VOL. II CHAPTER 8

ENVIRONMENTAL IMPACT ASSESMENT

CHAPTER 8 ENVIRONMENTAL IMPACT ASSESSMENT

8.1 Assessment Items

The three micro-hydro sites chosen for development were visited and assessed for probable environmental impact caused by the construction and operation of the micro-hydro systems. In assessing the environmental impacts the following specific areas were considered regarding the direct impact of the project both locally and in the area surrounding the sites.

(1) Direct Environmental Impacts

1. Land wildlife. This considers the aspect of changes due to the project in food availability, water availability and habitat for birds and terrestrial animals in the impacted area.

2. River wildlife. Fish and amphibious animals may be impacted through changes in water flow levels, water flow regulation, physical impediments to movement up or down stream, changes in turbidity levels and water temperature and such impacts may affect the total ecology of the stream area through the food chain.

3. Ground water. The depth at which water can be found along the stream bed will change as the flow rate of the stream changes. This will impact vegetation in the area as to speciation, rate of growth and density.

4. Geological. Construction of civil works and changes in water flow rates and locations can change the probability for landslides and other local geological changes.

5. River bed modification. Changes in flow rates and in the regulation of its flow can effect the movement of rock and earth by the stream and can change the structure and size of the river bed.

6. Communicable diseases. Human and animal diseases borne by water or insects requiring a water habitat which has certain conditions of flow and temperature may have infection rates changed due to the presence of a nearby hydro project.

7. Portable water availability. If water is removed from the stream for drinking and cooking purposes below the intake structure of the hydro facility and above the outfall from the power house, both the quality and quantity of water available for use may be changed.

8. Agriculture. Agricultural processes which have dependence on irrigation or periodic flooding of streams may be impacted through reduced stream flow and increased stream regulation.

9. Air pollution. Where the hydro system is replacing other energy systems, changes in the level of air pollution may be found. In particular the replacement of kerosene for lighting by electricity can reduce the level of air pollution in homes.

10. Water and ground pollution. The replacement of battery energy or diesel generation by hydro can change the amount of water and ground pollution in the area.

11. Micro-climate. Changes in the flow of rivers can have an impact on local temperature and humidity which in turn can effect local wildlife and human activity.

(2) Indirect Environmental Impacts

Changes in the way people act and what people do can have a marked effect on the local environment. Changes in life style, culture and in the form and scope of economic development resulting from the presence of electricity will probably ultimately have much larger effects on the environment than the installation of the system itself. Items which were considered regarding indirect environmental effects were:

1. Culture. The presence of electricity and associated mass communication devices can put heavy pressure on traditional local culture to change to a more national or international form. Changes in social structure may result due to the presence of village managed hydro electricity and the increased importance to the village of technically trained young people. The cultural changes may dramatically modify the land use patterns in the valley and may, in the very long term, produce large differences in the environment.

2. Economic development. The presence of a small hydro system can change the economic conditions of the recipient village through increased production of existing products and the creation of new products for the village. This increased economic activity can have significant environmental effects due to changes in the harvesting Patterns of agricultural or forestry products, changes in domestic animal populations and changes in the village use of manufactures goods and materials.

Other environmental impacts related only to the impoundment of water as energy storage were not considered here since all sites contemplated are "run-of-the-river" types with flow barriers only to divert sufficient water for the hydro system. There will be no attempt to impound water for later generation purposes.

8.2 Adardour Scheme

(1) General Description

The Adardour site was visited on 16 May, 1997. A 26kW output will require $0.11 m^3$ of water delivered with a head of 37 meters to meet maximum projected demand.

Firm discharge of $0.043 m^3/m$ (90% of annual discharge) is available for 329 days out of the year, and ultimate generating discharge is adjusted on the basis of actual power demand vis a vis river discharge. Also, since minimum discharge (discharge available for 355 days of the year) is $0.031 m^3/s$, it is anticipated that power demand may not be met for 26~36 days out of the year. During such period, it will be necessary for households to use the conventional butane gas, candles, etc. for lighting purposes.

The system construction will include the construction of a water diversion dam with intake chamber and gates, a 685 km head race, a head tank and penstock assembly. The proposed penstock is 300 mm in diameter and will have a length of 77 meters. The turbine, generator and switch gear will be housed in a building of approximately 12 m^2 in area. The power will be transmitted at 3.3 kV, three phase, for a distance of approximately 1.6 km and local distribution to houses will require about 2.7 km of distribution line.

At the intake site, the minimum flow is estimated to be well below the system requirements, therefore the hydro system can not be operated at full power through out the year. The reduction in stream flow due to the operation of the hydro plant will only appear between the intake and the location of the outfall from the power house since the water is exhausted into the same stream as its intake.

At the time of the site visit, several small streams join the main stream between the intake and outfall sites, therefore the percentage of stream flow reduction will be smaller moving downstream form the intake if the small streams continue to flow in the driest season.

The head race will follow the contour on the steep slope to the right of the stream when facing down stream, This path is almost continuous barren rock and most of the agricultural land is on the opposite side of the stream, The construction of the head race cannot be constructed by hand in a reasonable time period and blasting will be required for some sections.

The power house will not be located on land which is presently in use for agriculture. The penstock will not cross agricultural land but will pass over rock and rough grassland.

(2) Direct Environmental Impact Assessment Checklist

1) Land wildlife. Since the area has been in continuous cultivation for hundreds of years, local wildlife has accommodated to the presence of man and his works, The construction of the micro-hydro facility can be expected

to drive local land wildlife up or down the stream temporarily but there will be no significant change in habitats due to the presence of the facility and no long term impact on local land wildlife.

2) River wildlife, There are no fish, only water insects and small amphibians have been seen to inhabit the stream at the site. Since the system will be controlled such that significant flow will remain in the stream at all times for the purposes of irrigation, and the stream naturally fluctuates from very low flow to very large flow, these small aquatic life forms are not likely to face a significant change in their environment.

3) Ground water. The ground water level could be affected along the 1.1 km area between the intake and the outfall of the hydro facility. This could affect vegetation in that area. However, the entire area is under irrigation and since irrigation water will have strong priority over the power production water, moderate changes in the flow in the stream bed itself are not likely to cause significant lowering of the ground water in the adjacent areas.

4) Geological.

The envisioned headrace with total length of 685 m will for roughly half its length comprise rehabilitated irrigation canal. As the new portion of the canal alignment passes along the side of mountain, parts of this will be through rock. In the case of soft rock, excavation by hand will be possible. However, in the case of hard rock, it will be necessary to use small explosive charges. At such time, it is essential that adequate measures be taken to protect the local population and prevent rock fall at the construction site. Scale of explosive works is to be kept to the minimum possible with extreme care to prevention of future rock fall. