as: the bank foundation level (an intake bed level) is located at about 2 m below the surface in both the banks of Sunsari River; the riverbed foundation level (a pile cap level) is located at 6 to 7 m below the surface in the Sunsari River bed where the concrete floor of the headwork is designed; and the sheet pile foundation level is located at between 7 to 15 m below surface. The riverbed foundation on which the headwork's concrete floor is placed was designed to have about 10 or more SPT N values.

1.4.2. Sediment Basin and Flushing Channel

Sediment deposition is the characteristic of the Nepalese rivers in the plain areas. The annual sediment volume from the Sunsari River is estimated as follows:

Annual water volume from the Sunsari River	161 MCM
Estimated sediment volume entering into canal system	189,000 m^3 /year

The amount of sediment will reach 189,000 m^3 per year which is equal to 0.2m depth of sediment in canals. At the present level of information, this amount is not so high and farmers will themselves remove the accumulated sediment as and when needed. Therefore, the project has not planned to construct the sediment basin. Main canal will have the spillway to wash away the silt instead. Hence, the proposed flushing channel will solve the predicted sediment deposition.

1.4.3. Canal Alignment and Distribution System

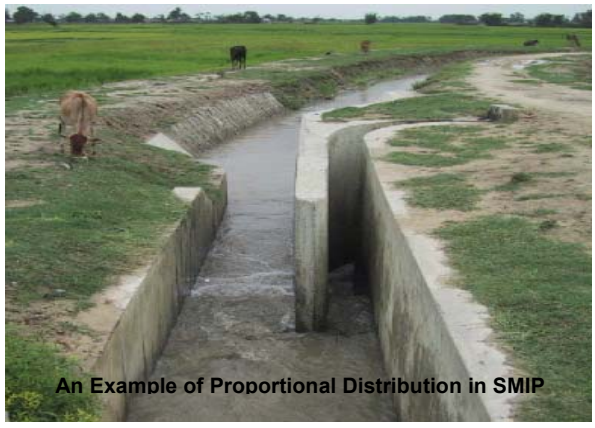
This Project aims to build on the successes of SMIP and other irrigation schemes implemented in Nepal. Canal will be designed following the standard methods. To meet with the present cross-section of the canals, the new design section basically follows the existing cross-section so that additional excavation / embankment as well as land acquisition can be minimised. Though the present canals are all unlined, the main canals of Suksena and Shankarpur plus the biggest secondary of 4SRR are concrete-lined.

SMIP standardized length from the beginning point of the secondary to the end of tertiary canals to be limited at about 5 km from the viewpoint of proper water distribution. This project also follows same standard, thereby no canal longer than 5 km will be allowed. The canal network follows the present irrigation network, taking into account the 5 km limit, so as to minimise the land acquisition. In case the density of canal network is found not enough from the viewpoint of system management and equal water distribution or a canal is longer than 5 km limit, some additional canals will be constructed.


A Water Course constructed on sandy soil, requiring frequent

For the watercourse, this project will follow designs much shorter unit than of SMIP. SMIP standard limits the length to about 1.2 km covering 28 ha each. In line with the Irrigation Policy, 1997, this study envisages that all watercourses should be constructed by the concerned farmers – the beneficiaries – as their contribution to the Project. It is expected that the sandy soil will shorten the durability of such small canal, and farmers should be involved in frequent maintenance and repair. Once a portion of the canal is breached, farmers will face difficulty to repair and maintain the longer watercourse. Therefore this Study proposes about 300 m length only as the limit of the watercourse together with about 20 ha command area. This proposal was discussed with the farmers during the consultation workshops, and most farmers have accepted the proposal and some raised even smaller unit.

The length of the main canal will be 35.83 km, followed by 60.52 km secondary canal and 172.41 km long tertiary canal. During the canal construction period, almost all of the existing roads including the canal maintenance road will be used as right of way (ROW) for temporary roads. According to site condition, some temporary roads will be added.


An Example of Proportional Distribution in SMIP

In order to ensure proper distribution system, the main canal adapts conventional check regulating system together with drops as required based on the topographic condition, and distribution once after the water gets into secondary canal block. No gated regulation within secondary canal block will be applied. This concept has been well verified in SMIP. Though the distribution system requires almost full water level even during lean period, the system lowers the construction and maintenance costs, and eliminates manipulation by delinquent users.

The southern most part of the study area, 397 ha in net, will not received gravity irrigation water from the Sunsari River due to its high elevation. This area is designed to have groundwater development. Designing the groundwater development refers to the result of the test well carried out as a part of this study, existing 5 deep tube-wells and 9 shallow tube-wells in the Sunsari district. Taking this elevation into consideration, a standard design for the well has been proposed as follows:

- **Depth:** The shallow tube well (STW) is designed to tap the unconfined Aquifer I, so the depth is fixed to be 30m. Similarly the deep tube well (DTW) is designed to tap confined Aquifer II and Aquifer III, so the designed depth is fixed to be 100m.
- **Diameter:** The diameter of shallow tube-well and deep tube-well will be 100 mm and 250 mm respectively. These diameters are fixed by referring to the existing standard tube-well data and availability of the materials e.g. pipes.
- **Screen length:** To fix the screen length of STW, it is considered the maximum value 9 m (with 12-1 percent opening area) among the three shallow tube-wells STW5, STW8 and STW10. Similarly in case of deep tube-well the screen length is fixed to be 25 m (12-15 percent opening area) considering the maximum value in DTW-15 and DTW-16.

