the site reconnaissance along the route, soil investigations at prospective tower locations are to be undertaken. Manual excavation, concrete mixing with portable mixer, backfilling with rammer or the like of it are to be used for civil works, while tower erection is to be carried out with pole type erector (gin pole) and line stringing with tension stringing method.

10.5 Construction Schedule

10.5.1 First Stage Construction

The first stage construction is to construct the power station having the installed capacity of 201 MW (3 units, 67 MW each) to cope with the domestic power demand after the middle of 1990s. The scheduled commissioning time of each unit is as shown below.

Unit No. 1	:	June 1994
Unit No. 2	:	September 1994
Unit No. 3	:	June 1999

[Commissioning time of unit 3 will change on September 1998 for the two stage development scheme.]

The construction schedule is drawn aiming at these commissioning dates on the basis of work plans described in 10.4 above. The construction schedule for the first stage is shown in Fig. 10-6 which also indicates the times required for the detailed design, tendering, etc.

The schedule of commencement of the major works are as shown below.

Access road	:	November 1987
Diversion tunnel	:	November 1989
Dam & spillway	:	November 1990
Headrace tunnel	:	November 1989
Powerhouse (civil)	:	June 1990
Generating equipment	:	November 1992
Transmission & substation facilities	:	June 1992

The critical path for execution of the first stage construction runs along access road and headrace tunnel as observed in Fig. 10-6. As to access road, it is planned to complete the first phase works which allow vehicle traffic to the dam site for transportation of construction materials and equipment by October 1989 in 24 months, and then to execute the finishing works as the second phase during the succeeding 24 months.

In order to start the road construction in November 1987, the utmost efforts of the related parties have to be exerted to shorten the necessary time for the detailed design, tendering, etc.

While, for shortening the construction period of headrace tunnel, it is planned to adopt tunnel boring machine (TBM) for driving the upstream tunnel section of 7.5 km long.

10.5.2 Second Stage Construction

The second stage construction is the extension of the generating facilities of 201 MW (3 units, 67 MW each) for the purpose of mainly power export. It is scheduled to start the second stage construction in June 1994 which is set up in consideration of the time required for negotiation of power export with the importing country which will be entered at the time of commencement of the first stage construction in November 1989 and the time for the detailed design, fund arrangement, tendering, etc., as discussed with NEA.

The overall construction schedule including the first and second stages is shown in Fig. 10-7. As shown there, the major works included in the second stage are the construction of headrace No. 2 and installation of the additional turbines, generators, etc. The time necessary for construction of headrace tunnel No. 2 is considered to be same as that for headrace tunnel No. 1.

The total project with the installed capacity of 402 MW including the first and second stages is planned to be completed in June 1999.

Fig. 10–6 Construction Schedule of 1st Stage (Without Export)

Item	Q'ty
Feasibility Study	
Support Facilities	
Access road	L = 115 Km
Preparatory works	L.S
Water Storage Facilities	
Diversion tunnel	D= 7.0 m L= 354m
Coffer dam	L.S
Dam & Spillway	Exca. 108,300 m³ Conc. 160,700 m³
Waterway	
Intake& Desanding basin	Exca. 225,900 m³ Conc. 42,700 m³
Headrace tunnel (U.S)	L= 7.5 Km(TBM) L= 0.2 km(CBM)
Headrace tunnel (D.S)	L= 3.7 Km(CBM)
Surge tank	Exca. 38,300 m³ Conc. 7,400 m³
Penstock	Exca. 25,200 m³ Conc. 7,400 m³
Powerhouse (Civil)	
Powerhouse	Exca. 132,900 m³ Conc. 36,900 m³
Tailrace & Outlet	Exca. 39,300 m³ Conc. 11,200 m³
Switchyard	L.S
Ele-Mecha Equipment	
Turbine & Generator	L.S
Auxiliary equipment	L.S
Switchyard equipment	L.S
Transmission Line & S.S.	
Transmission line	L.S
Substation	L.S

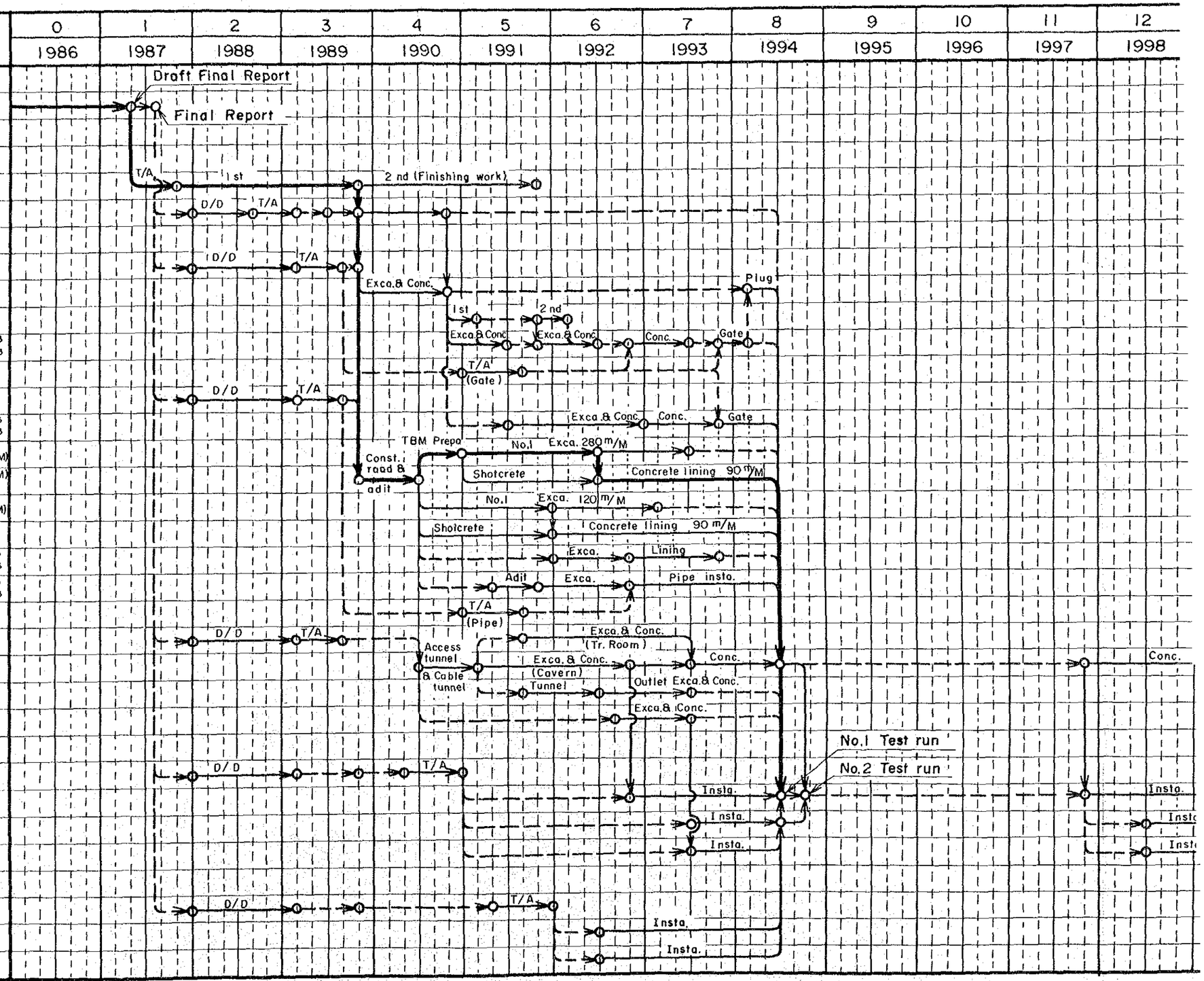


Fig. 10–6 Construction Schedule of 1st Stage (Without Export)

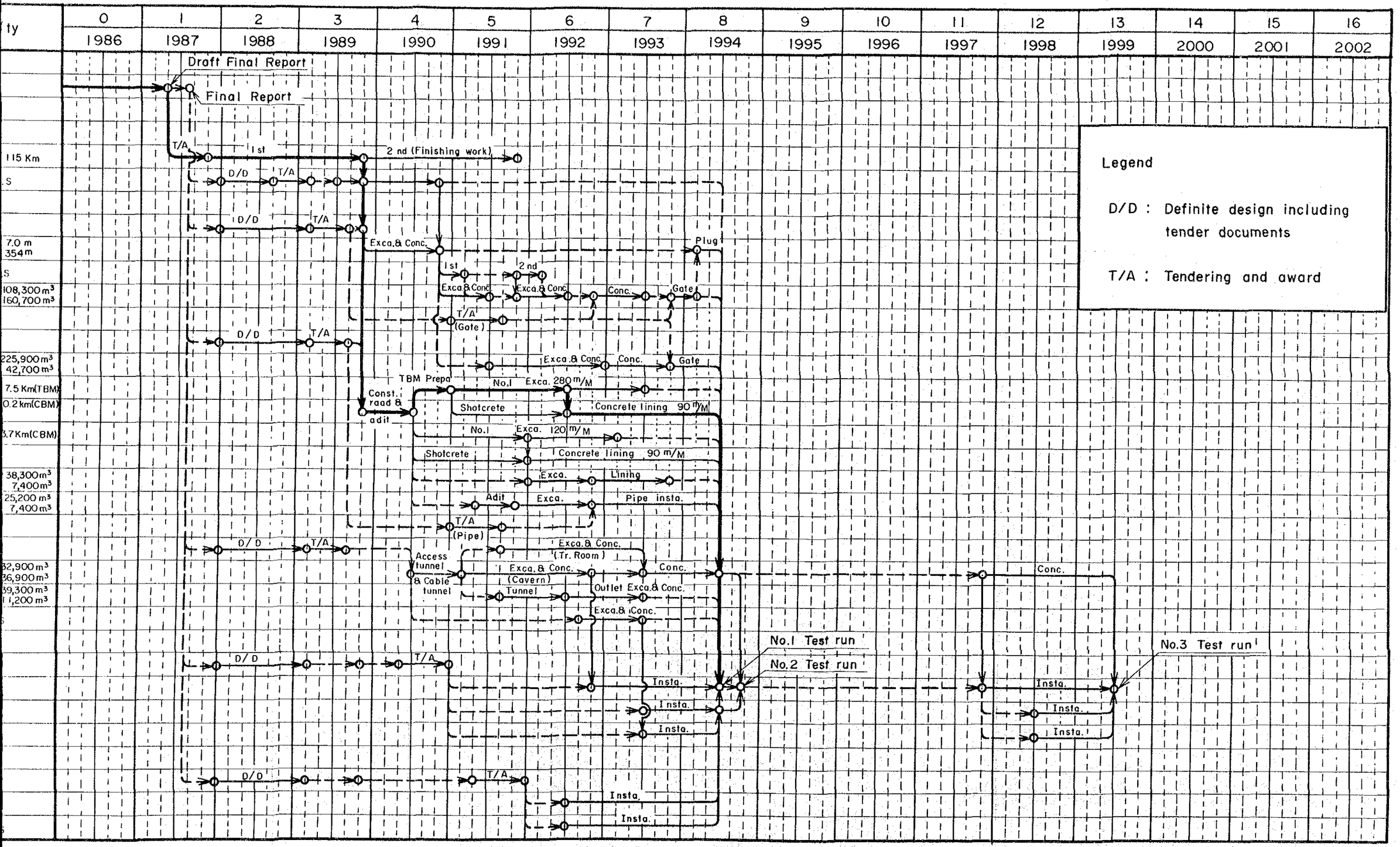


Fig. 10–7 Construction Schedule of 1st & 2nd Stages (With Export)

Item	Q'ty
Feasibility Study	
Support Facilities	
Access road	L= 115 Km
Preparatory works	L.S
Water Storage Facilities	
Diversion tunnel	D= 7.0 m L= 354 m
Coffer dam	L.S
Dam & Spillway	Exca. 108,300 m³ Conc. 160,700 m³
Waterway	
Intake & Desanding basin	Exca. 225,900 m³ Conc. 42,700 m³
Headrace tunnel (U.S.)	L= 7.5Km(TBM) L= 0.2km(CBM)
Headrace tunnel (D.S.)	L= 3.7 Km(CBM)
Surge tank	Exca. 71,800 m³ Conc. 12,000 m³
Penstock	Exca. 37,400 m³ Conc. 14,700 m³
Powerhouse (Civil)	
Powerhouse	Exca. 132,900 m³ Conc. 41,400 m³
Tailrace & Outlet	Exca. 48,000 m³ Conc. 14,700 m³
Switchyard	L.S
Ele-Mecha Equipment	
Turbine & Generator	L.S
Auxiliary equipment	L.S
Switchyard equipment	L.S
Transmission Line & S.S.	
Transmission line	L.S
Substation	L.S

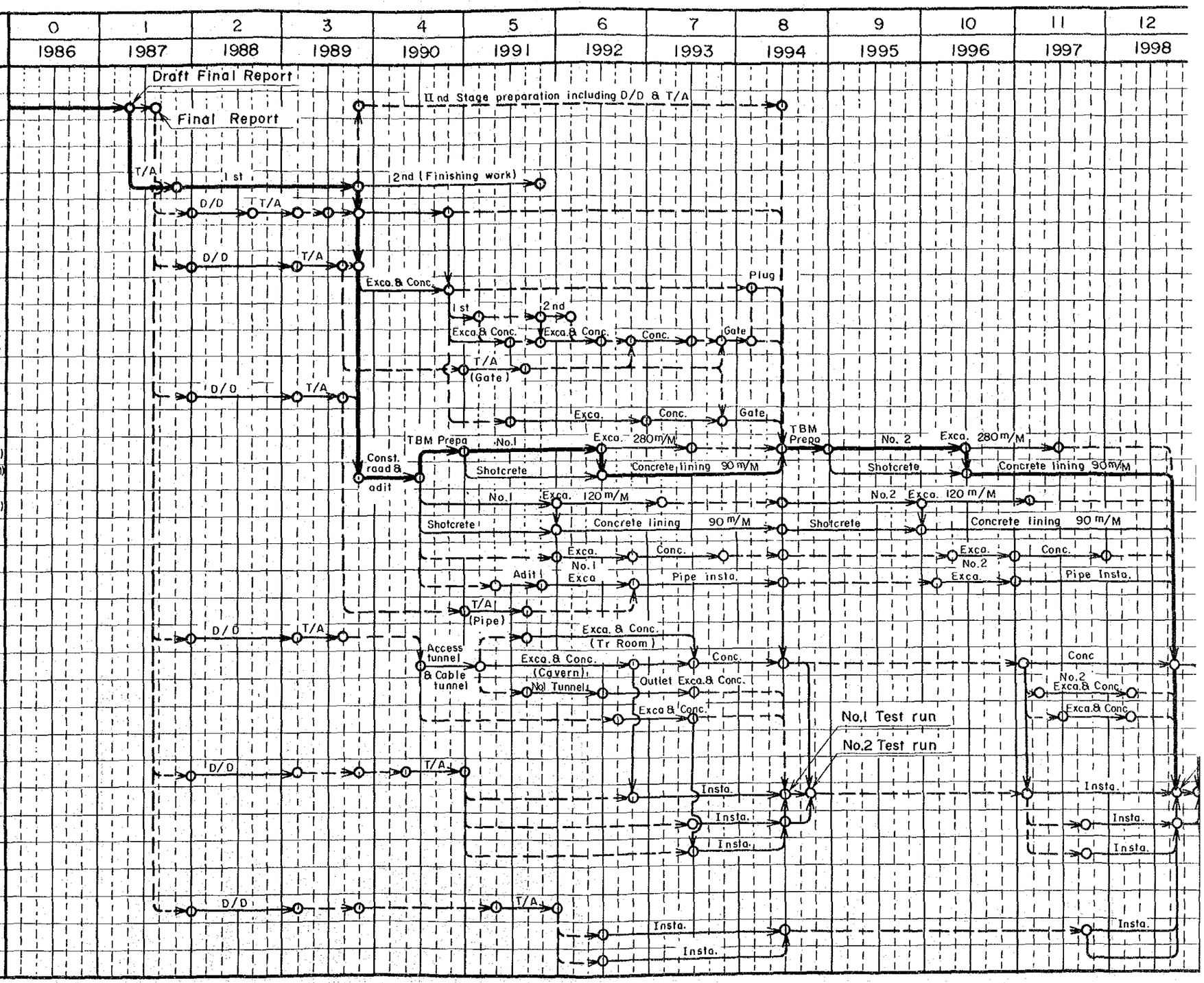
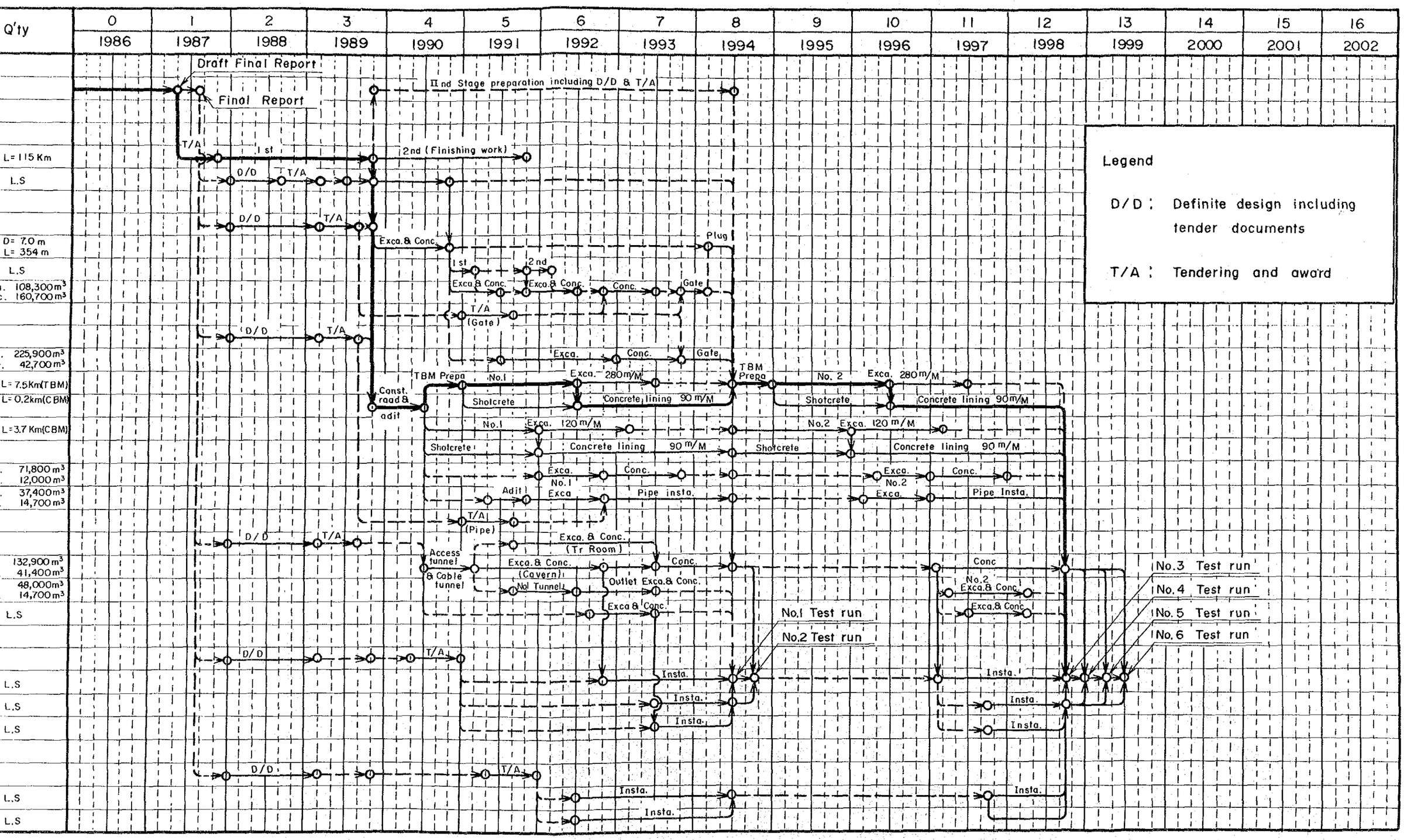