1.4.4. Drainage Development

The proposed drainage system consists of collector, tertiary or secondary, major existing steam and drain to the Sunsari River, old Sunsari River and Budhi River. The function of the collector drain is to receive excess rainwater from the irrigated areas. It will then carry to the tertiary, secondary drain or in some cases directly to natural stream. The smallest unit of on – farm is about 20 ha. each, which will have at least one access point to the either collect or tertiary drain. The tertiary drain will then be connected to secondary drain or existing streams. The tertiary and secondary drains are far as possible designed to run along tertiary and secondary canals. Total length of proposed drains in Shankarpur area (right bank) is 27.250 kms and Suksena area (left bank) is 37.650 kms.

The major outlets of the drainage systems are Sunsari River, Old Sunsari River Course (Mariya Dhar) and Budhi River.

The drainage system has been designed for the capacity of 4.3 lps/ha. with assumption that the design rainfall is 194 mm/day, effective water depth in the paddy field 110 mm and standing water depth in the paddy field is 30 mm.

1.4.5. Access and Farm Road

The road condition in the western part of the study area is poor and hence the improvement of road network condition in this area has been integrated in the Project. For this, three sections of existing village roads will be improved. They are: 1) Dewanganj – Ghuski, the length of 5 km, 2) Harinagara – Basantapur with the length of 1.3 km, and 3) Ghuski – Basantapur with the length of 5.5 km. The roads of 2) and 3) require construction of new bridges apart from existing road improvement. If these roads are improved, the people in Basantapur and Ghuski will have more easy access to Dewanganj and Harinagara. This will also connect to Inaruwa with Biratnagar. It is expected that it will provide access to vegetable collection center located at the right south of Dewanganj.

Canal maintenance road will be designed with five meters width (four meter for passing), wide enough for tractors and four-wheel vehicles to pass and the terminal or crossings of the canal maintenance road will be connected with the main village roads. Canal maintenance roads along both the Suksena canal and a branch canal running through the center of Basanterpur will be utilised for road networking.

During the construction stage, the Project will construct extensive road network together with the tertiary and secondary canals in addition to the main canals of Suksena and Shankarpur. The WUAs will be requested to construct small feeder road from their field to the nearby tertiary or secondary by themselves (utilising their own labour). Cash appropriation from their irrigation service fee ISF income may be an allocation from VDC budgets if available.

1.4.6. River Training Works

Submergence condition is associated with the location of the rivers and conditions of either prolonged or high intensity rainfall. Submergence and flood cannot be accurately predicated. However, river training works together with embankment as well as repairing/strengthening the existing banks along the areas where the runoff tends to concentrate could reduce the possibility of the probable damage. It means, river training works will be carried out in selected areas in order to minimise the sediment flow in the canal system and farmland.

In order to minimise the effects of flood, an Indian mission visited Nepal in January 2002 to discuss about the river training works and identify potential areas for such works. Though there is already an embankment along the Sunsari River in the Indian territory, it has yet to be constructed in the Nepalese side along the river bank in some areas of upstream and most of the mid to downstream reaches in the study area. A flood, taking place in Nepalese side, is also damaging to some extent to Indian side in spite of the embankment already constructed in the Indian side. Though concrete agreement between the two governments has yet to be made, this Study proposes that the river training works should be undertaken by the prospective arrangement and this should be separated from this proposed SRIP.

Instead, this project proposes bank strengthening of canals running along the Sunsari River so that flood will not spill over to the mid and southern part of the project area. The strengthening consists of 1 m width additional embankment almost all the reaches after the siphon point of Suksena and a part of gabion protection. This arrangement would mitigate the severe inundation sites the area is facing.

1.4.7. Flood Mitigation

As mentioned in the river training section, no additional civil works for flood mitigation have been proposed from the economic point of view. Rather, smooth draining of flood is planned. As many farmers raised concerns during interviews and consultation workshops, canal network sometimes hinders smooth flood recession, causing lasting submergence. This situation in worst cases results in breaching the canal intentionally by the local villagers to run the retarding water away. To mitigate this situation and retard water away in a short period, this project will design drainage siphons crossing canal networks.

In addition to those measures above, a proposal from agricultural aspect is also pursued. Under inundation condition, most crops except jute and paddy face difficulty to grow well. Therefore, the areas prone to flood and inundation are proposed to plant paddy and/or jute as most farmers are already practicing.

1.4.8. Earthworks

Along the headwork site, the volume of excavation and backfill materials for construction are estimated at 39,000m^3 and 19,000 m^3 respectively. About 20,000 m^3 will be used to construct flood embankment in the headworks vicinity. Therefore, a separate spoil disposal site will not be required.

The excavated materials of the canal will also be used to the extent possible including for canal road construction, and hence, no spoil disposal area is proposed for canal side. The process of earthwork is as follows.

a. Make the canal shape with excavation;
b. Make embankment with compaction collecting the soil from around the field by bulldozer and so on; and
c. Spread the excavated soils in the process of (b) in the field along the canal.

Therefore, the spoil disposal is done only around construction site.

1.4.9. Construction Materials

Construction materials such as coarse and fine aggregate, boulders will be collected from the riverbank around the construction site. It has been estimated that about 36,700 m^3 of aggregate, 19,100 m^3 of sand and 10,600 m^3 of timber will be required to construct the headwork and canal system (Table 1-4). And these materials will be collected locally. However, timber demand will be made through purchase from the market.

Table 1-4 : Estimation of the Local Construction Materials

	Aggregate (m^3)	**Sand (m^3)**	**Timber (m^3)**
Headwork	11,400	5,700	10,600
Canals	25,300	13,400	-
Total	**36,700**	**19,100**	**10,600**

1.4.10. Workforce and Labour Camps

It is expected that most of the construction workers will be the local people. During the construction stage, significant mandays of the skilled and unskilled labourers will be required. Based on the volume of work, about 2000 unskilled workers will be employed during the dry season for earthwork activities, and about 460 unskilled workers for concrete works. Table 1-5 presents the estimated requirement of labour force for the construction.