Fig. 10–7 Construction Schedule of 1st & 2nd Stages (With Export)



CHAPTER 11. COST ESTIMATE

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CHAPTER 11. COST ESTIMATE

11.1 General Concept

Construction costs of the Arun 3 project are estimated based on the following concepts.

(1) Project cost is divided into 7 categories; supporting facilities, civil works, hydraulic equipment, electromechanical equipment, transmission line and substation equipment, administration including engineering services and contingency.

(2) The unit prices of the similar works in Nepal are referred for cost estimate, however, those applied to works in Japan and other countries are also referred.

(3) The price level is on June 1, 1986 and the exchange rate of 21.35 Rupees per US$ (by Nepal Rastra Bank) is adopted.

(4) The administration including engineering services is calculated at 7.5% of the direct cost which is generally applied to the projects of similar scale.

(5) The contingency is calculated at 15% of cost for the supporting facilities and civil works and 10% for the hydraulic equipment, electromechanical equipment and transmission line and substation equipment and administration including engineering services.

(6) The interest during constructinn and price escalation are not included in the project cost.

(7) The construction costs are divided into two portions, namely, the foreign currency portion pertaining to those for equipment and materials to be imported and the local currency portion for labour, materials and equipment available in Nepal, inland transportation, etc.

(8) Taxes and duties are excluded in the cost estimation.

11.2 Component of Cost

(1) Supporting facilities

(i) Access road

The cost for access road includes the construction cost of new road from Dhankuta (Hile) to the dam site of about 115 km and also the cost for improvement of the existing road between Dharan and Dhankuta. The breakdown of the cost for the new road is shown in the separate Volume II.

(ii) Preparing works

The cost for preparation works includes those for camp facilities, telecommunication facilities and temporary diesel power plant.

The costs for camp facilities are for providing office buildings and living quarters to be used by NEA and the Engineer. The costs for telecommunication facilities are for providing wireless system between Kathmandu and the project site and also telephone system in the project area. The costs for temporary power plant are providing diesel engine generator being described in paragraph 10.3 and appurtenant facilities, fuel, and operation and maintenance of the plant.

The costs required for the above supporting facilities are calculated at respective lump sum prices. However, the costs for aggregate plant, concrete mixing and placing equipment, service roads in the project area, temporary bridges, water supply and drainage facilities, etc. which are directly required for execution of the works are to be included in the unit prices of civil works.

(2) Civil works

The costs for civil works are calculated on the basis of work quantities estimated based on design drawings described in Chapter 9 "Feasibility Design" multiplied by corresponding unit

prices. The unit prices are figured taking into consideration labour wages in Nepal (Table 11-6), prices of materials (Table 11-7), unit prices of the works adopted at the similar projects, etc. which are mainly collected during the field investigations as well as local conditions particular to the Arun 3 project. Some of the unit prices for constructing headrace tunnel and powerhouse are estimated referring to those applied to the similar works in Japan with adjustment for local conditions in Nepal.

The unit prices include the costs for labour, equipment and materials, transportation, insurance premium, temporary facilities and other incidental works. The costs for the works other than the major items are brought up together and estimated at the lump sum prices as miscellaneous.

(3) Hydraulic equipment

The costs for closure gate at the diversion tunnel, spillway gates, intake gates and trashracks, gates and other facilities in the desanding basin, steel lining in headrace tunnels and surge tanks, penstock steel pipes and tailrace gates are included in this category. The cost for each equipment pertains to materials, fabrication, transportation, installation, insurance premium and all other incidental works.

(4) Electromechanical equipment

The cost for the electromechanical equipment pertains to materials, fabrication, transportation, installation, insurance premium and other incidental works of turbines, generators, main transformers, auxiliary powerhouse equipment, switchyard, etc. The cost for each work item is estimated at the lump sum price.

(5) Transmission line and substation

(i) For domestic power supply

Costs for the following transmission lines and substations are included in the project cost.

° Transmission line

Transmission line connecting Arun 3 P/S - Dubi S/S - Dhalkebar S/Y - New Kathmandu S/S (220 kV, 2 cct), excepting those as follows:

New Kathmandu S/S - Balaju S/S (132 kV, 1 cct)
New Kathmandu S/S - Siuchatar S/S (132 kV, 1 cct)
Hetauda S/S - Dhalkebar S/S - Dubi S/S (132 kV, 1 cct)

° Substation/Switchyard

Dubi S/S (220 kV and 132 kV equipment), Dhalkebar S/Y (220 kV equipment) and New Kathmandu S/S (220 kV and 132 kV equipment), excepting those as follows:

Expansion of 132 kV equipment at Hetauda S/S
Static condenser and shunt reactor facilities at the existing power system near Kathmandu

(ii) For power export

In addition to the above facilities to be constructed in Nepal, the cost for the part inside Nepal only of 220 kV trnasmission lines (2 cct) and substation facilities at the Dubi S/S are included for power export.

(6) Compensation cost

The compensation cost includes those required for acquisition of lands to be occupied by dam and reservoir, surge tanks, facilities around powerhouse, access road, transmission line towers, substations, etc. and for removal of private houses and is esti-

mated at approximately US$1.6 millions. The details of compensation are as described in Chapter 12. Since the compensation cost of the above amount is relatively small compared with the others, this cost is included in the contingency cost for the project.

(7) Allocation of foreign currency portion

Percentage of foreign currency portion in respective construction costs are estimated as shown below, referring to the latest values applied to the projects of similar nature in Nepal.

Access road	74.1%
Preparatory works	76.1%
Civil works	85.0%
Hydraulic equipment	90.0%
Electromechanical equipment	90.0%
Transmission line and substation	90.0%
Administration and engineering services	85.6%
Contingency	84.8%
Total	85.5%

11.3 Construction Cost

11.3.1 Construction Cost for First Stage

The total construction cost for the first stage (3 units, 67 MW each, 201 MW in total) which is planned to cope with the domestic power demand is as shown below and Table 11-1. The above cost also includes those for a part of the facilities for power export in the future such as intake, desanding basin, powerhouse (extension), tailrace, etc. which are necessarily constructed simultaneously.

Summary of Construction Cost for 1st Stage (US$)

Supporting facilities	48,700,000
Civil works	131,187,000
Hydraulic equipment	11,673,000
Electromechanical equipment	38,400,000
Transmission line and substation	87,500,000
Administration and engineering services	23,810,000
Contingency	43,121,000
Total	384,391,000

Table 11-1 Total Construction Cost (1st Stage)

		F/C portion (10^3 US$)	L/C portion (10^3 US$)	Total (10^3 US$)
(1)	Supporting facilities	36,280	12,420	48,700
	Access road	28,900	10,100	39,000
	New Construction	28,900	5,100	34,000
	Improvement of existing road	0	5,000	5,000
	Camp facilities	0	1,500	1,500
	Telecommunication facilities	900	100	1,000
	Diesel engine generator	6,480	720	7,200
(2)	Civil works	111,509	19,678	131,187
	Diversion tunnel & cofferdam	5,797	1,023	6,820
	Dam & spillway	20,748	3,662	24,410
	Intake & desanding basin	18,114	3,197	21,311
	Headrace tunnel & surge tank	44,222	7,804	52,026
	Penstock	2,502	441	2,943
	Powerhouse & switchyard	15,938	2,812	18,750
	Tailrace tunnel & outlet	4,188	739	4,927
(3)	Hydraulic equipment (Gate, trashrack & penstock)	10,506	1,167	11,673
(4)	Electric equipment (Turbine, generator, transformer, auxiliary equipment & switchgear)	34,560	3,840	38,400
(5)	Transmission line & substation facilities	78,750	8,750	87,500
(6)	Administration & engineering services 1/	20,370	3,440	23,810
(7)	Contingency 2/	36,586	6,535	43,121
	Grand Total	328,561	55,830	384,391

Note 1/ : 7.5% of total cost for works from (1) to (5) above.
2/ : 15% of total cost for works (1) and (2) plus 10% of (3) to (6) above.

The yearly disbursement and breakdown of the total construction cost for the first stage are as shown in Table 11-2 and Table 11-3.

Table 11–2 Disbursement Schedule (1st Stage)

Unit: I,000 US$

Item		Total Cost	1 1987	2 1988	3 1989	4 1990	5 1991	6 1992	7 1993	8 1994	9 1995	10 1996	11 1997	12 1998	13 1999	14 2000
1. Access Road	F.C.	28,900	2,890	10,115	10,115	2,890	2,890									
	L.C.	10,100	1,010	3,535	3,535	1,010	1,010									
	Total	39,000	3,900	13,650	13,650	3,900	3,900	0	0	0	0	0	0	0	0	
2. Preparatory Works	F.C.	7,380		1,699	1,291	1,477	583	966	966	398						
	L.C.	2,320		533	407	464	183	304	304	125						
	Total	9,700	0	2,232	1,698	1,941	766	1,270	1,270	523	0	0	0	0	0	
3. Civil Works	F.C.	111,509			1,159	10,659	25,786	32,552	29,389	11,167				478	319	
	L.C.				205	1,881	4,551	5,744	5,186	1,971				84	56	
	Total	131,187	0	0	1,364	12,540	30,337	38,296	34,575	13,138	0	0	0	562	375	
4. Hydraulic Equipment	F.C.	10,506					1,050	2,102	4,202	3,152						
	L.C.	1,167					117	233	467	350						
	Total	11,673	0	0	0	0	1,167	2,335	4,669	3,502	0	0	0	0	0	
5. Electromechanical Equipment	F.C.	34,560					2,626	10,437	7,845	5,219			4,217	3,387	829	
	L.C.	3,840					292	1,160	872	580			468	376	92	
	Total	38,400	0	0	0	0	2,918	11,597	8,717	5,799	0	0	4,685	3,763	921	
6. Transmission Line & Substation	F.C.	78,750						7,087	42,604	21,342				4,646	3,071	
	L.C.	8,750						788	4,734	2,371				516	341	
	Total	87,500	0	0	0	0	0	7,875	47,338	23,713	0	0	0	5,162	3,412	
7. Administration & Engineering Services	F.C.	20,370	251	1,019	1,072	1,180	2,508	3,938	6,196	2,995			300	609	302	
	L.C.	3,440	42	172	181	199	424	665	1,046	506			51	103	51	
	Total	23,810	293	1,191	1,253	1,379	2,932	4,603	7,242	3,501	0	0	351	712	353	
8. Contingency	F.C.	36,586	521	2,122	2,233	2,456	5,051	7,276	10,328	4,837			428	889	445	
	L.C.	6,535	93	379	399	439	901	1,300	1,845	864			76	159	80	
	Total	43,121	614	2,501	2,632	2,895	5,952	8,576	12,173	5,701	0	0	504	1,048	525	
Grand Total	F.C.	328,561	4,109	16,731	17,605	19,365	41,005	63,724	99,138	47,761			4,735	9,613	4,775	
	L.C.	55,830	698	2,843	2,992	3,290	6,967	10,828	16,846	8,116			805	1,634	811	
	Total	384,391	4,807	19,574	20,597	22,655	47,972	74,552	115,984	55,877	0	0	5,540	11,247	5,586	

F.C. : Foreign currency portion
L.C. : Local currency portion

Table 11-3 Breakdown of Construction Cost (1st Stage)

(US$)

Item	Unit	Unit Price	Q'ty	Cost	Note
(1) Supporting Facility					
Access Road					
New construction	LS		1	34,000,000	
Improvement	LS		1	5,000,000	
Sub-total				39,000,000	
Camp Facilities	LS		1	1,500,000	
Telecommunications	LS		1	1,000,000	
Diesel engine generator	LS		1	7,200,000	
Sub-total				9,700,000	
Total				48,700,000	
(2) Diversion Tunnel					
Common excavation	m^3	5	530	2,650	
Rock excavation	"	12	2,120	25,440	
Tunnel excavation	"	48	19,000	912,000	
Structure concrete	"	170	810	137,700	
Lining concrete	"	150	4,500	675,000	
Tunnel form	m	310	355	110,050	
Plug concrete	m^3	130	1,280	166,400	
Shotcrete	m^2	40	1,400	56,000	
Wire mesh	m^2	15	1,400	21,000	
Rock bolt (L=3m)	pcs	70	200	14,000	
Reinforcement	t	635	100	63,500	
Grouting	t	410	100	41,000	

(US$)

Item	Unit	Unit Price	Q'ty	Cost	Note
Miscellaneous	LS		1	111,260	5%
Sub-total				2,336,000	
Closure gate	t	3,400	40	136,000	
Total				2,472,000	
(3) Khoktak Khola Diversion					
Common excavation	m^3	5	200	1,000	
Rock excavation	"	12	300	3,600	
Tunnel excavation	"	48	2,200	105,600	
Dyke concrete	"	125	500	62,500	
Structure concrete	"	170	100	17,000	
Lining concrete	"	150	470	70,500	
Tunnel form	m	250	135	33,750	
Shotcrete	m^2	40	1,200	48,000	
Wire mesh	"	15	1,200	18,000	
Rock bolt (L=3m)	pcs	70	700	49,000	
Miscellaneous	LS		1	21,050	5%
Total				430,000	
(4) Cofferdam					
Upstream cofferdam					
Impervious core	m^3	12	10,200	122,400	
Rockfill	"	12	68,600	823,200	
Slurry trench	"	450	570	256,500	
Dewatering	LS		1	200,000	
Reconstruction	"		1	1,580,000	
Miscellaneous	LS			296,900	10%
Sub-total				3,279,000	

(US$)

Item	Unit	Unit Price	Q'ty	Cost	Note
Downstream cofferdam					
Impervious core	m^3	12	2,500	30,000	
Rockfill	"	12	11,320	135,840	
Slurry trench	"	450	460	207,000	
Re-construction	LS		1	332,000	
Miscellaneous	LS		1	70,160	10%
Sub-total				775,000	
Total				4,054,000	
(5) Dam and Spillway					
Reservoir cleaning	ha	1,000	75	75,000	
Common excavation	m^3	8	52,500	420,000	
Rock excavation	"	15	55,800	837,000	
Foundation clean up	m^2	13	8,800	114,400	
Mass concrete	m^3	115	150,900	17,353,500	
Structure concrete	"	170	9,800	1,666,000	
Reinforcement	t	635	820	520,700	
Grouting	m	140	8,600	1,204,000	
Miscellaneous	LS		1	2,219,400	10%
Sub-total				24,410,000	
Spillway gate	t	5,000	600	3,000,000	
Total				27,410,000	
(6) Intake					
Common excavation	m^3	8	9,740	77,920	
Rock excavation	"	15	39,000	585,000	
Tunnel excavation	"	48	26,000	1,248,000	

(US$)

Item	Unit	Unit Price	Q'ty	Cost	Note
Structure concrete	m^3	170	13,200	2,244,000	
Lining concrete	"	150	8,100	1,215,000	
Tunnel form	m	530	150	79,500	
Shotcrete	m^2	40	5,400	216,000	
Wire mesh	m^2	15	5,400	81,000	
Rock bolt (L=3m)	pcs	70	440	30,800	
Reinforcement	t	635	680	431,800	
Grouting	t	410	90	36,900	
Miscellaneous	LS		1	312,080	5%
Sub-total				6,558,000	
Control gate	t	5,000	160	800,000	
Trashrack	"	3,000	70	210,000	
Sub-total				1,010,000	
Total				7,568,000	
(7) Desanding Basin					
Underground excavation	m^3	45	144,000	6,480,000	
Tunnel excavation	"	48	7,400	355,200	
Side wall concrete	"	170	16,100	2,737,000	
Base concrete	"	155	11,000	1,705,000	
Lining concrete	"	150	2,700	405,000	
Tunnel form	m	250	600	150,000	
Shotcrete	m^2	40	15,800	632,000	
Wire mesh	"	15	15,800	237,000	
Rock bolt	pcs	70	9,300	651,000	
Reinforcement	t	635	1,100	698,500	

(US$)

Item	Unit	Unit Price	Q'ty	Cost	Note
Miscellaneous	LS		1	702,300	5%
Sub-total				14,753,000	
Drainage gate	t	5,000	90	450,000	
Steel pipe		3,200	100	320,000	
Sub-total				770,000	
Total				15,523,000	
(8) Headrace Tunnel					
Common excavation	m^3	5	3,000	15,000	
Rock excavation	"	12	5,000	60,000	
Tunnel excavation (TBM)	"	47	290,000	13,630,000	Upstream part
" (CBM)	"	48	156,000	7,488,000	Downstream part
Adit tunnel excavation	m^3	48	41,000	1,968,000	
Lining concrete	m^3	150	55,500	8,325,000	
Tunnel form	m	310	4,600	1,426,000	
Invert concrete	m^3	150	2,000	300,000	
Culvert concrete	"	170	7,550	1,283,500	
Plug concrete	"	130	6,250	812,500	
Shotcrete	m^2	40	114,500	4,580,000	
Wire mesh	"	15	114,500	1,717,500	
Rock bolt (L=3m)	pcs	70	17,000	1,190,000	
Reinforcement	t	635	1,950	1,238,250	
Grouting	t	410	650	266,500	
Rock trap	LS		1	1,200,000	
Miscellaneous	LS		1	2,275,750	5%
Sub-total				47,776,000	

(US$)

Item	Unit	Unit Price	Q'ty	Cost	Note
Steel pipe	t	3,200	150	480,000	
Total				48,256,000	
(9) Surge Tank					
Common excavation	m^3	5	4,000	20,000	
Rock excavation	"	12	15,500	186,000	
Shaft excavation	"	70	15,550	1,088,500	
Adit tunnel excavation	"	61	9,150	558,150	
Lining concrete	"	150	1,100	165,000	
Prelining concrete	"	175	650	113,750	
Shaft concrete	"	210	3,650	766,500	
Bottom concrete	"	170	1,950	331,500	
Plug concrete	"	130	2,850	370,500	
Shotcrete	m^2	40	1,450	58,000	
Wire mesh	"	15	1,450	21,750	
Slope protection	m^2	60	1,650	99,000	
Reinforcement	t	635	295	187,325	
Grouting	"	410	200	82,000	
Miscellaneous	LS		1	202,025	5%
Sub-total				4,250,000	
Steel lining	t	3,200	205	656,000	
Total				4,906,000	
(10) Penstock					
Common excavation	m^3	5	500	2,500	
Rock excavation	"	12	1,000	12,000	
Tunnel excavation	"	61	2,900	176,900	
Shaft excavation	"	56	8,800	492,800	

(US$)

Item	Unit	Unit Price	Q'ty	Cost	Note
Adit tunnel excavation	m^3	48	13,000	624,000	
Structure concrete	"	170	650	110,500	
Filling concrete	"	130	6,300	819,000	
Plug concrete	"	130	1,400	182,000	
Shotcrete	m^2	40	5,800	232,000	
Wire mesh	"	15	5,800	87,000	
Reinforcement	t	635	100	63,500	
Miscellaneous	LS		1	140,800	5%
Sub-total				2,943,000	
Steel penstock	t	3,200	1,300	4,160,000	
Total				7,103,000	

(11) Powerhouse

Powerhouse					
Underground excavation	m^3	45	82,000	3,690,000	
Adit tunnel excavation	"	48	3,300	158,400	
Arch concrete	"	190	4,600	874,000	
Side wall concrete	"	170	11,000	1,870,000	
Base concrete	"	155	7,300	1,131,500	
Shotcrete	m^2	40	13,600	544,000	
Wire mesh	"	15	13,600	204,000	
Rock bolt (L=3m)	pcs	70	670	46,900	
Rock bolt (L=5m)	"	120	450	54,000	
Rock bolt (L=15m)	"	1,000	450	450,000	
Reinforcement	t	635	1,740	1,104,900	
Mortar injection	m^3	250	300	75,000	
Architectural finishing work	LS		1	1,260,000	

(US$)

Item	Unit	Unit Price	Q'ty	Cost	Note
Miscellaneous	LS		1	573,300	5%
Sub-total				12,036,000	
Main Trans. Room					
Underground excavation	m^3	45	17,300	778,500	
Arch concrete	"	190	1,800	342,000	
Side wall concrete	"	170	3,800	646,000	
Base concrete	m^3	155	300	46,500	
Shotcrete	m^2	40	6,400	256,000	
Wire mesh	"	15	6,400	96,000	
Rock bolt (L=3m)	pcs	70	320	22,400	
Rock bolt (L=5m)	pcs	120	300	36,000	
Rock bolt (L=15m)	pcs	1,000	150	150,000	
Reinforcement	t	635	400	254,000	
Miscellaneous	LS		1	131,600	5%
Sub-total				2,759,000	
Access Tunnel					
Common excavation	m^3	5	1,400	7,000	
Rock excavation	"	12	5,400	64,800	
Tunnel excavation	"	48	9,000	432,000	
Wall concrete	"	170	200	34,000	
Lining concrete	"	150	3,000	450,000	
Tunnel form	m	310	330	102,300	
Reinforcement	t	635	160	101,600	
Miscellaneous	LS		1	59,300	5%
Sub-total				1,251,000	

(US$)

Item	Unit	Unit Price	Q'ty	Cost	Note
Cable Tunnel					
Common excavation	m^3	5	11,000	55,000	
Rock excavation	"	12	1,000	12,000	
Banking	"	4	7,000	28,000	
Tunnel excavation	"	48	2,500	120,000	
Culvert concrete	"	170	2,400	408,000	
Lining concrete	"	150	900	135,000	
Tunnel form	m	250	173	43,250	
Reinforcement	t	635	150	95,250	
Miscellaneous	LS		1	44,500	5%
Sub-total				941,000	
Busbar Tunnel					
Tunnel excavation	m^3	48	1,700	81,600	
Lining concrete	"	150	600	90,000	
Tunnel form	m	250	190	47,500	
Reinforcement	t	635	50	31,750	
Miscellaneous	LS	635	1	12,150	5%
Sub-total				263,000	
Total				17,250,000	
(12) Switchyard and Control Building					
Switchyard	LS			500,000	
Control building	LS			1,000,000	
Total				1,500,000	

(US$)

Item	Unit	Unit Price	Q'ty	Cost	Note
(13) Tailrace Tunnel					
Tunnel excavation (A)	m^3	48	7,700	369,600	
Tunnel excavation (B)	"	61	8,300	506,300	Branch tunnel
Adit tunnel excavation	"	48	1,500	72,000	
Plug concrete	"	130	1,500	195,000	
Lining concrete	"	150	5,300	795,000	
Tunnel form (A)	m	310	180	55,800	
Tunnel form (B)	"	250	340	85,000	Branch tunnel
Shotcrete	m^2	40	1,500	60,000	
Wire mesh	"	15	1,500	22,500	
Rock bolt (L=3m)	pcs	70	200	14,000	
Reinforcement	t	635	200	127,000	
Miscellaneous	LS		1	115,800	5%
Sub-total				2,418,000	
Draft gate	t	5,000	120	600,000	
Total				3,018,000	
(14) Tailrace Outlet					
Common excavation	m^3	5	7,000	35,000	
Rock excavation	"	12	16,000	192,000	
Wall concrete	"	170	2,000	340,000	
Structure concrete	"	170	2,500	425,000	
Shotcrete	m^2	40	2,700	108,000	
Wire mesh	"	15	2,700	40,500	
Reinforcement	t	635	220	139,700	
Care of river	LS		1	1,000,000	

(US$)

Item	Unit	Unit Price	Q'ty	Cost	Note
Miscellaneous	LS		1	228,800	10%
Sub-total				2,509,000	
Tailrace gate	t	5,000	210	1,050,000	
Total				3,559,000	
(15) Electromechanical Equipment					
Turbine	LS		1	10,080,000	
Generator	"		1	8,520,000	
Main transformer	"		1	1,660,000	
Others	"		1	9,940,000	
Sub-total				30,200,000	
Arun 3 switchyard	LS		1	8,200,000	
Total				38,400,000	
(16) Transmission Line and Substation					
Transmission Line					
Arun 3 S/Y - Dubi S/S	LS		1	23,200,000	
Dubi S/S - Dhalkebar S/Y	"		1	14,800,000	
Dhalkebar S/Y - New Kathmandu S/S	"		1	12,100,000	
Sub-total				50,100,000	
Substation and Switchyard					
Dubi S/S	LS		1	11,900,000	
Dhalkebar S/Y	"		1	7,500,000	
New Kathmandu S/S	"		1	12,500,000	
Sub-total				31,900,000	
Telecommunication	LS		1	5,500,000	
Total				87,500,000	

11.3.2 Total Construction Cost for First and Second Stages

The total construction cost for the whole project (6 units, 67 MW each, 402 MW in total) which includes both the first stage for domestic power demand and the second stage for power export is shown below and Table 11-4. In connection with the transmission line and substation facilities required for power export, only the costs for those to be constructed in Nepal are included in the above total cost.

Summary of Construction Cost for 1st and 2nd Stages (US$)

Supporting facilities	48,700,000
Civil works	185,872,000
Hydraulic equipment	17,569,000
Electromechanical equipment	69,400,000
Transmission line and substation	107,000,000
Administration and engineering services	32,141,000
Contingency	57,797,000
Grand Total	518,479,000

Table 11–4 Total Construction Cost (1st & 2nd Stages)

		F/C portion (10^3 US$)	L/C portion (10^3 US$)	Total (10^3 US$)
(1)	Supporting facilities	36,280	12,420	48,700
	Access road	28,900	10,100	39,000
	Construction	28,900	5,100	34,000
	Improvement of existing road	0	5,000	5,000
	Camp facilities	0	1,500	1,500
	Telecommunication facilities	900	100	1,000
	Diesel engine generator	6,480	720	7,200
(2)	Civil works	157,991	27,881	185,872
	Diversion tunnel & cofferdam	5,797	1,023	6,820
	Dam & spillway	20,748	3,662	24,410
	Intake & desanding basin	18,114	3,197	21,311
	Headrace tunnel & surge tank	86,686	15,298	101,984
	Penstock	4,161	734	4,895
	Powerhouse & switchyard	17,101	3,018	20,119
	Tailrace tunnel & outlet	5,383	950	6,333
(3)	Hydraulic equipment (Gate, trashrack & penstock)	15,812	1,757	17,569
(4)	Electro-mechanical equipment (Turbine, generator, transformer, auxiliary equipment & switchgear)	62,460	6,940	69,400
(5)	Transmission line & substation facilities	96,300	10,700	107,000
(6)	Administration & engineering services 1/	27,664	4,477	32,141
(7)	Contingency 2/	49,365	8,432	57,797
	Grand Total	445,872	72,607	518,479

Note 1/ : 7.5% of total cost for works from (1) to (5) above.
2/ : 15% of total cost for works (1) and (2) plus 10% of (3) to (6) above.

The yearly disbursement for the first stage and second stages are as shown in Table 11-3.

Table 11–5 Disbursement Schedule (1st and 2nd Stages)

Unit: 1,000 US$

Item		Total Cost	1 1987	2 1988	3 1989	4 1990	5 1991	6 1992	7 1993	8 1994	9 1995	10 1996	11 1997	12 1998	13 1999	14 2000
1. Access Road	F.C.	28,900	2,890	10,115	10,115	2,890	2,890									
	L.C.	10,100	1,010	3,535	3,535	1,010	1,010									
	Total	39,000	3,900	13,650	13,650	3,900	3,900	0	0	0	0	0	0	0	0	
2. Preparatory Works	F.C.	7,380		1,699	1,291	1,477	583	966	966	398						
	L.C.	2,320		533	407	464	183	304	304	125						
	Total	9,700	0	2,232	1,698	1,941	766	1,270	1,270	523	0	0	0	0	0	
3. Civil Works	F.C.	157,991			1,159	10,659	25,786	32,552	29,389	15,583	8,330	13,764	15,350	5,100	319	
	L.C.	27,881			205	1,881	4,551	5,744	5,186	2,750	1,470	2,429	2,709	900	56	
	Total	185,872	0	0	1,364	12,540	30,337	38,296	34,575	18,333	9,800	16,193	18,059	6,000	375	
4. Hydraulic Equipment	F.C.	15,812					1,050	2,102	4,202	3,152			2,893	2,416		
	L.C.	1,757					117	233	467	350			321	268		
	Total	17,569	0	0	0	0	1,167	2,335	4,669	3,502	0	0	3,214	2,684	0	
5. Electromechanical Equipment	F.C.	62,460					2,626	10,437	7,845	5,219			18,169	14,547	3,619	
	L.C.	6,940					292	1,160	872	580			2,019	1,616	402	
	Total	69,400	0	0	0	0	2,918	11,597	8,717	5,799	0	0	20,188	16,163	4,021	
6. Transmission Line & Substation	F.C.	96,300						7,087	42,604	21,342			15,188	10,080		
	L.C.	10,700						788	4,734	2,371			1,688	1,120		
	Total	107,000	0	0	0	0	0	7,875	47,338	23,713	0	0	16,874	11,200	0	
7. Administration & Engineering Services	F.C.	27,497	251	1,019	1,072	1,180	2,508	3,938	6,196	3,328	628	1,039	3,743	2,312	283	
	L.C.	4,644	42	172	181	199	424	665	1,046	562	107	176	632	391	47	
	Total	32,141	293	1,191	1,253	1,379	2,932	4,603	7,242	3,890	735	1,215	4,375	2,703	330	
8. Contingency	F.C.	49,034	521	2,122	2,233	2,456	5,051	7,276	10,328	5,530	1,310	2,164	6,086	3,542	417	
	L.C.	8,763	93	379	399	439	901	1,300	1,845	988	234	387	1,088	633	75	
	Total	57,797	614	2,501	2,632	2,895	5,952	8,576	12,173	6,518	1,544	2,551	7,174	4,175	492	
Grand Total	F.C.	445,374	4,109	16,731	17,605	19,365	41,005	63,724	99,138	54,552	10,268	16,965	61,427	37,997	4,637	
	L.C.	73,105	698	2,843	2,992	3,290	6,967	10,828	16,846	7,724	1,811	2,992	8,457	4,928	580	
	Total	518,479	4,807	19,574	20,597	22,655	47,972	74,552	115,984	62,276	12,079	19,957	69,884	42,925	5,217	

F.C. : Foreign currency portion
L.C. : Local currency portion

Table 11–6 Labour Wage

Labour Type	Rate per day	
	Rs 1/	US$ 2/
Head labour	50	2.34
Labour	40	1.87
Porter	60	2.81
Head mason	80	3.74
Mason	70	3.28
Carpenter	70	3.28
Painter	80	3.74
Plumber	100	4.68
Electrician	100	4.68
Auto Mechanics	100	4.68
Auto Electrician	120	5.62

1/ Wage at 1986 price level

2/ Exchange rate 1US$ = Rs21.35

Table 11–7 Price of Construction Materials

Material	Unit	Price (US$)	Remarks
Cement	t	150	CIF plus inland transportation
Reinforcement bar	t	380	"
Formed steel	t	490	"
Petroleum	kl	520	"
Light oil	kl	360	"
Explosive	kg	5.2	"
Detonator	pcs	1.0	"
Rock bolt (L=3m)	pcs	27	"
Rock bolt (L=5m)	pcs	43	"
P.C. bar (L=15m)	pcs	160	"

CHAPTER 12. ENVIRONMENTAL IMPACT

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CHAPTER 12. ENVIRONMENTAL IMPACT

12.1 General

The project area is presently only accessible by footpaths or trails. By implementation of the Arun 3 project and its long access road environmental changes of different magnitude may occur in the villages as well as to the natural ecosystem.

Environmental impact studies in connection with a large development project have a short history in Nepal. Therefore, available data are scarce and systematic analysis of data and evaluation is a very difficult task. The present study attempts to quantify the possible magnitude of compensation and to qualitatively identify the probable areas of environmental impact, including both ecological and socio-economic impacts to be induced by the project. Limited field survey on land-use in the vicinity of the project areas was conducted and the existing land utilization maps (1/50,000 scale) were extensively used for the study.

12.2 Methodology

An environmental impact assessment (EIA) is defined by Munn[1/] as being actively designed to identify and predict the impact on man's health and well-being and on environmental conditions, of legislative proposals, policies, programs, projects, and operational procedures, and to interpret and communicate information about them.