Table 1-5 : Estimation of the Skilled and Unskilled Manpower Requirement

	Construction Items	Unskilled (man/day)	Skilled (man/day)	Construction Period (Provisional)
Headwork	Earthwork	60	1	2 Dry Season
	Concrete Works	250	30	2 Dry Season
Canals	Earthwork	1680	-	3 Dry Season
	Concrete Works	210	50	3 Dry Season
River Training	Earthwork	280	-	3 Dry Season

Source: Feasibility Study Report, 2002.

Majority of the labour force will be available locally. However, the contractor may have some permanent labours in their payroll who will be used in this construction works. In such case, a labour camp will be operated during the construction. The labour camp will have housing facilities with necessary service facilities such as drinking water, heath, sanitation, solid wastes disposal and so on.

1.4.11. Agriculture Supporting Services

Both irrigation system and agricultural supporting system should function well and work closely together in order to achieve expected benefit. Although there is a system of extension service, farmers were not noted satisfied with the existing services. Efforts are underway to tackle this problem through the implementation of agricultural extension and research programmes funded by the World Bank. The programme aims at decentralising the responsibility of supporting services to NGOs involving the private sector and to build farmers' capacity. SMIP is also moving ahead to develop the farmers' faculties through Farmers' Field School programme, and this project will follow it in providing appropriate agricultural supporting services to the beneficiaries together with the provision of irrigation water. A structure of agricultural supporting services under the Project is proposed below:

- It is proposed that water users association should play a role of a window to receive supporting services instead of setting up new farmers' organisation. Supporting services will be provided on demand basis or needs of farmers basically as a part of extension services.

- The project will promote to disseminate appropriate application of fertiliser and chemicals with due consideration on toxicity and residual effect.

- The project will also accelerate research activities on low-input farming practices. Equal emphasis will be given on post-harvesting and marketing system.

- A collection point has been constructed in Kaptanganj VDC with the assistance of the Department of Cooperatives under MOAC. This facility has not well functioned yet due to middleman and/or merchant. An additional collecting point will be arranged along the main trunk road in the central area in order to make it convenient to ship the product. Similarly arrangement will be made to operate cold storage.

- The project will also promote the implementation of the supporting programmes such as extension programmes for vegetable production, and vegetable marketing. They are given below (Table 1-6 and Table 1-7):

Table 1-6 : Program Digest: Extension Program for Vegetable Production

Program Title	**Extension Program for Vegetable Production**
Objectives	This program aims at promoting vegetables production throughout the year through disseminating appropriate farming practice and strengthening farmers' faculty.
Program Area	12 VDCs, Sunsari district (check 12 or 13 VDCs) Northern area: Babiya, Narsingha, Jalpapur Central area: Ramnagar Bhutaha, Gautampur, Rajganj Sinwari, Madhya Harsahi, Harinagara Southern area: Basantapur, Dewanganj, Ghuski, Kaptanganj
Implementation Agency	Responsible Agency: Ministry of Agriculture and Cooperatives (MOAC) Executing Agency: Sunsari District Agriculture Development Office (DADO)
Proposed Date of Commencement of the Program	FY 2008 (1st year of SRIP operation)
Proposed Duration	Five Years
Activities	1) Management of Demonstration Field/Farmers Field School (6 places) 2) Dissemination of appropriate fertilization, chemical use, etc. 3) Introduction of Integrated Pest Management (IPM)
Required Personnel	1) Extension Worker; 180 M/M (3 personnel x 12 months/year x 5years) 2) Assistant; 360 M/M (6 personnel x 12 months/year x 5 years)
Equipment	1) Motorcycle, 6 Nr 2) Extension Kit, 90 Nr
Remarks	1) Experienced extension workers should be recruited. 2) Existing JTA are appointed as assistant. 3) Existing JT/JTA will take over duty of supporting services related to vegetables production after the Program.

Table 1-7 : Program Digest: Promotion Program for Vegetable Post Harvesting and Marketing

Program Title	**Promotion Program for vegetable Post harvesting and Marketing**
Objectives	This program aims at promoting vegetables post harvesting and marketing especially by inviting private businessman.
Program Area	Cities/towns in Eastern Region specially along E-W highway, Kathmandu
Implementation Agency	Responsible Agency: Ministry of Agriculture and Cooperatives (MOAC) Executing Agency: Eastern Regional Agriculture Directorate
Proposed Date of Commencement of the Program	FY 2008 (1st year of SIP operation)
Proposed Duration	Five Years
Activities	1) Information dissemination to private vender 2) Field observation/site visiting by private vender 3) Study tour for the farmers to progressed area for vegetable marketing 4) Training to farmers for post-harvesting and marketing management
Required Personnel	1) Information officer; 60 M/M (1 personnel x 12 months/year x 5years) 2) Assistant; 60 M/M (1 personnel x 12 months/year x 5 years)
Remarks	1) Information officer will station in Eastern Agriculture Development Directorate and takes charge of disseminating the Project information to private vender and inviting them to see the vegetables. 2) Extension worker and assistant in charge of extension program for vegetable promotion will collaborate this program.

1.4.12. Additional Facilities

This feasibility study has proposed to promote STW, total 80 numbers, since the initial cost is very preferable. The area is solely practiced for upland irrigation. There may be a possibility to establish simple drip irrigation system. Drip irrigation system requires about 40 percent less irrigation water leading to 40 percent less diesel cost.

1.4.13. Project Cost

The total cost of the project is estimated to be NRs. 1,386,840,000.00 equivalent to US $ 17.78 millions. The breakdown of cost on the major components is presented in Table 1-8

Table 1-8 : The Major Projects Cost (Financial Price excluding Tax)

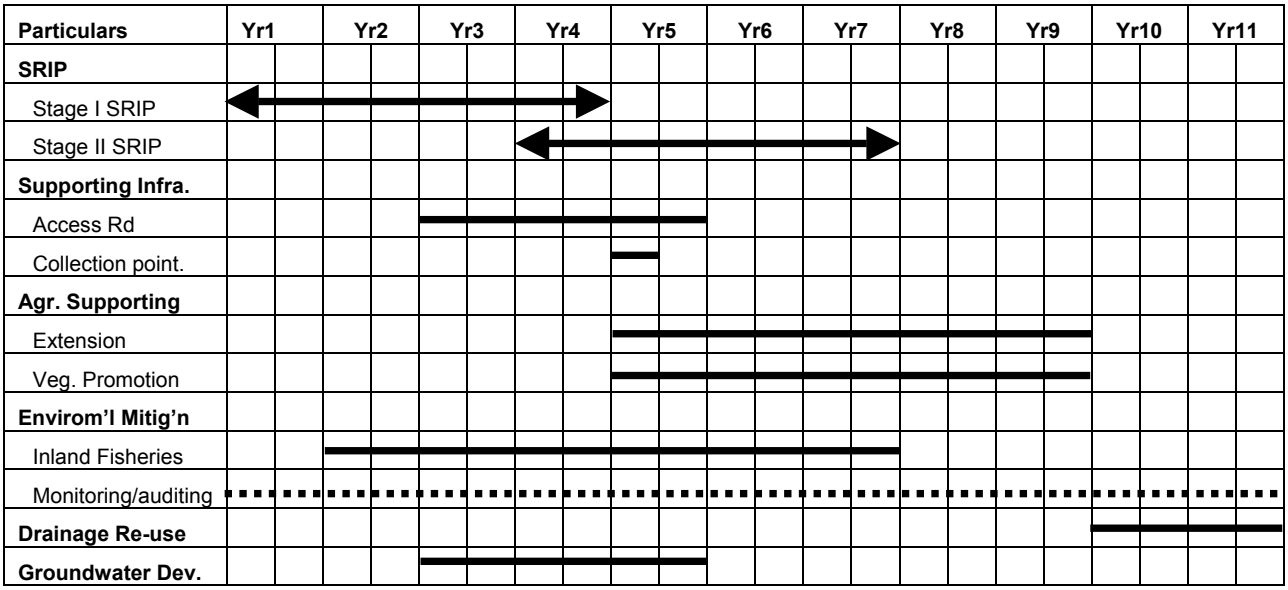
Description	Project Cost		Remarks
	(Rs.)	(Mil US $)	
1. SRIP			
1.1 Software			
1) Headworks/Intake	330,875,000	4.24	1)+2) = (Rs)
2) Main Canal	323,271,000	4.14	654,146,000
3) Secondary Canal	146,495,000	1.88	(mil US $) 8.39
4) Teritary Canal	116,590,000	1.50	
5) Canal Protection Works	5,662,000	0.07	
6) Drainage Structure	15,297,000	0.20	3)~9) =
7) Office Building	1,155,000	0.02	(Rs) 318,420,000
8) Quality Testing Lab	3,465,000	0.04	(mil US $) 4.08
9) Farm Development Works (Watercourse)	29,756,000	0.38	
Sub Total (1)	**972,566,000**	**12.47**	
1.2 Software			
1) Institution Development	58,443,000	0.75	
2) Consultant Services	108,638,000	1.39	
Sub Total (2)	**167,081,000**	**2.14**	
1.3 Others			
1) Land Acquisition	113,808,000	1.46	
2) Administration	21,728,000	0.28	
Sub Total (3)	**135,536,000**	**1.74**	
Main Component Total	**1,275,183,000**	**16.35**	
2. SUPPORTING INFRASTRUCTURES	23,318,000	0.30	
3. AGRICULTURE SUPPORTING	42,465,000	0.54	
4. ENVIRONMENTAL MITIGATION MEASURES	45,874,000	0.59	
Grand Total	**1,386,840,000**	**17.78**	

1.4.14. Implementation Schedule

The project has been planned to be implemented in two stages. Stage I will be construction of headworks and main canals and Stage II will be construction of secondary canals and distributaries network including on farm development of water courses for 20ha. blocks.

Together with the SRIP implementation, other component such as supporting infrastructure will also be implemented in order to bear the expected full benefit. The implementation schedule is shown in Table 1-9

Table 1-9 : Implementation Schedule



1.4.15. Economic Evaluation

For the purpose of economic evaluation of the project, but feasibility study had made economic evaluation of the project considering three different implementation cases and a base case. Description of the cases is summarized in Table 1-10. The economic internal rate of return (EIRR) of the different cases are presented in Table 1-11

Table 1-10 : Description of Cases

Case	Spring Monsoon	Winter		Water Extraction during Winter	Conditions
Case 0 (Base)	SWI Full Yield 10,147 ha.	TWI No Yield Change 10,147 ha		No extraction from Sunsari River	No condition is required
Case 1	SWI Full Yield 10,147 ha	SWI No Yield change 5,047 ha (Diesel cost Reduction is the Benefit).	TWI No Yield Change 5,047 ha	50% extraction (Min. 1.8 cum/s DS release)	1. Paper factories should establish in treatment plant reducing the effluent by 80%. 2. 50% of agriculture promotion in Maria Dhar or any form of compensation including farm land provision is agreed with and arranged for the concerned fishermen (about 180 HHs)
Case 2	SWI Full Yield 10,147 ha	SWI Full Yield 5,074 ha	TWI No Yield Change 5,074 ha	80% extraction (Min. 0.7 cum/s DS release)	1. Paper factories should establish a treatment plan meeting with Nepal Standard. 2. Aquaculture promotion in Maria Dhar or any form of compensation including farm land provision is agreed with and arranged for the concerned fishermen (about 180 HHs).
Case 3	SWI Full Yield 10,147 ha	SWI Full Yield 7,131 ha	TWI No Yield change 3,016 ha	Min. 3.8 – 5.0 cum/s water release from SMIP, and min. 1.8 cum/s DS release	No condition is required