The present study will attempt to identify the environmental impact by the following two approaches:

(1) Estimation of Compensation

The amount of compensation was estimated in connection with land acquisition and resettlement involving houses, cultivated &

1/ Munn, R.E., 1975: Environmental Impact Assessment - Principles and Procedures. SCOPE Report 5. Toronto, Canada

non-cultivated land, forests, etc. to be affected by the Arun 3 project including the access road, the transmission line, and substations. The existing land utilization maps (1/50,000 scale) were used to obtain land-use data on the entire geometrical location to be affected by the project. Distribution of houses is based on field inspection and newly developed 1/10,000 scale maps which cover an area of about 180 km^2 containing two alternative access road routes.

(2) Qualitative Identification of Impact Areas

Impact areas were identified by a systematic approach developed by Aegerter and Messerli[1/] for a formal EIA to identify significant impact areas and probable effects. Elaborate mathematical treatment has been omitted due to the lack of substantive data.

The following terminology is defined to clarify the approach:

(1) actions: man's activities in connection with a project
(2) effects: change of environmental conditions due to a project
(3) impacts: change of environmental quality and of human well-being

The study will identify activities and impact area of effects, followed by prediction and estimation of the extent of environmental impact on the qualitative basis.

Project work is classified into three categories:

(1) *Preparation Phase:*

This includes engineering studies, land acquisition and compensation.

1/ Aegerter, S., and Messerli, P., 1985: The Impact of Hydroelectric Power Plants on a Mountain Environment. Chapter 4 of Integrated Mountain Development. Himalayan Books, New Delhi, India

(2) Construction Phase:

This involves all construction activities, both permanent and temporary. Also included are actions related to socio-cultural-economic area such as creation of jobs, migration of workers and exposure of the local people to foreign workers.

(3) Operation Phase:

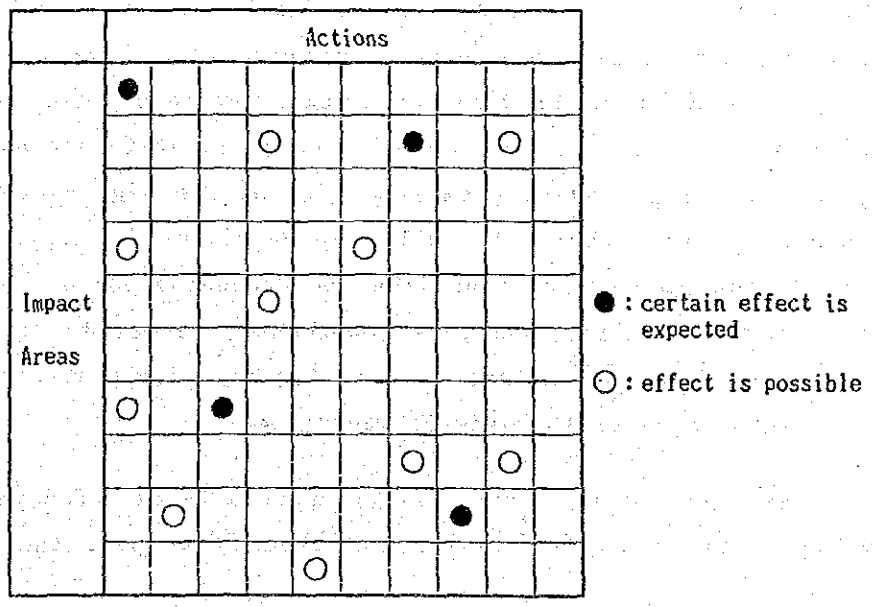
This covers a variety of action components such as operation of existing installations (pondage, roads, buildings, etc.), creation of permanent jobs, generation of energy and development of fish culture in the pondage.

Detailed action components are listed in Table 12-1.

Impact areas consist of a spectrum of possible areas to be affected or influenced directly or indirectly by the specified actions. Major components are (1) Non-Biotic Area, (2) Biotic Area, (3) Social Area, (4) Cultural Area, (5) Economic Area, and (6) Political Area. A detailed breakdown of each area mentioned above is shown in Table 12-2.

The relationship between the actions and the impact areas for a particular project can be conveniently expressed by the Relevance Matrix a sample of which is shown below.

Fig. 12–1 Relevance Matrix



The matrix only shows the result of systematic entry of certain and possible effects on the impact areas corresponding to each action. The matrix does not show whether the effect attached to the impact area identified is significant enough for predicting impacts. Such effects will be disclosed through an iteration process generally using subjective judgment because quantitative measuring of most effects except for limited cases such as the number of houses to be inundated is not practical in this study due to the difficulty in collecting relevant data or the time factor involved.

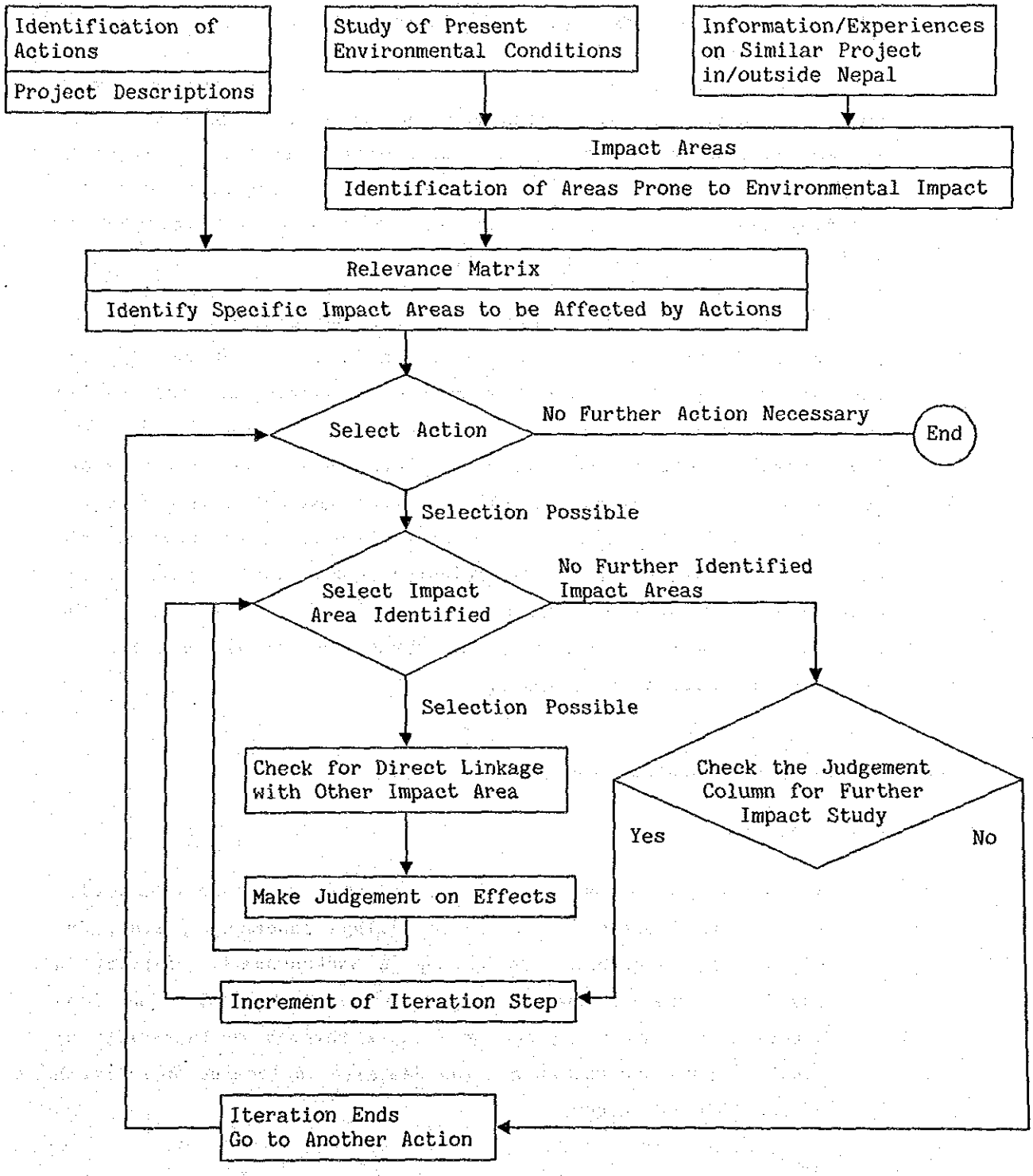
For each action an iterative consideration is made for further scrutiny of the entire impact area identified as effective by the matrix. During an iteration each sub-impact area prone to a certain effect is examined for its direct linkage to the overall impact area. Through the iteration process the effects in the impact areas become clearer and enhanced, and the process is terminated when there is no additional impact to be considered. Fig. 12-2 shows a flow chart of the process.

12.3 The Project

The project is composed of the power generating facilities (civil & electro-mechanical works) and the access road. The former consist of major components such as a pondage, an underground desanding basin, a power tunnel, a surge tank and penstock, and an underground powerhouse. Since the project is a typical run-of-river type utilizing high quality flow of the Arun river the project is essentially simple despite its large power generating capacity. The pondage creates only 4 km of backwater with a maximum water level rise of 50 m which will minimize the possibility of inundation of forest and cultivated land. Local villagers generally live on the high elevation terrace areas. Houses, therefore, will not be affected. Major civil works are of the underground type like the desanding basin, the power tunnel, and the underground type powerhouse. These facilities will be invisible from the surface or very low-key in appearance, with minimal disturbance of the natural landscape.

The main flow of the Arun river is partially diverted throughout the year to the desanding basin, and then flows into the power tunnel

Fig. 12–2 Flow Chart for Environmental Impact Study



reaching the surge tank. Water drops through the penstock to the powerhouse and eventually returns to the Arun river. Even during the dry season the minimum flow of 10 m^3/sec will be available eliminating drying-up of the river section between the dam and the powerhouse. This planning consideration is particularly important for maintaining the aquatic environment in the said section.

The project requires a long access road because the only motorable road terminates near Hile-Basantapur in the Dhankuta District about 100 km south of the project site. The proposed alignment of the road is the river-side route. Consequently the alignment near the riverbed is generally at a lower elevation than the terraced or cultivated field typical on the hills.

The transmission line is divided into three sectors; namely, (a) the powerhouse - Dubi substation sector which is about 120 km long, (b) the 146 km long Dubi - Dhalkebar substation sector, and (c) the 120 km long Dhalkebar - Kathmandu substation sector. The first sector (a) generally follows the access road but there will be more short cuts and straight sections through hill areas eventually reducing the total distance. The sector (b) is located in the Terai running from east to west. The sector (c) is oriented in the north west direction passing Sindhuli and the Swalik range to the Kathmandu valley. The details are shown in Chapter 9. The land space requirement for the transmission tower is very small.

12.4 Present Environmental Conditions

(1) Location

The project area covering the dam and the powerhouse (550 m elevation) is located in the three village panchayats, i.e., Num (1,200 m), Pathibhara and Diding in Sankhuwasabha District in the Kosi Zone of the Eastern Development Region. The long access road runs along the Arun river through the districts of Sankhuwasabha and Dhankuta. The dam site is located 40 km south of the Chinese border.

(2) Natural Environment

The majority of local people are engaged in farming using the terrace fields on the hills. There are no irrigation facilities and natural environment is tranquil without any sizable industrial activities. Air pollution is non-existent. The Arun river has a low fluctuation of annual discharge with steep gradients and high sediment loads of both suspended and bed-loads. The climate is subtropical with a moderate temperature fluctuation between 7°C and 20°C on the average. District-wise average annual rainfall is 1,950 mm.

The topography shows a typical Midland landscape of rolling terrain with gentle slopes along the Arun river surrounded by steep ridges. Most of the slopes are composed of terraced slopes and barren hillsides. This area is geologically called the Tumlingtar Window and is rectangular in shape, 20 km wide and extending 50 km (direct distance) with its southern boundary near Pakharibas sitting atop of the ridge in northwest Hile. The northern boundary lies near Diding where the powerhouse is located. The sector between the powerhouse and the dam shows steep topography.

(3) Biotic Environment

The total forest area is about 160,000 ha which is approximately 45% of the total district area. The area under cultivation is 9,000 ha. There are many grassy slopes and no rare species of flora and fauna are found in the project area or in the area along the access road. Among the protected wildlife species, the tiger is reported to be found in the project area. There is no protected species of aquatic vegetation in the Arun river and its tributaries close to the project areas. Only limited information is available on fish distribution and habitat and there appears to be no fish migration.

(4) Social Environment

The total area of the district is 3,480 km^2 with a population density of 37.2/km^2 (1981). This sparsely populated condition is partially due to migration of the villagers to the Terai Plain where there are better living conditions. Average family size per household is 5 persons with a declining trend due to the fragmentation of households and other reasons. Population composition for the three groups of (1) under 14 years, (2) between 15 and 49, and (3) over 49, is 39%, 48% and 13%, respectively. Communication with other parts of the nation is possible through postal services and private porters who carry messages to the postal facilities. Telecommunication services are available between Khandbari, the district headquarters, and Kathmandu.

(5) Cultural Environment

Availability of hospital beds is about 4 persons per bed. There is one health center in Chainpur and 8 health posts. Schools in the district include 131 primary, 51 lower secondary and 5 secondary schools.

Traditional land use includes cultivation, buildings for both people and cattle, forest for fuelwood and grazing, and paths and trails. Ethnic composition shows a leading majority of Rai (36%) followed by Chetri (18%) and Magar (18%). The rest are Damai, Kami, Newar, Tamang and Gurung in order of population size. There are no outstanding archeological or cultural sites in the area.

(6) Economic Environment

More than 97% of the labor force is engaged in agriculture, forestry and fishing. Other sectors, including public services, manufacturing and commerce, occupy at most 3% of the labor force.

Principal cereals are paddy, maize, millet, wheat and barley. Cash crops are oilseeds, potato and sugarcane. The majority of

cultivated land is allocated for paddy and maize. Per hectare production is low and the trend shows a declining production rate. Forests are mainly used for firewood, construction materials and grazing. The average farmer's agricultural production meets only his own subsistence needs and only surplus is given for trading. Due to the low production rate, the average farmer purchases foods to make up the supply deficit. Livestock production also contributes to cash income. Low-income villagers are generally engaged as porters on a regular basis. Wages are subject to seasonal fluctuation varying between 20 and 40 Rupees/day.

Tourist attraction centers are Chainpur for the main trade center, Khandbari for the district headquarters, Tumlingtar for the airfield and pottery industries, and Chyankerti Bhanjyang for viewing the Himalayan Peaks. There are no roads except footpaths and trails. Hile or Tumlingtar is the starting point for trekking to the base-camp of Mount Makalu. Hile-Piluwa-Tumlingtar-Khandbari is the only main trail for the passage of porters. There are no hotels for travelers and trekkers beyond Khandbari.

(7) Political Environment

Sankhuwasabha District is included in the Kosi Zone of the Eastern Development Region. The district is sparsely populated. The area is 3,480 km^2 and administratively divided into 36 village panchayats. Development plans for hydropower generation and construction of motorable roads are well received among the villagers as a means for betterment of the living standard. National level interest in development in the district is focussed on inter alia, rural electrification, advancement of agricultural production, cottage industries, water supply, and forest conservation.

12.5 Impact Assessment

This section describes the results of (1) estimation of compensation and (2) qualitative impact identification study. Table 12-3 summarizes the estimated compensation. Table 12-4 through 12-20 show the results of impact identification. Identified impacts are described in the following subsections according to the major subjects relevant to the impact assessment.

(1) Negligible Compensation Requirement

Inundation of forest and cultivated areas by the small pondage to be created is minimal and the access road will require minimum acquisition of residential and cultivated lands. The road alignment along the riverbed can make such route selection possible.

As shown in Table 12-3, the estimated total compensation cost in connection with the major civil works and the access road is US$0.312 million. This cost, as it is relatively small, is included in the project contingency cost. Similarly the estimated compensation cost for the transmission line and substations, is only US$1.627 million and is included within the contingency cost for this work component.

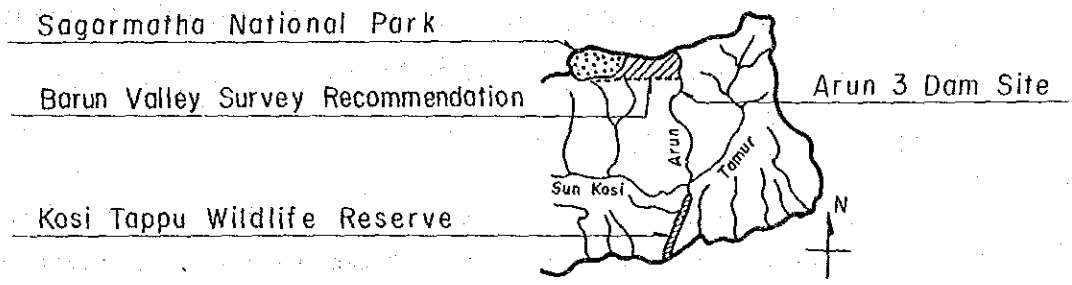
(2) Negligible Impact on the Ecology

Encroachment on flora and fauna will be negligible due to the fact that the project is a typical run-of-river type and the access road will mostly follow the route near the riverbed of the Arun river where the geology is stable and houses and farmland are scarce. There is no ecologically sensitive area nor endangered species in the project areas.