Note : SWI = Surface Water Irrigation, TWI = Tube Well Irrigation

Table 1-11 : EIRR of 4 Cases

Case	Case 0 (Base)	Case 1	Case 2	Case 3
EIRR (%)	15.6	16.1	18.9	20.2
PV Cost (mil. Rs.)	822	835	848	847
(mil. US $)	(10.5)	(10.7)	(10.9)	(10.9)
PV Benefit (mil.Rs)	1,165	1,235	1,587	1,735
(mil. US $)	(14.9)	(15.8)	(20.3)	(22.2)
NPV B – C (mil. Rs)	343	400	738	888
(mil. US $)	(4.4)	(5.1)	(9.5)	(11.4)
B/C (12%)	1.42	1.48	1.87	2.05

1.5. Study Team

This EIA report has been prepared by involving the following team.

1. ……. Team Leader/Environmental Specialist
2. ……. Irrigation Engineer
3. ……. Socio-Economist
4. …… Sociologist and/or Environmental Management Specialist
5. …… Hydrologist
6. ……. Fishery Expert
7. ……. Soil Scientist
8. ….. Policy and Legal Expert

1.6. Objective of the EIA Study

The main objective of this study is to assess and mitigate the potential impacts of the Sunsari River Irrigation Project on the environment and make the project environmentally sound and sustainable. Specifically, the study has the objectives of:

- Assessing the likely impacts of the Project on the local environment and examine their significance;
- Recommending the benefit augmentation and adverse impacts mitigation measures;
- Preparing an environmental management plan and providing suggestions for environmental monitoring and auditing; and
- Providing information to the decision-makers about the environmental implications of the proposed project and associate costs.

1.7. Methodology

The EIA report has been prepared in accordance with the provisions of the Environment Protection Rules 1997, and the approved Scoping Document and the Terms of Reference. The primary baseline information has been generated through field study, Participatory Rural Appraisal (PRA), focus group discussion, observation, and walkover survey along the canal alignment from the intake site to command area. Impact identification and prediction has been made and significance of the impacts has been determined following the methods and techniques as included in the EIA Training Manual for Professionals and Managers (Khadka et al., 1996). Secondary information was collected from various sources – the documents, reports, maps, detail design and cost estimates of the main canal, including official records. Soil and water samples were analysed at the laboratory by employing standard methods.

1.7.1. Desk Study

As a part of desk study, available literatures were reviewed, maps were interpreted, and questionnaire and checklists were prepared for field study. Most of the baseline information has been taken from the Feasibility Study Report of the SRIP (Progress Report 2). Relevant irrigation and environment-related policies, environmental legislation, particularly the Environment Protection Rules 1997, and environmental assessment guidelines such as National Environmental Impact Assessment Guidelines

1993, EIA Guidelines for Industry Sector 1995, Draft EIA Guidelines for Water Resources Sector 1997, etc. were reviewed to the extent applicable. The EIA guidelines for water resources sector published by ESCAP were also reviewed to make the list of environmental parameters comprehensive.

The following maps were studied to collect secondary information of the canal side and the proposed command area.

a. A 1:25,000 scale topographical map;
b. A 1:50,000-scale land utilization map;
c. A 1:50,000 scale land system map;
d. A 1:50,000-scale land capability map; and
e. A 1:125,000-scale district map of Sunsari district.

Questionnaire was developed to collect socio-economic information. Checklist was also developed and used to collect necessary information on physical and socio-economic information.

1.7.2. Field Study

The study team conducted field study several times during the pre-feasibility and feasibility study periods. The field study was also carried out from ……. to …….. to verify information collected from secondary sources and also generate additional information for the preparation of the EIA report.

As a part of involving the local people in the project activities, and also seeking inputs of the local people, one district level and four farmer level consultation meetings were organized on 1st, 5th, 7th, 9th and 11th of August 2002. For the farmer level meetings the 13 VDCs of the study area were divided in four groups as shown as follows (Table 1-12): A total of 282 persons participated in the consultation meetings.

Table 1-12: Schedules of Farmer Level Consultation Meetings

SN	Date (2002)	Venue	Participating VDCs	Number of Participants
1	August 5	Primary Teachers' Training Centre, Inaruwa	Narsingh, Babiya and Jalpapur	56
2	August 7	Krishna Secondary School, Bhutaha	Ramnagar, Bhutaha, Gautampur and Basantpur	70
3	August 9	Harinahara Higher Secondary School	Harinagara, Madhya Harsahi and Rajganj Sinwari	71
4	August 11	Kaptanganj Higher Secondary School	Kaptanganj, Devanganj, Ghuski and Sahebganj	85
			Total	**282**

Furthermore, the consultation meetings were attended by the participants from upstream to downstream areas. Some of them were the key decision-makers in the VDC level **(**Table 1-13**).**

Table 1-13 : Representatives in the Consultation Meetings

Meeting place	Participants from:	VDC chair/ vice chair	Non-local*	Ward representatives	Parties represented	Farmer representatives	Total
Babiya	upstream	5	3	28	6	14	56
Ramnagar	upper-midstream	5	16	17	13	19	70
Harinagara	lower-midstream	5	5	19	15	27	71
Kaptangunj	downstream	2	16	15	10	42	85
Total		**17**	**40**	**79**	**44**	**102**	**282**

Note: * denotes teachers, VDC secretary, health post personnel and others (who are categorised as non-local)

Data were also collected by conducting separate meetings with the fishermen. Participants have raised various issues and they have been accommodated at appropriate places in this report. In addition, it was noted that participants showed bargaining motivation, reflected first hand experience, as a valuable input for the Project. Some farmers also showed uncertainty syndrome while others reflected social hierarchies. However, local people have provided various pertinent issues including sharing of costs and benefits on irrigation project.

A Consultation Workshop

1.7.3. Water Quality Analysis

After the collection of necessary water samples at representative sampling points, they were analysed in the laboratories in the Kathmandu by employing standard methods. Water samples were collected from Sunsari River, outlets from the efficient discharging to Sunsari River from paper mills and shallow tubewells within the command area.

1.7.4. Data Processing

All data collected from literature review and field including laboratory analysis were processed, summarised, tabulated and interpreted at appropriate place in this report. Socio-economic and cultural information was thoroughly cross-checked and edited.

Impacts are identified by using ad hoc, checklist and interaction matrix methods. They are predicted based on subjective judgement and evaluated through Delphi method as suggested in the EIA Training Manual for Professionals and Managers (Khadka et. al, 1996). Significance of the impacts is also evaluated through expert judgement.

1.7.5. Draft Report Preparation

The structure of the draft report follows the tentative report format as included in the approved Terms of Reference and it also accommodates all issues as mentioned in the Schedule 6 of the EPR 1997. The report contains seven chapters. The chapter one basically includes reviewed information. The chapter two documents relevant policies, strategies, laws, guidelines and standards which are also the reviewed information. The chapter 3, the baseline information, includes details on the present situation and chapter 4 analyses the alternatives and includes the best alternative chosen with due consideration on the technical and environmental perspectives. The chapter 5 is the core of this report which includes identified and predicted impacts with environment protection measures. The chapter 6 focus on the ways to implement the environmental protection measures, conduct environmental monitoring and auditing including staff, and budget for the implementation of the Environmental Management Plan. The Chapter 7 outlines major conclusions and recommendations to make the project environmentally sound and sustainable.

1.7.6. Public Hearing

After the preparation of the draft EIA report, a public hearing was conducted at ……. (place) on … (date). About …….. participants attended the meeting and raised number of issues relevant to the project activities.

1.7.7. Final Report Preparation

Base on the inputs received during the public hearing, a separate public hearing report was prepared and key issues which are relevant to the project activities have been accommodated in this final EIA report. The chapter plan follows as mentioned in section 1.7.5.

1.8. Scope and Limitation

The scope of this study has been made clear in the approved Scoping Document and the Terms of Reference (TOR). The feasibility study report has been used extensively to include the project related information. This study relies on secondary information and minimum level of primary information has been collected during the preparation of this report. The approved Scoping Report and the Terms of Reference has sufficiently guided and they are annexed in this report.

CHAPTER

POLICIES, LAWS, GUIDELINES AND INSTITUTIONS 2

2. POLICIES, LAWS, GUIDELINES AND INSTITUTIONS

This chapter reviews the environment-related policies, legislation and guidelines relevant to the irrigation project, and they have been presented in this report in a concise form.

2.1. Relevant Policies and Strategies

2.1.1. Environment

Realisation of the need for environment conservation in socio-economic development and infrastructure projects was realised in the 1980s. HMGN included the need for conducting environmental impact assessment of the infrastructure projects in the Sixth Plan (1980-'85). This policy was elaborated in the Seventh Plan (1985-'90) and the Eighth Plan (1992-'97) and further re-enforced in the Ninth Plan (1997-2002). The environmental policies as documented in the periodical plans emphasise to implement environment management activities to make the development projects and programs environment-friendly and sustainable. The Ninth Plan also emphasised on promoting and using the participatory environmental assessment (EA) system. The Approach Paper of the Tenth Plan (2002-2007) further emphasises on continuing EIA system, followed by environmental monitoring and auditing. Similarly, the concept of Strategic Environmental Assessment (SEA) has been included in this Plan.

Besides the periodical plans, the National Conservation Strategy 1988, the Master Plan for Forestry Sector 1989, the Nepal Environmental Policy and Action Plan 1993 etc. also emphasise the need for conducting environmental assessment of the major development projects before their implementation.

2.1.2. Irrigation

HMGN has formulated Irrigation Policy in 1992 and revised it in 1997 with the objectives of developing, *inter alia*, environment-friendly and sustainable irrigation system. It emphasises the need for promoting people's participation through user group concept, i.e., it emphasises to gradually decrease the government's responsibility in irrigation construction, operation and maintenance. It aims to develop and expand irrigation facilities which are technically feasible, economically cost-effective, institutionally manageable and environment-friendly. It also aims to phase-out government involvement in rehabilitation and maintenance of irrigation programmes and projects. This policy has also emphasised the development of a mechanism to generate fund through irrigation service tax for maintenance and rehabilitation works. The policy clearly recognises the role of Water Users Association (WUA) for the maintenance of irrigation schemes and about 20 per cent of the total members will be women in such WUAs. The policy states the projects larger than 2,000 ha in the Terai will shall be jointly managed by the concerned Irrigation Office and the WUA. Hence, this project falls in the category of joint management.