The Sagarmatha National Park is located 80 km northwest of the dam site. The present boundary of the park does not reach the Arun river. The project area including 4 km backwater of the pondage is far to the east of the park boundary. Although the Barun Valley Survey recommends expansion of the Sagarmatha National Park such that the present park boundary will be

extended directly eastward to the Arun river, the expected new boundary still be outside the Arun 3 project area. Fig. 12-3 shows approximate boundaries of the park and the dam site.

Fig. 12–3 Location of the Sagarmatha National Park



(3) Climatic Change & Pondage

Local climatic change by the development of a small pondage is not expected. The estimated surface area of the pondage is about 50 hectares and thus evaporation from such a small surface will not alter climate in the pondage vicinity.

The pondage will attract birds migratory. This type effect was already demonstrated by the Kosi Barrage which created a large swamp area now designated as Kosi Tappu Wildlife Reserve gazetted in July 1976.

Possible adverse effects would be as follows:

- silting in the pondage
- scouring or lowering of the riverbed downstream of the dam
- possible breeding of mosquitos (although seasonal water fluctuation and rapid movement of the surface water layer may prevent such breeding)
- the creation of the pondage may effect the slope stability of the weak zone in the area, and thus adequate precautionary measures may be required.

(4) Air Pollution

Air pollution by internal combustion engines operated during the construction period is temporary and if it occurs at all, will occur only in very limited locations. Therefore, no environmental problem is envisioned. Possible air pollution by traffic along the access road will not be an immediate environmental issue but some plan for monitoring the degree of pollution may be necessary for an extended period.

(5) Fishery

A fish ladder facility is not considered because there is no reported fish migration activities in the Arun river near the project site. Reported fish production rate in Nepal varies from 6 kg/ha/year to 39 kg/ha/year. An expected water surface of 50 ha may not significantly contribute to fish production.

(6) Forest Conservation

Rapid reduction in forest resources in the Himalaya range is posing serious problems for Nepal. People in Nepal heavily relies on wood for their daily supply of energy. Wood accounts for almost 87% of total energy. This heavy reliance on wood is the major reason for the disappearance of forest.

Deforestation will eventually be stabilized by the following factors:

- Demand reduction for new farmland due to the increase of agricultural production and availability of cheap surplus foods obtainable by the improved transportation system.

- Availability of alternative sources of energy for fuelwood such as kerosene and electricity. As shown in the following table, fuelwood is the source for 95% of domestic energy consumption while electricity accounts for only 2%. It is envisaged that transition from fuelwood to other alternative sources of energy may take some time.

Table 12–22 Sectoral Distribution of Total Energy Consumption by Major Sources of Energy in Nepal

Year 1978-79
in Toe (Tons of equivalent)

Sector	Fired wood		Vegetable Waste		Animal Dung		Coal and Cokes		Petroleum		Electricity		All energies	
	Toe	%	Toe	%	Toe	%	Toe	%	Toe	%	Toe	%	Toe	%
1. Transportation							3000	5.0	56775	94.7	153	0.3	59928	100
2. Domestic	2516700	95	52000	2.0	20000	0.8			28685	1.1	6559	0.2	2623944	100
3. Agriculture									4403	86.5	688	13.5	5091	100
4. Commercial & Industrial	20300	28.9					33078	47.0	10956	15.6	6013	8.5	70347	100
5. Street Lightning											175	100	175	100
6. Other uses											5000	100	5000	100
All Uses	253700	91.8	52000	1.9	20000	0.7	36078	1.3	100819	3.6	18588	0.7	2764485	100

Ref.: C. K. Sharma, Water and Energy Resources of the Himalayan Block

- Since approximately one million cubic meters of waste soil and rock debris will be produced during the construction of the access road, this waste could be utilized to develop new useful land for various purposes including reforestation.

(7) Rural Electrification and Telecommunication

Besides the national level benefit in energy supply, people near the project area and also the entire district will eventually benefit from the supply of electricity. Water supply and irrigation will be potential projects. Local people will benefit from the telecommunication facility (Power Line Carrier System) of the Arun 3 Project.

(8) Employment Opportunity

The construction period is about six years including the main facilities and the access road. But power generation capacity will be developed in stages up to the maximum capacity. This will require additional years of upgrading and maintenance works. The construction works will require the operation of various heavy construction equipment and considerable manpower thus creating many short-term and long-term employment opportunities to the local villagers and people farther away from the project areas.

The access road will eventually become a trunk road for transportation in the district, and generated electricity will be provided to the local people. Moreover the project will require a certain number of people for operation and maintenance of the facilities. The project site will also become a new tourist attraction and various development activities will be planned and implemented. Creation of project related employment is envisaged.

(9) Multiple Impacts of the Access Road

Interconnection of people on the hills and the Terai Plain will create complex influences on the total socio-economical area of the hill people. The following are major items to be considered:

- Increase in migration of people
- Stimulation to new industries

With the supply of cheap electricity and availability of good access, certain mineral resources may commercially be developed at the following sites:

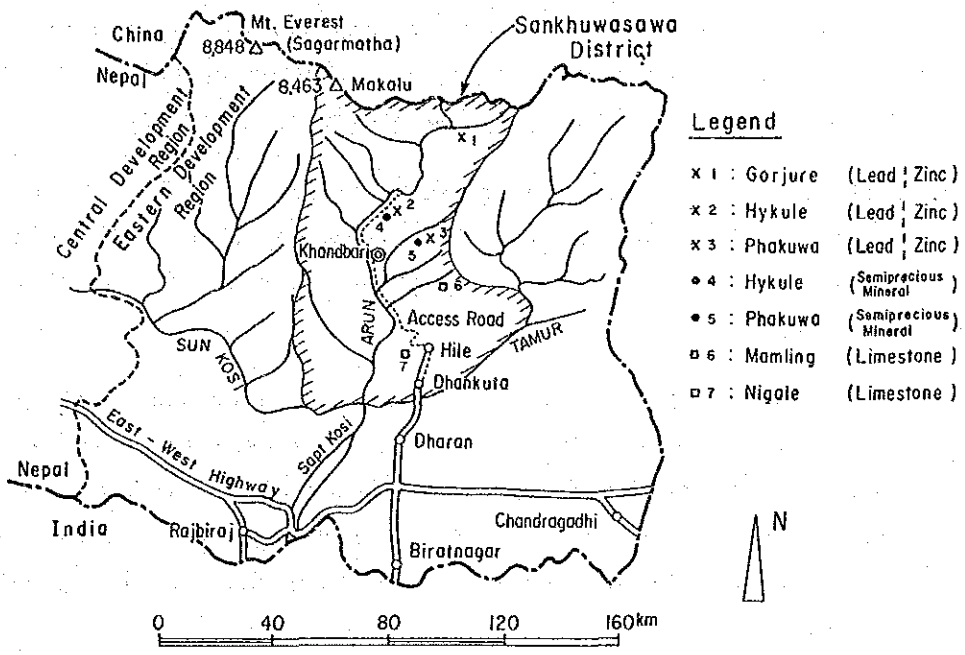
a. limestone at Mamling and Nigale near Dhankuta
b. semiprecious minerals, e.g., pegmatite, at Hykule and Phakuwa
c. lead and zinc at Hykule and Phakuwa
d. copper in the area between Khandbari and Phakuwa
e. garnet 10 km east of Khandbari

Fig. 12-4 shows the above mentioned locations.

- Development of tourism and associated new jobs
- Better communications
- Requirements for public services and facilities in the fields of health, education, administration, and vocational training

Special attention should be given to coping with infections diseases related with labourer inflow and traffic increase. Some examples are as follows:

Fig. 12–4 Locations of Mineral Deposits



a. gastro-intestinal parasitic infections
b. tuberculosis
c. dysentery
d. malaria

Adequate health and sanitation facilities should be prepared and health check of labourers should be carried out.

(10) Improved Living Standard and Social Reform

Income increase, agricultural modernization, and exposure of the local people to various outside technical and socio-cultural influences will force the local community to change in a number of ways in different degrees, which will likely contribute to the betterment of the quality of their lifestyle and well-being.

12.6 Conclusion and Recommendations

This study was qualitatively conducted based on the limited field survey and document research. It is obvious that a large project like the Arun 3 Hydropower Project and its long access road will inevitably have a profound influence on the health and well-being of the local villagers living close to the project and to certain people

throughout the district. From the study it may be concluded that there will be no detrimental or harmful effects to local people or the ecosystem except for very limited compensation or resettlement of people. A total compensation cost is estimated at about two million U.S. dollars. The magnitude of compensation is very small.

The following recommendations are made towards the successful implementation of the project to eliminate unnecessary and unintended environmental effects and to avoid jeopardizing the fundamental well-being of people:

(1) Although compensation or resettlement will create no problem due to the small magnitude, there will be a need for careful implementation to ensure appropriate timing of disbursement and care of the villagers who will be compensated or removed. Their experiences will be totally new to them thus requiring relevant advice and guidance from the concerned authority.

(2) Disturbance during the construction period to the natural ecosystem should be minimized, and construction planning should be critically reviewed from this standpoint. Adequate health and sanitation facilities should be provided at the construction camps and health check of labourers should be carried out.

(3) Design and construction of the access road should be carefully conducted to minimize landslide and soil erosion along the route. Sufficient funds for maintenance should be allocated.

(4) A relevant monitoring program should be launched for long term observations in the areas of environmental impacts which require long term data collection and subsequent analyses. Such areas may include air pollution, deforestation, population movement and other socio-economical studies. These will provide important informaton for future large scale development projects.

(5) Education of villagers should be considered as one of the prime means towards better management of their potential in adjusting to the new environment to be created by the project. The new environment will include new job opportunities and associated income increase, access road for efficient transportation and better communications.

(6) Impact studies of the access road require a continuous and elaborate scope of works. Linking the mountain communities and those in the plain by the access road will produce valuable data on environmental impact assessment for a future large scale development project. Implementation of a relevant EIA project in connection with the Arun 3 project is recommended.

Table 12–1 List of Actions

Preparation Phase

1. Engineering Studies (Field Activities: Seismic Prospecting, Boring, Survvey)
2. Payment of Compensation
3. Real Compensation
4. Resettling
5. Land Reform and Reform of Land Use
6. Development of Agricultural land & Forest
7. Improvement and Construction of Public Buildings & Installation

Construction Phase

8. Land Use of the Entire Plant
9. Quarries (Stone and Gravel)
10. Timber Cutting
11. Storage and Deposit of Construction Material
12. Improvement or Modification of Existing Road
13. Road-Bed
14. Bridge
15. Protective Measures
16. Parking
17. Transportation by Road, Airplane, Heli
18. Diversion Tunnel
19. Coffer Dam
20. Dam & Spillway
21. Intake & Desilting Basin
22. Power Tunnel
23. Surge Tank
24. Penstock
25. Powerhouse
26. Tailrace
27. Switchyard
28. Erection of Towers and Installation of H/V Line
29. Blasting & Cleaning of Loose Rock
30. Erection of Protective Construction against Rock Falling
31. Protective Wroks for Land Slide
32. Reforestation
33. Landscaping
34. Temporary Accommodation
35. Storage of Construction Materials
36. Supply and Refuse Logistics
37. Construction Workers and Auxiliary Personnel
38. Technician
39. Professional Personnel
40. Service and Administrative Personnel
41. Contact with foreign Workers
42. Contact with Stranger
43. Contact with Science and Technology

Operation Phase

44. Pondage
45. Buildings and Constructions
46. Transmission Line
47. Road
48. Energy Production
49. Permanent Jobs
50. Contract for Maintenance & Repair
51. Taxes (Revenue)
52. New Supply of Services & Consumer Goods
53. Outdoor Activities & Sport
54. Fishing
55. Hiking & Camping
56. Latent Risk
57. Connecting across the Valley
58. Seasonal Variation of Water Level
59. Emergency Drainage
60. Retention of Gravel & Slit
61. Dredging of Pondage
62. Production of Fish
63. Change of Erosion Process
64. Loss of Water
65. Transport of Gravel and Silt
66. Maintenance of Breaks (Pressure Ducts and Power Line)
67. Transport of Goods and Persons
68. Protective Construction

Table 12–2 List of Impact Areas

Non-Biotic Area

1. Air (1.1 Polution, 1.2 Noise Intensity)
2. Water (2.1 Surface Water, 2.2 Underground Water)
3. Soil & Rock (3.1 Cultivated Soil, 3.2 Natural Soil, 3.3 Rawsoil and Rock)
4. Underground
5. Surface (Landscape)
6. Climate (6.1 Sunshine, 6.2 Micro-climate)

Biotic Area

7. Flora and Fauna of the Soil
8. Surface Fauna Terrestrial Ecosystem
9. Plant Formations of Terrestrial Ecosystem (9.1 Forest, 9.2 Glassland)
10. Aquatic Ecosystems (10.1 River & Brook, 10.2 Pondage)

Social Area

11. Population Structure (11.1 Age, 11.2 Profession)
12. Population Movement
13. Health (13.1 Physical Health, 13.2 Psychical Health)
14. Security (14.1 material Security, 14.2 Existential Security, 14.3 Social Security)
15. Aesthetic
16. Freedom of Choice and Decision
17. Communication

Cultural Area

18. Institutions (18.1 School, 18.2 Cultural Sites)
19. Scales of Values
20. Traditions and Customs (20.1 Festival, 20.2 Traditional Land Use, 20.3 Art Craft)
21. Content of Cultural Landscape (21.1 Habit, 21.2 Natural Features to be Protected)

Economic Area

22. Professional Structure
23. Agriculture and Forestry
24. Trade
25. Industry
26. Tourism
27. Public Service
28. Infrastructure (28.1 Roads, 28.2 Public Bldg. + Installations, 28.3 Supply Service)
29. Management of Public Finances

Political Area

30. Interest of Indigenous Population (30.1 Development, 30.2 Administration)
31. External (31.1 Economic, 31.2 Other Public, 31.3 Private)

Table 12–3 Estimation of Compensation

1. Dam and Powerhouse Areas

Facility	Effected Area (ha)	Land Use	Unit Rate (Rs/ha)	Compensation (Rs)
Pondage	23.0 17.00 35.00	B H G	5,000 25,000 25,000	115,000 425,000 875,000
Dam	0.48 1.32	B H	5,000 25,000	2,400 33,000
Intake	1.00	H	25,000	25,000
Surge Tank	0.90	H	25,000	22,500
Powerhouse & Switchyard	2.60	H	25,000	65,000
Total				Rs1,630,400 ($77,640)
				Rs1,562,900 ($74,420)

Notes: B=Sand/Gravel/Boulder
G=Grazing Land
H=Forest

2. Access Road

a. House

- 22 houses @ Rs50,000 = Rs1,100,000 ($52,380)

b. Land

- Level Terrace (T) 24.612ha @ Rs50,000 = Rs1,230,600
- Sloping Terrace (C) 10.976ha @ Rs50,000 = Rs548,800
- Valley Floors including Tars, Foot Slopes, etc (V) 1.260ha @ Rs40,000 = Rs50,400
- Tars, Alluvial Fans, etc. (F) 10.794ha @ Rs50,000 = Rs539,700
- Grazing Land (G) 6.580ha @ Rs25,000 = Rs164,500

- Sand/Gravel/Boulder (B)
  38.668ha @ Rs5,000 = Rs193,340

- Forest (H) 90.384 @ Rs25,000 = Rs2,259,600

Subtotal Rs4,986,940
($237,500)

3. Substation & Transmission Line

a. Substation (Land Acquisition)

- Kathmandu

  20,000m^2 @ Rs900 = Rs18,000,000

- Dhalkiewar

  10,000m^2 @ Rs520 = Rs5,200,000

- Duhubi

  20,000m2 @ Rs520 = Rs10,400,000

Subtotal Rs33,600,000
($1,600,000)

b. Transmission Tower (Land Acquisition)

- Arun 3 Powerhouse Substation (S.S.) to Duhubi S.S. (120km Line Length)

  Land (B) : 0.68ha @ Rs5,000 = Rs340

  Land (H) : 6.345ha @ Rs25,000 = Rs158,625

  Land (V) : 0.338ha @ Rs50,000 = Rs16,900

- Duhubi S.S. to Dhalkiewar S.S. (146km)

  Land (B) : 0.383ha @ Rs5,000 = Rs1,915

  Land (H) : 7.448ha @ Rs25,000 = Rs186,200

  Land (V) : 0.383ha @ Rs50,000 = Rs19,150

Notes: B = Sand/Gravel/.Boulder
H = Forest
V = Cultivated Land

- Dhalkiewar S.S. to Kathmandu S.S. (120km)

Land (B) : 0.068ha @ Rs5,000	= Rs340
Land (H) : 6.345ha @ Rs25,000	= Rs158,625
Land (V) : 0.338ha @ Rs50,000	= Rs16,900
Subtotal	Rs558,995
	($26,600)

RELEVANCE MATRIX FOR ENVIRONMENTAL IMPACT STUDY

IMPACT AREAS

ACTIONS

Preparation Phase

1. Engineering Studies (Field Activities: Seismic Prospecting, Boring, Survey)
2. Payment of Compensation
3. Real Compensation
4. Resettling
5. Land Reform and Reform of Land Use
6. Development of Agricultural land & Forest
7. Improvement and Construction of Public Buildings & Installation

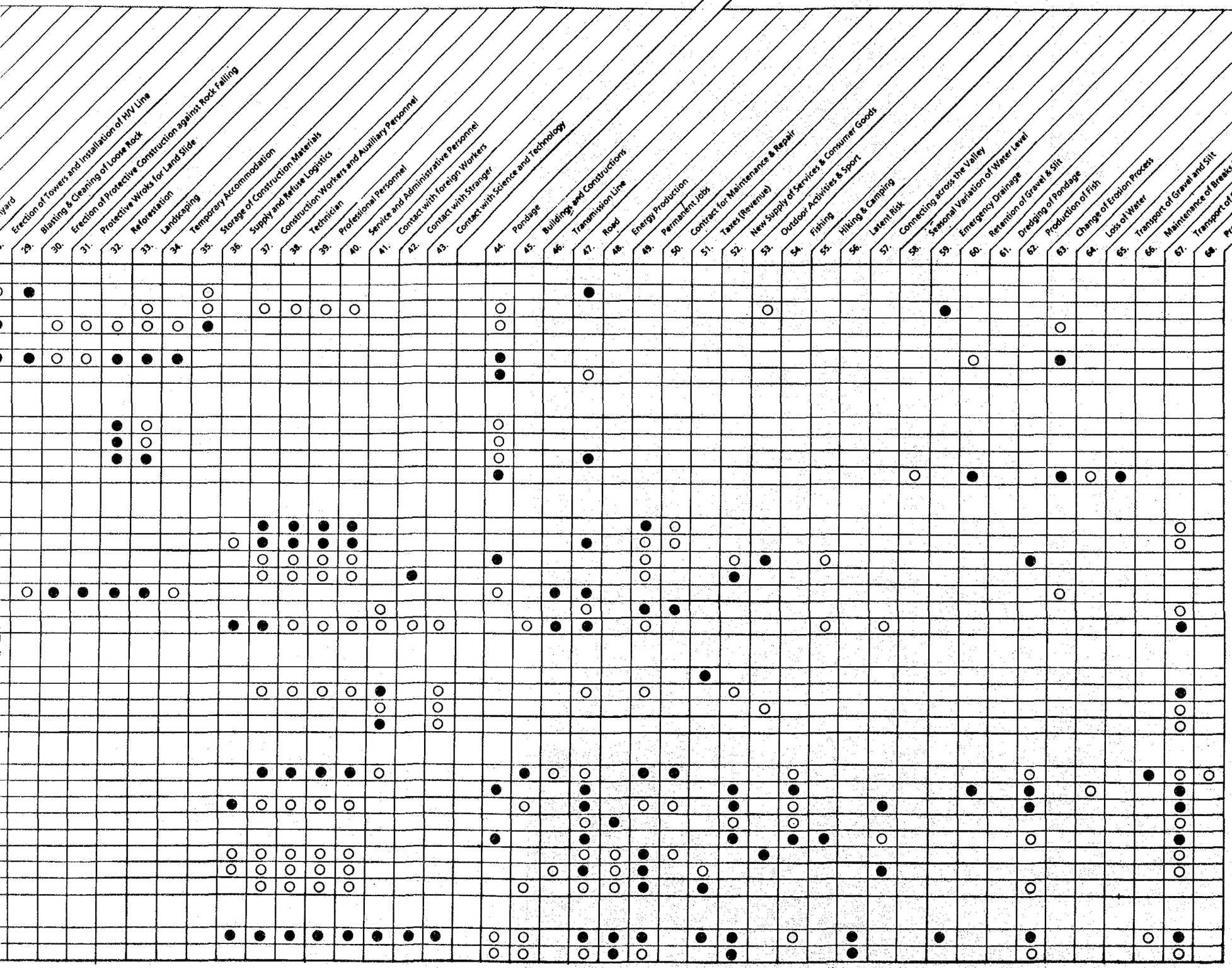
Construction Phase

8. Land Use of the Entire Plant
9. Quarries (Stone and Gravel)
10. Timber Cutting
11. Storage and Deposit of Construction Material
12. Improvement or Modification of Existing Road
13. Road-Bed
14. Bridge
15. Protective Measures
16. Parking
17. Transportation by Road, Airplane, Heli
18. Diversion Tunnel
19. Coffer Dam
20. Dam & Spillway
21. Intake & Desitting Basin
22. Power Tunnel
23. Surge Tank
24. Penstock
25. Powerhouse
26. Tailrace
27. Switchyard
28. Erection of Towers and Installation of H/V Line
29. Blasting & Cleaning of Loose Rock
30. Erection of Protective Construction against Rock Falling
31. Protective Wroks for Land Slide
32. Reforestation
33. Landscaping
34. Temporary Accor
35. Storag
36.

		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.
Non-Biotic Area																																					
1.	Air (1.1 Polution, 1.2 Noise Intensity)	●								○		○	○	●	●	●	●	●	●	●	●	●	●	●	●	●	●	○	○	●						○	
2.	Water (2.1 Surface Water, 2.2 Underground Water)	●								○	○	○	○	●					○	●	●	●	●	●	●	●	●	○						●		○	
3.	Soil & Rock (3.1 Cultivated Soil, 3.2 Natural Soil, 3.3 Rawsoil and Rock)	●								●	○	●	○	●								●	●	●	●	●	●	○	●		○	○	○	○	○	●	
4.	Underground	○																	●			●	●	●	●	●	●										
5.	Surface (Landscape)						●		●	●	●	○		●	○	○	○				●	○	○	○	○	○	○	●	●	●	○	○	●	●	●			
6.	Climate (6.1 Sunshine, 6.2 Micro-climate)																																				
Biotic Area																																					
7.	Flora and Fauna of the Soil	○							●	○				●																		●	○				
8.	Surface Fauna Terrestrial Ecosystem	○							●	○				●																		●	○				
9.	Plant Formations of Terrestrial Ecosystem (9.1 Forest, 9.2 Glassland)								●	○	○			●																		●	●				
10.	Aquatic Ecosystems (10.1 River & Brook, 10.2 Pondage)	○							●										○		●																
Social Area																																					
11.	Population Structure (11.1 Age, 11.2 Profession)	○	○	○	●		○																														
12.	Population Movement	○	○	●	○		○		○								○																				○
13.	Health (13.1 Physical Health, 13.2 Psychical Health)																																				
14.	Security (14.1 material Security, 14.2 Existential Security, 14.3 Social Security)																																				
15.	Aesthetic					○	○		●	●	●			●	●	●	●			●	●			○			○	●	●	○	●	●	●	●	○		
16.	Freedom of Choice and Decision		●	●	●																																
17.	Communication	○															○																				●
Cultural Area																																					
18.	Institutions (18.1 School, 18.2 Cultural Sites)							○																													
19.	Scales of Values		○	○	○																																
20.	Traditions and Customs (20.1 Festival, 20.2 Traditional Land Use, 20.3 Art Craft)																																				
21.	Content of Cultural Landscape (21.1 Habit, 21.2 Natural Features to be Protected)																																				
Economic Area																																					
22.	Professional Structure																																				
23.	Agriculture and Forestry						●																														
24.	Trade						○										●																				●
25.	Industry																																				
26.	Tourism																																				
27.	Public Service		○	○	○	○	○																														○
28.	Infrastructure (28.1 Roads, 28.2 Public Bldg. + Installations, 28.3 Supply Service)					●		○	●												●																○
29.	Management of Public Finances		●	○	○																																
Political Area																																					
30.	Interest of Indigenous Population (30.1 Development, 30.2 Administration)	○	○	○	○	○	○	○		○								○																			●
31.	External (31.1 Economic, 31.2 Other Public, 31.3 Private)																	○																			

Construction Phase

Operation Phase



● : CERTAIN EFFECT IS EXPECTED

○ : EFFECT IS POSSIBLE

Table 12–4 Relevance Matrix for Environmental Impact Study

(Basic Form by S. Aegerter and P. Messerli)

Table 12–5 Environmental Impact Study (1 of 17)

(Basic Form by S. Aegerter and P. Messerli)

Judgement Symbols for Effects
A: Effect is not negligible
B: Effect is negligible
C: Need more data
E: Need long time monitering
F: Already considered in Action No. ___
G: Red flag
"Not Acceptable Alteration"
H: Already considered in Iteration Step No. ___

No. of Activity	Iteration Step	No.	Impact Area	Subdivision of IIA	Effect	Judgement
1 Engineering Studies	I	1	Air	Pollution Noise	Increase Increase	B
		2	Water	Surface Underground	Contamination Contamination	B
		3	Soil & Rock	Cultivated Soi-	Disturbance	B
		4	Underground		Disturbance	B
		7	Flora & Fauna		Disturbance	B
		8	Ecosystem		Disturbance	B
		10	Aquatic Ecosystem	River	Disturbance	B
		11	Population Structure		Change	B
		12	Population Movement		Increase	B
		17	Communi-cation	Possibility	Increase	B
		30	Interest of Population	Development	Increase	A
2 Payment of Compensation	I	11	Population Structure	Profession	Change	B
		12	Population Movement		Increase	B
		16	Freedom of Choice		Increase	B
		19	Scales of Values		Appreciate	B
		27	Public Finances		Increase	B
		29	Public Service		Increase	B
		30	Interest of Population	Economy	Increase	A

1. Air (1.1 Pollution, 1.2 Noise Intensity)
2. Water (2.1 Surface Water, 2.2 Underground Water)
3. Soil & Rock (3.1 Cultivated Soil, 3.2 Natural Soil)
4. Underground
5. Surface (Landscape)
6. Climate (6.1 C
7. Flor
8.

No Iteration For These Activities

Table 12–6 Environmental Impact Study (2 of 17)

(Basic Form by S. Aegerter and P. Messerli)

Judgement Symbols for Effects
- A: Effect is not negligible
- B: Effect is negligible
- C: Need more data
- E: Need long time monitering
- F: Already considered in Action No. ___
- G: Red flag "Not Acceptable Alteration"
- H: Already considered in Iteration Step No. ___

No. of Activity	Iteration Step	No.	Impact Area	Subdivision of I/A	Effect	Judgement
3, 4 Real Compensation Resettling	I	11	Population Structure	Profession	Change	B
		12	Population Movement		Increase	B
		16	Freedom of Choice	Housing Work	Increase	B
		19	Scales of Values		Appreciate	B
		27	Public Service		Increase	B
		29	Public Finance		Increase	B
		30	Interest of Population	Settlement	Increase	A
5 Land Reform	I	15	Aesthetic		Change	B
		27	Public Service		Increase	B
		28	Infrastructure		Improvement	A
		30	Interest of Population		Increase	A
6 Development of Agricultural Land & Forest	I	5	Landscape		Change	B
		11	Population Structure		Change	B
		12	Population Movement		Increase	B
		15	Aesthetic		Change	B
		23	Agriculture & Forestry	Activity	Increase	B
		24	Trade	Activity	Increase	B
		30	Interest of Population	Settlement	Increase	B
7 Improvement & Construction of Public Building		18	Institution	School	Improvement	B
		28	Infrastructure	Public Bldg.	Improvement	B
		30	Interest of Population	Administration	Increase	A

1.	2.	3.	4.	5.	6.	7.	8.
Air (1.1 Polution, 1.2 Noise Intensity)	Water (2.1 Surface Water, 2.2 Underground Water)	Soil & Rock (3.1 Cultivated Soil, 3.2 Natural Soil)	Underground	Surface (Landscape)	Climate (6.1	Flor	

No Iteration For These Activities

Table 12–7 Environmental Impact Study (3 of 17)

(Basic Form by S. Aegerter and P. Messerli)

Judgement Symbols for Effects
- A: Effect is not negligible
- B: Effect is negligible
- C: Need more data
- E: Need long time monitering
- F: Already considered in Action No. ____
- G: Red flag "Not Acceptable Alteration"
- H: Already considered in Iteration Step No. ____

No. of Activity	Iteration Step	No.	Impact Area	Subdivision of I/A	Effect	Judgement
8 Land use of the Entire Plant	I	5	Land-scape		Change	A
		7	Flora & Fauna		Encroachment	B
		8	Surface Fauna		Encroachment	B
		9	Plant Formation		Encroachment	B
		10	Aquatic Ecosystem		Encroachment	B
		12	Population Movement		Increase	B
		15	Aesthetic		Change	B
		28	Infrastructure	Roads	Improvement	B
		30	Interest of Population	Economy	Increase	A
9 Quarries (Stone and Gravel)	I	1	Air	Polution Noise	Increase	B
		2	Water	Surface Water	Polution	B
		3	Soil & Rock	Cultivated Soil	Encroachment	B
		5	Land-scape		Change	B
		7	Flora & Fauna		Encroachment	B
		8	Surface Fauna		Encroachment	B
		9	Plant Formation		Encroachment	B
		15	Aesthetic		Change	B
10 Timber Cutting	I	2	Water	Surface Water	Discharge Change	B
		3	Soil & Rock	Erosion	Increase	B
		5	Land-scape		Change	B
		9	Plant Formation	Forest	Reduction	B
		15	Aesthetic		Change	B
11 Storage of Construction Material	I	1	Air	Noise	Increase	B
		2	Water		Polution	B
		3	Soil & Rock	Cultivated Soil	Encroachment	B
		5	Land-scape		Change	B

No Iteration For These Activities

1. Air (1.1 Polution, 1.2 Noise Intensity)
2. Water (2.1 Surface Water, 2.2 Underground Water)
3. Soil & Rock (3.1 Cultivated Soil, 3.2 Natural So
4. Underground
5. Surface (Landscape)
6. Climate (6.1 C
7. Flor
8.

Table 12–8 Environmental Impact Study (4 of 17)

(Basic Form by S. Aegerter and P. Messerli)

Judgement: Symbols for Effects
A: Effect is not negligible
B: Effect is negligible
C: Need more data
E: Need long time monitering
F: Already considered in Action No. ___
G: Red flag
"Not Acceptable Alteration"
H: Already considered in Iteration
Step No. ___

No. of Activity	Iteration Step	No.	Impact Area	Subdivision of IIA	Effect	Judgement
12 Existing Road	I	1	Air	Noise	Increase	B
		2	Water		Pollution	B
		3	Soil & Rock		Encroachment	B
		5	Infrastructure	Roads	Improvement	A
13 Road-Bed	I	1	Air	Pollution Noise	Increase	B
		2	Water		Pollution	B
		3	Soil & Rock		Encroachment	B
		5	Land-scape		Change	A
		7	Flora & Fauna		Encroachment	B
		8	Surface Fauna		Encroachment	B
		9	Plant Formations		Encroachment	B
		15	Aesthetic		Change	A
14 Bridge	I	1	Air	Pollution Noise	Increase	B
		5	Land-scape		Change	A
		15	Aesthetic		Change	B
15 Protective-Measures	I	1	Air	Pollution Noise	Increase	B
		5	Land-scape		Change	B
		15	Aesthetic		Change	B
16 Parking	I	1	Air	Pollution Noise	Increase	B
		5	Land-scape		Change	B
		15	Aesthetic		Change	B
17 Transportation by Road, Airplane, Heli	I	1	Air	Pollution Noise	Increase Increase	B A
		17	Communi-cation		Improvement	A
		24	Trade	Activity	Increase	A
		12	Population	Migration/ Shuttle	Increase	A
		30	Indigenous Population	Development	Increase	A
		31	External	Economic	Increase	A

No Iteration For These Activities

Table 12–9 Environmental Impact Study (5 of 17)

(Basic Form by S. Aegerter and P. Messerli)

Judgement: Symbols for Effects
A: Effect is not negligible
B: Effect is negligible
C: Need more data
E: Need long time monitering
F: Already considered in Action No. ____
G: Red flag
"Not Acceptable Alteration"
H: Already considered in Iteration
Step No. ____

No. of Activity	Iteration Step	No.	Impact Area	Subdivision of I/A	Effect	Judgement
18 Diversion Tunnel	I	1	Air	Pollution	Increase	B
		2	Water	Underground	Discharge Change	B
		4	Under-ground	Groundwater level	Change	B
19 Coffer Dam	I	1	Air	Pollution Noise	Increase	B
		2	Lano-scape	Surface	Change	B
		15	Aesthetic		Change	B
20 Dam & Spillway	I	1	Air	Pollution Noise	Increase	B
		2	Water	Surface	Change	B
		5	Lano-scape		Change	B
		15	Aesthetic		Change	B
		10	Aquatic Ecosystem		Stoppage	A
21 Intake & Desilting Basin	I	1	Air	Pollution Noise	Increase	B
		2	Water	Underground	Discharge Change	B
		4	Underground	Water Level	Change	A, E
		5	Lano-scape		Change	B
22 Power Tunnel	I	1	Air	Pollution	Increase	B
		2	Water	Underground	Discharge Change	A
		4	Underground	Water Level	Change	A, E
		5	Lano-scape		Change	B
23 Surge Tank	I	1	Air	Pollution Noise	Increase	B
		2	Water	Underground	Discharge Change	B
		4	Underground	Water Level	Change	A, E
		5	Lano-scape		Change	B
		15	Aesthetic		Change	B

1. Air (1.1 Pollution, 1.2 Noise Intensity)
2. Water (2.1 Surface Water, 2.2 Underground Water)
3. Soil & Rock (3.1 Cultivated Soil, 3.2 Natural Soil
4. Underground
5. Surface (Landscape)
6. Climate (6.1
7. Flo

No Iteration For These Activities

Table 12--10 Environmental Impact Study (6 of 17)

(Basic Form by S. Aegerter and P. Messerli)

Judgement Symbols for Effects

A: Effect is not negligible
B: Effect is negligible
C: Need more data
E: Need long time monitering
F: Already considered in Action No. ____
G: Red flag
"Not Acceptable Alteration"
H: Already considered in Iteration Step No. ____