The Irrigation Policy also emphasises the need for minimising environmental impacts during the construction and operational stages of irrigation projects and focuses to design and implement irrigation projects and programmes based on the recommendation of the Environmental Impact Assessment (EIA) and Initial Environmental Examination (IEE) reports, as per National EIA Guidelines 1993 (MOWR, 1997). The Policy further realises the need for providing training to officials of the Irrigation Offices for implementing the findings and recommendations of environmental studies. This Policy opens a number of avenues to make the irrigation projects environment-friendly and sustainable.

The irrigation policy as mentioned in the Approach Paper of the Tenth Plan (2002-2007) underscores the importance of implementing the Agriculture Perspective Plan. It emphasises the need for users participation in the construction, rehabilitation and maintenance of the irrigation projects.

Other relevant policies and strategies include:

- Although the Hydropower Development Policy 2001 is applicable to hydroelectricity projects, it emphasises to make necessary arrangement to implement environmental protection measures recommended by the EIA study. Minimum monthly downstream water release in the river and stream should be maintained at 10 percent of the total discharge or as recommended by the EIA study. This discharge option provides a basis to release water to maintain downstream ecosystem in this Project as well.

- The agriculture policy emphasizes the development of sustainable irrigation system in order to ensure diversification in agriculture sector and increase the yield rate thereby contributing to poverty reduction. The Agriculture Perspective Plan also documents the need for maintaining the average annual investment allocation in the surface irrigation schemes.

- The Water Resources Strategy 2002 emphasises to understand the environmental processes fully (e.g., soil erosion, landslides, sediment transport and deposition, floods etc.) so as to avoid adverse impacts, improve conditions and/or to reduce negative elements (WECS, 2002). The Strategy also underscores the need for effective implementation of the EIA and SEA norms and recommendations. The Strategy has dissected environmental problems in the water resources sector and has emphasised to, inter alia, improve environmental database system, implement watershed and aquatic ecosystem protection, rehabilitation and management programmes, and promote community participation. The Strategy recommends to assess the state of compliance with the application of environmental assessment regulations and guidelines, and the reasons for non-compliance.

- HMGN has also endorsed the National Biodiversity Strategy in 2002 which focuses on the conservation of all life forms. This Strategy also emphasises on the conservation of aquatic species, including fishes.

In nutshell, these policies favour the implementation of this surface irrigation scheme to provide year-round water facility to irrigate the command area as envisaged, and make the project environmentally sound and sustainable.

2.2. Relevant Laws

2.2.1. Environment

Nepal has enforced several regulatory measures to make the irrigation schemes sustainable and ensure the integration of environmental aspects in the irrigation development programmes and projects.

In order to integrate environmental aspects in development projects and programs including irrigation projects, HMGN has enforced the *Environment Protection Act (EPA) 1996*. As per the legislation, the proponent has to prepare and process for approval of the EIA reports of the prescribed projects in accordance with the EPA, 1996 (Section 3 to 6). It also calls for **not** to implement the proposals **without** approving the EA reports for the prescribed projects (Section 4). The Act empowers the Ministry of Population and Environment to approve the EIA report (Section 6). Enacted under this Act, the *Environment Protection Rules (EPR), 1997* (amendment 1999) has been enforced to facilitate the proponents for the preparation and approval of EIA and associated reports. The EPR contains elaborated provisions for the preparation and approval of projects requiring EIA, including the Scoping report, terms of reference, public consultation and environmental auditing (Rules 3 to 14). The EPR also oblige the government to inform stakeholders prior to the approval of EIA report.

The EPR, 1997 contains provisions to conduct public hearing and submit recommendation letter(s) of the concerned VDC or municipality along with the EIA report. It empowers the concerned Ministry - the Ministry of Water Resources in this project - for environmental monitoring (Rule 13) and MOPE for environmental auditing (Rule 14). MOPE should prepare the environmental auditing report after two years once the project starts providing the services.

2.2.2. Water and Irrigation

The *Water Resources Act, 1992* has placed the use of water resources for irrigation purposes in the second priority (Section 7). It opens avenues for land and property acquisition or use, if necessary, for the construction of the canals. However, HMGN, in case it constructs the project, should compensate the concerned individual(s) for any loss of the property or land while utilising water resources (Section 16). The Act, inter alia, clearly emphasises to avoid and/or minimize impacts of soil erosion, landslide, flood or other significant adverse environmental impacts during the utilisation of water resources (Section 20). The Water Resources Rules, 1993 obliges the proponent to analyse environmental impacts of the proposed action and include impact mitigation and safety measures including arrangements for displaced people (Rule 17). The Conflict Examination Committee has also been mandated to collect site-specific information on likely environmental impacts of the concerned project (Rule 28). The Rules contain clear provisions for compensation of the land and property acquired or any loss by the project activities.

The Irrigation Rules, 1998 (amendment 2000) contains several provisions with regards to the distribution of irrigation water, listing of water users, functions and duties of WUAs. The Rules empowers to collect water tax. It also empowers the government to transfer canal, secondary canal, sub-secondary or tertiary canal to user associations (Rules 10). It contains provisions to involve them in the construction, and operational and maintenance stages of the irrigation canals. The users are empowered to charge for the service and utilise the accumulated amount for the operation and maintenance of the project.

2.2.3. Land and Property Acquisition

The *Constitution of the Kingdom of Nepal, 1990* empowers HMGN to acquire privately owned land or property only in the public interest by providing necessary compensation [Article 17 (2) and (3)]. HMGN is also empowered to acquire the required land of any area by enforcing the *Land Acquisition Act, 1977* (Section 3). Although the people will provide land for the construction of the irrigation canal, this legal provision can be enforced to construct all types of canals through land acquisition and compensation processes. Based on this Act, HMGN should form the Compensation Fixation Committee and the proponent should compensate as per the decision of this Committee and/or the proponent may also compensate through negotiation with the concerned landowner (Section 13-17 and 27). The VDCs from where the irrigation canal passes may facilitate the negotiation process. Once the land is taken by adopting appropriate compensatory mechanisms, land ownership will be automatically transferred to the compensator.