No. of Activity	Iteration Step	No.	Impact Area	Subdivision of I/A	Effect	Judgement
24 Pen-stock	I	1	Air	Polution	Increase	B
		2	Water	Underground	Change	B
		4	Underground	Water Level	Change	A, E
		5	Land-scape		Change	B
25 Powerhouse (Underground)	I	1	Air	Polution Noise	Increase	B
		2	Water	Underground	Dischange Change	A, E
		4	Underground	Water Level	Change	A, E
		5	Surface		Change	B
26 Tailrace	I	1	Air	Polution	Increase	B
		2	Water	Underground	Dischange Change	B
		4	Underground	Water Leve	Change	B
		5	Land-scape		Change	B
		15	Aesthetic		Change	B
27 Switch-yard	I	1	Air	Noise	Increase	B
		3	Soil & Rock	Cultivated Soil	Encroachment	B
		5	Land-scape		Change	A
		15	Aesthetic		Change	B
28 Erection of Towers & H/V Lines	I	1	Air	Noise	Increase	B
		3	Soil & Rock	Cultivated Soil	Encroachment	B
		5	Underground		Change	B
		8	Land-scape	Birds	Collision Hazare	A E
		15	Aesthetic		Change	B
29 Loose Rock	I	1	Air	Noise	Increase	B
		3	Soil & Rock	Rock Stability	Increase	A
		5	Land-scape		Change	B
		15	Aesthetic		Change	B
30 Rock Falling	I	3	Soil & Rock	Rock Stability	Increase	A
		5	Land-scape		Change	B
		15	Aesthetic		Change	B

1. Air (1.1 Polution, 1.2 Noise Intensity)	2. Water (2.1 Surface Water, 2.2 Underground Water)	3. Soil & Rock (3.1 Cultivated Soil, 3.2 Natural So	4. Underground	5. Surface (Landscape)	6. Climate (6.1	7. Flo	8
No Iteration For These Activities							

Table 12–11 Environmental Impact Study (7 of 17)

(Basic Form by S. Aegerter and P. Messerli)

Judgement Symbols for Effects
- A: Effect is not negligible
- B: Effect is negligible
- C: Need more data
- E: Need long time monitering
- F: Already considered in Action No. ___
- G: Red flag "Not Acceptable Alteration"
- H: Already considered in Iteration Step No. ___

No. of Activity	Iteration Step	No.	Impact Area	Subdivision of I/A	Effect	Judgement
31 Land Slide	I	3	Soil & Rock	Slope Stability	Increase	A
		5	Land-scape		Change	B
		15	Aesthetic		Change	B
32 Reforestation (Small Scale)	I	3	Soil & Rock	Erosion	Reduction	B
		5	Land-scaping		Change	B
		7	Flora & Fauna		Improvement	B
		8	Ecosystem		Improvement	B
		9	Plant	Forest	Development	B
		15	Aesthetic		Improvement	B
33 Landscaping (Small Scale)	I	2	Water	Drainage	Improvement	B
		3	Soil & Rock	Cultivated Land	Encroachment	B
		5	Land-scaping		Improvement	B
		7	Flora & Fauna	Formation	Change	B
		8	Ecosystem		Change	B
		9	Plant		Change	B
		15	Aesthetic		Change	B
34 Temporary Accommodation	I	3	Soil & Rock		Encroachment	B
		5	Land-scape		Change	B
		15	Aesthetic		Change	B
35 Construction Materials	I	1	Air	Pollution	Increase	B
		2	Water	Pollution	Change	B
		3	Soil & Rock		Encroachment	B

1.	2.	3.	4.	5.	6.	7.	8.
	Air (1.1 Pollution, 1.2 Noise Intensity)	Water (2.1 Surface Water, 2.2 Underground Water)	Soil & Rock (3.1 Cultivated Soil, 3.2 Natural Soil)	Underground	Surface (Landscape)	Climate (6.1	Flor

No Iteration For These Activities

Table 12–12 Environmental Impact Study (8 of 17)

(Basic Form by S. Aegerter and P. Messerli)

Judgement Symbols for Effects
A: Effect is not negligible
B: Effect is negligible
C: Need more data
E: Need long time monitering
F: Already considered in Action No. ___
G: Red flag
"Not Acceptable Alteration"
H: Already considered in Iteration Step No. ___

No. of Activity	Iteration Step	No.	Impact Area	Subdivision of I/A	Effect	Judgement
36 Supply & Refuse Logistics	I	12	Population Move	Activity	Increase	B
		17	Communi-cation		Improvement	B
		24	Trade		Increase	A
		27	Public Service		Stimulation	A
		28	Infrastructure		Improvement	A
		30	Indigenous Population	Traffic	Increase	A
41 Contract with Foreign Workers	I	16	Freedom of Choice	Sense of Importance	Increase	A
		17	Commu-nication	General Information	Increase	A
		19	Scale of Values		Change	A
		20	Traditions & Customs	Traditional Land Use	Change	B
		21	Cultura Landscape	Habit	Change	B
		22	Professional Structure		Change	B
		30	Indigenous Population	Development	Increase	B

1. Air (1.1 Pollution, 1.2 Noise Intensity)
2. Water (2.1 Surface Water, 2.2 Underground Water)
3. Soil & Rock (3.1 Cultivated Soil, 3.2 Natural Soil
4. Underground
5. Surface (Landscape)
6. Climate (6.1 S
7. Flor
8.

No Iteration For These Activities

Judgement Symbols for Effects
A: Effect is not negligible
B: Effect is negligible
C: Need more data
E: Need long time monitering
F: Already considered in Action No. ___
G: Red flag
"Not Acceptable Alteration"
H: Already considered in Iteration
Step No. ___

No. of Activity	Iteration Step	No.	Impact Area	Subdivision of I/A	Effect	Judgement
Construction Workers & Aux.Personnel / Technician: 37, 38, 39, 40	I	2	Water		Polution	B
		11	Pop. Struc.		Change	A
		12	Pop. Move.		Increase	A
		13	Health	Physical	Disease Increase	A
		14	Security	Social	Change	B
		17	Communi-cation	Possibility	Increase	B
		19	Scales of Value		Change	A
		22	Profeccional Structure		Change	A
		24	Trade		Increase	A
		27	Public Service	Health	Increase	A
		28	Infrastructure	Supply Service	Improvement	A
		29	Pub. Finances		Improvement	A
		30	Indigenous Population	Employment	Increase	A
Professional Personnel / Service and Administrative Personnel	II	11	Pop. Struc.		Change	A
		12	Pop. Move.		Increase	A
		13	Health		Improvement	A, E
		14	Security		Change	A
		16	Freedom		Increase	A
		17	Communi-cation	Possibility	Increase	A
		18	Institution	School	Improvement	A
		19	Scale of Value		Change	A
		21	Tradition		Change	A, E
		22	Prof. Struct.		Change	A
		24	Trade		Increase	A, E
		27	Public Svc.	Health	Improvement	A
		28	Infrastructure	Supply Service	Improvement	A
		29	Pub. Finances		Increase	B
		30	Indig. Pop.	Development	Increase	A
		31	External	Activity	Increase	A

Impact Area

Non-Biotic Area: 1. Air (1.1 Polution, 1.2 Noise Intensity); 2. Water (2.1 Surface Water, 2.2 Underground Water); 3. Soil & Rock (3.1 Cultivated Soil, 3.2 Natural Soil, 3.3 Rawsoil and Rock); 4. Underground; 5. Surface (Landscape); 6. Climate (6.1 Sunshine, 6.2 Micro-climate); 7. Flora and Fauna of the Soil; 8. Surface Fauna Terrestrial Ecosystem; 9. Plant Formations of Terrestrial Ecosystem (9.1 Forest, 9.2 Glassland)

Biotic Area: 10. Aquatic Ecosystems (10.1 River & Brook, 10.2 Pondage)

Social Area: 11. Population Structure (11.1 Age, 11.2 Profession); 12. Population Movement; 13. Health (13.1 Physical Health, 13.2 Psychical Health); 14. Security (14.1 material Security, 14.2 Existential Security, 14.3 Social Security); 15. Aesthetic; 16. Freedom of Choice and Decision; 17. Communication; 18. Institutions (18.1 School, 18.2 Cultural Sites); 19. Scales of Values; 20. Traditions and Customs (20.1 Festival, 20.2 Traditional Land Use, 20.3 Art Craft)

Cultural Area: 21. Content of Cultural Landscape (21.1 Habit, 21.2 Natural Features to be Protected); 22. Professional Structure; 24. Agriculture and Forestry; 25. Trade; 26. Industry; 27. Tourism; 28. Public Service; 29. Infrastructure (28.1 Roads, 28.2 Public Bldg. + Installations, 28.3 Supply

Economic: 30. Management of Public Finances; 31. Interest of Indigenous Population (30.1 Developm; External (31.1 Economic, 31.2 Other Public

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△ one o I/A wil

Table 12–13

Environmental Im

(Basic Form by S. A

Symbols for Effects
not negligible
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re data
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considered in Action No. ___

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considered in Iteration
___

No.	Impact Area	Subdivision of I/A	Effect	Judgement
2	Water		Polution	B
11	Pop. Struc.		Change	A
12	Pop. Move.		Increase	A
13	Health	Physical	Disease Increase	A
14	Security	Social	Change	B
17	Communi-cation	Possibility	Increase	B
19	Scales of Value		Change	A
22	Profeccional Structure		Change	A
24	Trade		Increase	A
27	Public Service	Health	Increase	A
28	Infrastructure	Supply Service	Improvement	A
29	Pub. Finances		Improvement	A
30	Indigenous Population	Employment	Increase	A
11	Pop. Struc.		Change	A
12	Pop. Move.		Increase	A
13	Health		Improvement	A, E
14	Security		Change	A
16	Freedom		Increase	A
17	Communi-cation	Possibility	Increase	A
18	Institution	School	Improvement	A
19	Scale of Value		Change	A
21	Tradition		Change	A, E
22	Prof. Struct		Change	A
24	Trade		Increase	A, E
27	Public Svc.	Health	Improvement	A
28	Infrastructure	Supply Service	Improvement	A
29	Pub. Finances		Increase	B
30	Indig. Pop.	Development	Increase	A
31	External	Activity	Increase	A

Impact Area

Non-Biotic Area: 1. Air (1.1 Polution, 1.2 Noise Intensity); 2. Water (2.1 Surface Water, 2.2 Underground Water); 3. Soil & Rock (3.1 Cultivated Soil, 3.2 Natural Soil, 3.3 Rawsoil and Rock); 4. Underground; 5. Surface (Landscape); 6. Climate (6.1 Sunshine, 6.2 Micro-climate); 7. Flora and Fauna of the Soil; 8. Surface Fauna Terrestrial Ecosystem; 9. Plant Formations of Terrestrial Ecosystem (9.1 Forest, 9.2 Grassland)

Biotic Area: 10. Aquatic Ecosystems (10.1 River & Brook, 10.2 Pondage)

Social Area: 11. Population Structure (11.1 Age, 11.2 Profession); 12. Population Movement; 13. Health (13.1 Physical Health, 13.2 Psychical Health); 14. Security (14.1 material Security, 14.2 Existential Security, 14.3 Social Security); 15. Aesthetic; 16. Freedom of Choice and Decision; 17. Communication; 18. Institutions (18.1 School, 18.2 Cultural Sites); 19. Scales of Values

Cultural Area: 20. Traditions and Customs (20.1 Festival, 20.2 Traditional Land Use, 20.3 Art Craft); 21. Content of Cultural Landscape (21.1 Habit, 21.2 Natural Features to be Protected); 22. Professional Structure

Economic Area: 23. Agriculture and Forestry; 24. Trade; 25. Industry; 26. Tourism; 27. Public Service; 28. Infrastructure (28.1 Roads, 28.2 Public Bldg. + Installations, 28.3 Supply Service); 29. Management of Public Finances

Political Area: 30. Interest of Indigenous Population (30.1 Development, 30.2 Administration); 31. External (31.1 Economic, 31.2 Other Public, 31.3 Private)

▲ at least one subdivision of Impact Area will be altered

△ one or more subdivisions of I/A will possibly be altered

Table 12–13

Environmental Impact Study (9 of 17)

(Basic Form by S. Aegerter and P. Messerli)

Table 12–14 Environmental Impact Study (10 of 17)

(Basic Form by S. Aegerter and P. Messerli)

Judgement Symbols for Effects
A: Effect is not negligible
B: Effect is negligible
C: Need more data
E: Need long time monitering
F: Already considered in Action No. ___
G: Red flag
"Not Acceptable Alteration"
H: Already considered in Iteration Step No. ___

No. of Activity	Iteration Step	No.	Impact Area	Subdivision of I/A	Effect	Judgement
42 Contact with Stranger	I	14	Security	Social Security	Change	B
		17	Communication	General Information	Increase	A
		30	Indigenous Population	Development	Increase	B
43 Contact with Science & Technology	I	17	Communication	General Information	Increase	B
		19	Scale of Values		Change	E
		20	Traditions & Customs		Change	E
		21	Cultural Landscape		Change	E
		30	Indigenous Population	Development	Increase	B
44 Pondage	I	2	Water	Surface	Vegetation	B
		3	Soil & Rock		Encroachment	B
		5	Landscape	Micro-climate	Change	A, E
		6	Climate		Change	B
		7	Flora Fauna		Encroachment	B
		8	Ecosystem	Birds	Attraction	A
		9	Plant		Encroachment	B
		10	Aquatic Ecosystem	Fishing Mosquito	Activity Breeding	A A
		15	Aesthetic		Change	A
		3	Soil & Rock	Potential Landslide	Increase	B
		23	Agriculture & Forestry	Stimulation	Increase	B
		26	Tourism		Increase	E
		30	Indigenous Population	Development	Increase	B
		31	External	Economic	Stimulation	B

1. Air (1.1 Pollution, 1.2 Noise Intensity)
2. Water (2.1 Surface Water, 2.2 Underground Water)
3. Soil & Rock (3.1 Cultivated Soil, 3.2 Natural Soil)
4. Underground
5. Surface (Landscape)
6. Climate (6.1
7. Flor
8.

No Iteration For These Activities

Table 12–15 Environmental Impact Study (11 of 17)

(Basic Form by S. Aegerter and P. Messerli)

Judgement Symbols for Effects
- A: Effect is not negligible
- B: Effect is negligible
- C: Need more data
- E: Need long time monitering
- F: Already considered in Action No. ____
- G: Red flag
  "Not Acceptable Alteration"
- H: Already considered in Iteration Step No. ____

No. of Activity	Iteration Step	No.	Impact Area	Subdivision of I/A	Effect	Judgement
45 Buildings & Constructions	I	17	Communication		increase	B
		22	Professionals		Stimulation	A
		24	Trade	Employment	Stimulation	A
		29	Public Finances	Profit	increase	A
		30	Indigenous Population	Development	increase	A
		31	External	Economic	increase	A
46 Transmission Line	I	15	Aesthetic		Change	A
		17	Communication	Tele-communication	Establishment	A
		22	Professionals		Stimulation	A
		26	Infrastructure		Improvement	A
48 Energy Production	I	25	Industry	Cheap Energy Supply	Possibility	A
		27	Public Service	Demand	increase	A
		28	Infrastructure	Supply Service	Possibility	A
		30	Indigenous Population	Development	increase	A
		31	External	Economic Development	increase	A

1. Air (1.1 Polution, 1.2 Noise Intensity)
2. Water (2.1 Surface Water, 2.2 Underground Water)
3. Soil & Rock (3.1 Cultivated Soil, 3.2 Natural Soil)
4. Underground
5. Surface (Landscape)
6. Climate (6.1 C
7. Flor
8.

No Iteration For These Activities

Judgement Symbols for Effects

- A: Effect is not negligible
- B: Effect is negligible
- C: Need more data
- E: Need long time monitering
- F: Already considered in Action No. ___
- G: Red flag
  "Not Acceptable Alteration"
- H: Already considered in Iteration
  Step No. ___

No. of Activity	Iteration Step	No.	Impact Area	Subdivision of I/A	Effect	Judgement
47	I	1	Air	Polut. & Nois.	Increase	E
		6	Climate	Micro-Clim.	Change	E
		9	Forest	Area	Reduction	B
		12	Pop. Move.	Migr. & Shut.	Increase	A
		15	Aesthetic		Change	A
		16	Freedom	Work	Increase	A
		17	Commun.		Increase	A
		19	Values		Change	A
		22	Prof. Stru.		Change	A
		23	Agr. & Fors.	Activity	Increase	A
		24	Trade		Increase	A
		25	Industry	New Opport.	Increase	A
		26	Tourism		Increase	A
		27	Pub. Serv.		Increase	A
		28	Infra.		Improve.	A
		29	Manage		Increase	A
		30	Interest	Development	Increase	A
		31	External	Economy	Increase	A
	II	8	Ecosystem		Change	E
		9	Plant		Change	E
		11	Pop. Str.		Change	E
		12	Pop. Mov.		Change	E
		13	Health		Improve.	E
		14	Security		Improve	E
		15	Aethetic		Change	A
		16	Freedom		Increase	A
		17	Commun.		Improve	A
		18	Institution		Improve	A
		19	Scal. Val.		Change	E
		20	Tradition		Change	E
		21	Culture		Change	E
		22	Prof. Str.		Versatality	A
		23	Agr. & Fore.		Increase	E
		24	Trade		Increase	E

Road

Impact Area

Non-Biotic Area | Biotic Area | Social Area | Cultural Area | Economic Ar

1. Air (1.1 Polution, 1.2 Noise Intensity)
2. Water (2.1 Surface Water, 2.2 Underground Water)
3. Soil & Rock (3.1 Cultivated Soil, 3.2 Natural Soil, 3.3 Rawsoil and Rock)
4. Underground
5. Surface (Landscape)
6. Climate (6.1 Sunshine, 6.2 Micro-climate)
7. Flora and Fauna of the Soil
8. Surface Fauna Terrestrial Ecosystem
9. Plant Formations of Terrestrial Ecosystem (9.1 Forest, 9.2 Grassland)
10. Aquatic Ecosystems (10.1 River & Brook, 10.2 Pondage)
11. Population Structure (11.1 Age, 11.2 Profession)
12. Population Movement
13. Health (13.1 Physical Health, 13.2 Psychical Health)
14. Security (14.1 material Security, 14.2 Existential Security, 14.3 Social Security)
15. Aesthetic
16. Freedom of Choice and Decision
17. Communication
18. Institutions (18.1 School, 18.2 Cultural Sites)
19. Scales of Values
20. Traditions and Customs (20.1 Festival, 20.2 Traditional Land Use, 20.3 Art Craft)
21. Content of Cultural Landscape (21.1 Habit, 21.2 Natural Features to be Protected)
22. Professional Structure
23. Agriculture and Forestry
24. Trade
25. Industry
26. Tourism
27. Public Service
28. Infrastructure (28.1 Roads, 28.2 Public Bldg. + Installations, 28.3 Supply Serv
29. Management of Public Finances
30. Interest of Indigenous Population (30.1 Development, 3
31. External (31.1 Economic, 31.2 Other Public, 31

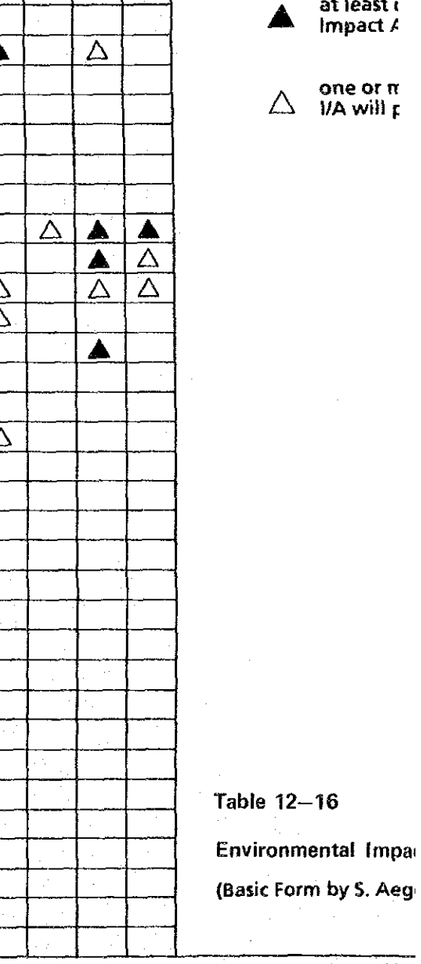

Table 12–16

Environmental Impa

(Basic Form by S. Aeg

t Symbols for Effects
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Acceptable Alteration"
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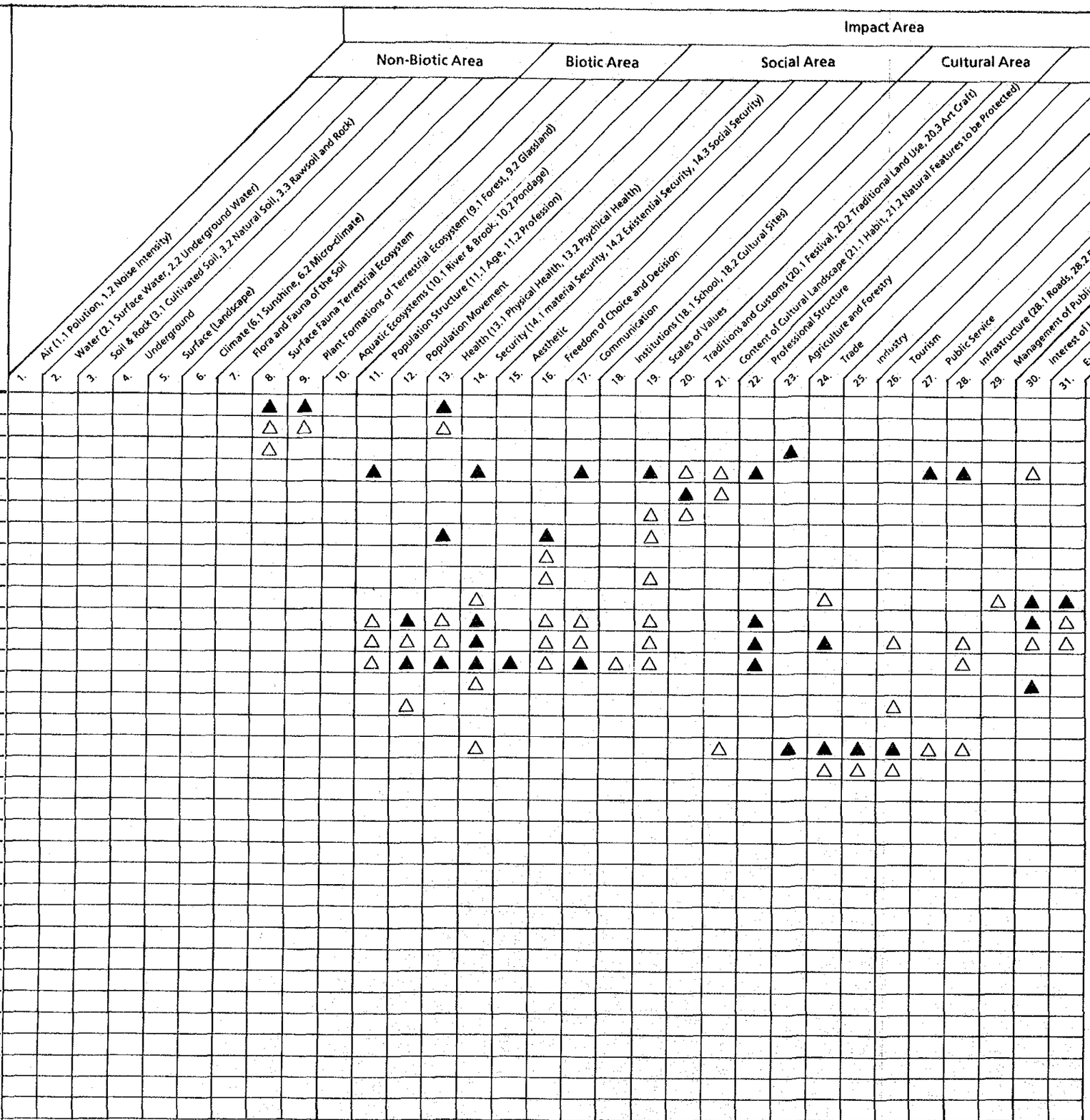
on	No.	Impact Area	Subdivision of I/A	Effect	Judgement
	1	Air	Polut. & Nois.	Increase	E
	6	Climate	Micro-Clim.	Change	E
	9	Forest	Area	Reduction	B
	12	Pop. Move.	Migr. & Shut.	Increase	A
	15	Aesthetic		Change	A
	16	Freedom	Work	Increase	A
	17	Commun.		Increase	A
	19	Values		Change	A
	22	Prof. Stru.		Change	A
	23	Agr. & Fors.	Activity	Increase	A
	24	Trade		Increase	A
	25	Industry	New Opport.	Increase	A
	26	Tourism		Increase	A
	27	Pub. Serv.		Increase	A
	28	Infra.		Improve.	A
	29	Manage		Increase	A
	30	Interest	Development	Increase	A
	31	External	Economy	Increase	A
	8	Ecosystem		Change	E
	9	Plant		Change	E
	11	Pop. Str.		Change	E
	12	Pop. Mov.		Change	E
	13	Health		Improve.	E
	14	Security		Improve	E
	15	Aethetic		Change	A
	16	Freedom		Increase	A
	17	Commun.		Improve	A
	18	Institution		Improve	A
	19	Scal. Val.		Change	E
	20	Tradition		Change	E
	21	Culture		Change	E
	22	Prof. Str.		Versatality	A
	23	Agr. & Fore.		Increase	E
	24	Trade		Increase	E



▲ at least one subdivision of Impact Area will be altered

△ one or more subdivisions of I/A will possibly be altered

Table 12–16

Environmental Impact Study (12 of 17)

(Basic Form by S. Aegerter and P. Messerli)

Table 12–17 Environmental Impact Study (13 of 17)

(Basic Form by S. Aegerter and P. Messerli)

Judgement Symbols for Effects
A: Effect is not negligible
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C: Need more data
E: Need long time monitering
F: Already considered in Action No. ___
G: Red flag
"Not Acceptable Alteration"
H: Already considered in Iteration Step No. ___ .

No. of Activity	Iteration Step	No.	Impact Area	Subdivision of II/A	Effect	Judgement
47	II	25	Industry		Increase	E
		26	Tourism		Increase	E
		27	Pub. Serv.		Increase	A
		28	Infra. Str.		Improve.	A
		29	Pub. Fin.		Increase	A
		30	Ind. Pop.	Diversic.	Increase	A
		31	Externai	Economy	Increase	A
49 Permanent Jobs	I	11	Popul. Str.	Profession	Creation	A
		12	Popul. Mov.		Increase	A
		13	Healtr		Improvement	A
		14	Security	Material	Improvement	A
		16	Freedom	Job	Increase	A
		17	Commu-nication		Improvement	A
		19	Scales of Values		Change	A E
		22	Profess. Struct.	Versatality	Increase	A
		24	Trade	Activity	Increase	A
		27	Public Service	Requirement	Increase	A
		28	Infrastructure	Subdiv Service	Increase	A
		29	Public Finances	Profit	Increase	A
		30	Indigenous Population	Administration	Increase	A
		31	Externa.	Private interest	Increase	A
50 Contract for maintenance & repair	I	11	Population Structure	New Profession	Increase	A
		12	Population Movement		Stimulation	B
		16	Freedom of Choice		Increase	B
		22	Professional Structure		Change	A
		24	Trade		Stimulation	A
		27	Public Service		Increase	A

No Iteration For These Activities

1. Air (1.1 Pollution, 1.2 Noise Intensity)
2. Water (2.1 Surface Water, 2.2 Underground Water)
3. Soil & Rock (3.1 Cultivated Soil, 3.2 Natural So
4. Underground
5. Surface (Landscape)
6. Climate (6.1
7. Flo

Table 12–18 Environmental Impact Study (14 of 17)

(Basic Form by S. Aegerter and P. Messerli)

Judgement Symbols for Effects
A: Effect is not negligible
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F: Already considered in Action No. ____
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"Not Acceptable Alteration"
H: Already considered in Iteration Step No. ____

No. of Activity	Iteration Step	No.	Impact Area	Subdivision of I/A	Effect	Judgement
51 taxes (revenue)	I	18	Institutions	Improvement	Possibility	A
		28	Infrastructure	General Improvement	Possibility	A
		29	Public Finances	Profit	Increase	A
		30	Indigenous Population	Administration	Increase	A
52 New Supply of Services & Consumer Goods	I	13	Health	Physical	Improvement	A
		14	Security	Material	Increase	A
		19	Scales of Values		Change	A
		23	Agriculture & Forestry	Fertilizer	Production Increase	A
		24	Trade	Activity	Increase	A
		25	Industry	New	Possibility	C
		26	Tourism		Possibility	A
		30	Indigenous Population	Economic Development	Increase	A
		31	External	Economic Interest	Increase	A
53 Outdoor Activities & Sport	I	2	Water	Surface	Pollution	B
		13	Health	Physical	Improvement	B
		20	Tradition & Customs		Change	B E
		26	Tourism		Stimulation	A E
54 Fishing	I	22	Professionals		Versatility	B
		23	Agriculture	Production	Increase	C
		24	Trade		Increase	C
		25	Industry		Stimulation	B
		26	Tourism		Stimulation	A
		30	Indigenous Population	Development	Increase	B
55 Hiking & Camping	I	13	Health	Physical	Improvement	B
		17	Communication		Improvement	B
		26	Tourism		Stimulation	A

1. Air (1.1 Pollution, 1.2 Noise Intensity)
2. Water (2.1 Surface Water, 2.2 Underground Water)
3. Soil & Rock (3.1 Cultivated Soil, 3.2 Natural So
4. Underground
5. Surface (Landscape)
6. Climate (6.1
7. Flo

No Iteration For These Activities

Table 12–19 Environmental Impact Study (15 of 17)

(Basic Form by S. Aegerter and P. Messerli)

Judgement Symbols for Effects
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F: Already considered in Action No. ____
G: Red flag
"Not Acceptable Alteration"
H: Already considered in Iteration Step No. ____

No. of Activity	Iteration Step	No.	Impact Area	Subdivision of I/A	Effect	Judgement
56 Latent Risk	1	30	Interest Indigenous Population	Awareness of Risk	Increase	A
		31	External	Public Safety	Increase of Awareness	A
		31	External	Investment Early Warning	Increase of Awareness	A
57 Connecting across the Valley	1	17	Communication		Improvement	B
		24	Trade		Stimulation	A
		26	Tourism		Stimulation	A
		28	Infrastructure	Supply Service	Improvement	A
58 Water Level	1	10	Aquatic Ecosystem	Pondage	Adversity	B
59 Emergency Drainage	1	2	Water	Surface Water	Flooding	B
		30	Indigenous Population	Safety Awareness	Increase	A
60 Retention Gravel & Silt	1	10	Aquatic Ecosystem	River Bed	Lowering at Downstream	B
		5	Landscape		Detrioration	B
61	1	Dredging of Pondage (Not Expected				
62 Production of Fish	1	22	Professional Structure	Fish Culturing	New Entry	A
		23	Agriculture & Forestry	Income Increase	Stimulation	B
		24	Trade		Stimulation	B
		26	Tourism		Promotion	B
		29	Public Finances	Needs	Increase	B
		30	Indigenous Population	Creation of Job	Increase	B
		13	Health	Nutritious Level	Increase	B

1. Air (1.1 Pollution, 1.2 Noise Intensity)
2. Water (2.1 Surface Water, 2.2 Underground Water)
3. Soil & Rock (3.1 Cultivated Soil, 3.2 Natural So
4. Underground
5. Surface (Landscape)
6. Climate (6.1 C
7. Flor
8.

No Iteration For These Activities

Table 12–20 Environmental Impact Study (16 of 17)

(Basic Form by S. Aegerter and P. Messerli)

Judgement Symbols for Effects
- A: Effect is not negligible
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- E: Need long time monitering
- F: Already considered in Action No. ___
- G: Red flag "Not Acceptable Alteration"
- H: Already considered in Iteration Step No. ___

No. of Activity	Iteration Step	No.	Impact Area	Subdivision of IA	Effect	Judgement
63 Change of Erosion Process	I	3	Soil & Rock	Cultivated Soil	Loosing	B
		10	Ecosystem	River	Silting (Upstream)	B
			Ecosystem	River	Scouring (Downstream)	B
		15	Aesthetic		Change	B
64 Loss of Water	I	10	Aquatic Ecosystem	Downstream (Dam to Pat)	Alteration	B
		23	Agriculture & Forestry	Downstream Fishing	Change	B
65 Gravel & Silt	I	10	Aquatic Ecosystem	Pondage	Silting	A E
66 Maintenance of Breaks	I	22	Professional Structure	New Job	Creation	A
		30	Indigenous Population	Interest for Job	Increase	A
68 Protective Construction	I	22	Professional Structure	Creation of Job	Increase	A

No Iteration For These Activities

1. Air (1.1 Pollution, 1.2 Noise Intensity)
2. Water (2.1 Surface Water, 2.2 Underground Water)
3. Soil & Rock (3.1 Cultivated Soil, 3.2 Natural Soil
4. Underground
5. Surface (Landscape)
6. Climate (6.1
7. Flor

Table 12–21 Environmental Impact Study (17 of 17)

(Basic Form by S. Aegerter and P. Messerli)

Judgement Symbols for Effects
- A: Effect is not negligible
- B: Effect is negligible
- C: Need more data
- E: Need long time monitering
- F: Already considered in Action No. ___
- G: Red flag "Not Acceptable Alteration"
- H: Already considered in Iteration Step No. ___

No. of Activity	Iteration Step	No.	Impact Area	Subdivision of I/A	Effect	Judgement
67 Transport of Goods and Persons	I	11	Population	Profession	Creation	A
		12	Movement		Increase	A
		16	Freedom		Increase	A
		17	Communication		Improvement	A
		19	Values		Versatilization	A
		20	Traditions	Art Craft	Demand	A
		21	Culture	Habit	Outside Influence	A
		22	Profession		Versatilization	A
		23	Agriculture	Availability of Fertilizer	Production Increase	E
		24	Trade		Stimulation	A
		25	Industry		Stimulation	A
		26	Tourism		Stimulation	A
		27	Public Service	Employment	Increase	A
		28	Infrastructure	Supply Service	Increase	A
		30	Indigenous Population	Development	Increase	A
		31	External	Economic	Increase	A

1. Air (1.1 Polution, 1.2 Noise Intensity)
2. Water (2.1 Surface Water, 2.2 Underground Water)
3. Soil & Rock (3.1 Cultivated Soil, 3.2 Natural Soil)
4. Underground
5. Surface (Landscape)
6. Climate (6.1 C
7. Flor
8.

No Iteration For These Activities