2.2.4. Local Self-Governance

The *Local Self-Governance Act, 1999* empowers the local bodies for the conservation of soil, forest and other natural resources and implement environmental conservation activities. Sections 28 and 43 of the Act provide the VDC(s) provisions to formulate and implement programs related to the protection of the environment and biodiversity. Similarly, sections 189 and 201 of the Act provide that DDCs(s) should formulate and implement the programmes related to the protection of the environment and give adequate priority for the conservation of the environment during the formulation and implementation of the district level plan(s). In this context, the respective VDCs and DDCs can regulate soil and water conservation activities that support to improve irrigation system and minimise its likely adverse impacts.

2.2.5. Aquatic Life Conservation

The *Aquatic Life Protection Act 1961* provides provisions to regulate killing and catching of aquatic life particularly the fish species and its Rules 2000 emphasises on the need for constructing the fish ladder to ensure habitat of the migratory species and/or develop fish hatchery for the conservation of fish species.

2.2.6. Relevant Conventions

Besides the national legislation, some of the international legal instruments are also attracted to this project. As a Party, inter alia, to the Convention on Biological Diversity (CBD), Convention on Wetland of International Importance Especially as Waterfowl Habitat (Ramsar), and the Convention to Combat Desertification (CCD) which contain, *inter alia*, provisions to ensure the conservation of flora and fauna, natural resource and land forms, this project should emphasise to conserve the aquatic flora and fauna. The project should also minimise the loss of aquatic flora and fauna and should not harm life forms during the project construction and operational stages.

Adequate emphasis will be given to least damage the aquatic species at its source and along the canal alignment, to the extent possible, and this will help in meeting national and international obligations.

2.3. Environmental Guidelines

Nepal has emphasised on the use of environmental assessment guidelines to integrate environmental aspects including in the irrigation projects. The National EIA guidelines 1993 and sectoral guidelines for Industry Sector 1995 and draft EIA guidelines for Water Resources Sector 1996 provides procedures to identify, predict and evaluate the environmental impacts. The guidelines also provide guidance for the identification of mitigation measures, conduction of environmental monitoring and auditing. The processes included in these guidelines have been fully used for impact identification, prediction and evaluation, and propose environmental protection measures including monitoring and auditing.

2.4. Environmental Standards

This Project may likely suffer from effluent discharge of the Arvinda and Baba paper industries. HMGN has issued effluent standards for paper industries in May 2001 in accordance with the Rule 15 of the Environment Protection Rules 1997. Base on this provision, these two mills should comply with the provisions of the Rule 16 of the EPR 1997 and should obtain pollution control certificate. The effluent standard for the paper and pulp industries is as follows:

- pH 5.5 – 9
- Suspended Solids (mg/l) 100
- BOD_5 days at 20^0C, mg/l max 100

These paper mills discharge effluents on to the Sunsari River without any treatment and load of pollutants is very high.

2.5. Relevant Institutions

The project construction, operational and maintenance depends upon the effective participation of the relevant institutions and WUAs. Though this Project will follow the joint management approach, participation of other organisations will be necessary during the EIA report approval and implementation of the project. The relevant institutions are given below:

2.5.1. Local and District Level Institutions

The command area of this Project covers 13 VDCs. This VDC may provide necessary assistance for its smooth construction and maintenance. The Project management will contact the VDC officials and community leaders and will continue to let them know the pros and cons of the project activities on environmental aspects. Comments and suggestions of the affected VDCs will be the part of EIA report document. The VDC can also cooperate the project during the land and property acquisition and compensation, if any. The WUAs will be involved right from the construction stage to joint management. The Project will facilitate the formation of water users associations as and when necessary to promote their participation in the project construction and operational stages. Other local clubs and NGOs will be informed as and when necessary and their participation will be promoted.

The District Development Committee (DDC), Sunsari and other line agencies will also be contacted and the DDC can participate in resolving people – project conflict, if any. The District Irrigation Office will assist the Project Management right from its planning to implementation stages. The Chief District Office, the District Development Committee and other local bodies shall provide necessary assistance to the project as and when necessary.

2.5.2. Central Level Institutions

Prior to project construction, the Department of Irrigation (DOI) will be involved in processing for the approval of EIA report in accordance with the provisions of the environmental laws. The DOI through its Environment Section may also be involved in environmental monitoring and compliance of the environmental requirements on behalf of the Ministry of Water Resources.

Two ministries – Ministry of Water Resources (MOWR) and the Ministry of Population and Environment (MOPE) – will be involved in decision-making process of this EIA report and provide necessary guidance on technical and environmental matters to the Project during its construction and operational stages. MOWR is the policy making body responsible for the overall guidance and policy formulation for water resources development and utilisation. MOWR after receiving the EIA report from the Department of Irrigation should review and send it to MOPE for approval. As per the EPR 1997, MOWR should also be involved in monitoring and evaluation of the project activities on local environment.

MOPE upon receipt of the EIA report can process for early decision by complying with the environmental legislation. MOPE should be involved in preparing the environmental auditing report, as per the Rule 14 of the EPR 1997, after completion of this irrigation project. MOPE may also be involved in environmental monitoring and supervision during the construction and operational stages in order to generate issues for consideration in future irrigation development projects.

This review indicates that this Project can be implemented smoothly within the framework of the existing policies, legal frameworks, strategies, standards and institutions. And there are possibilities to make the Project environmentally sound and sustainable.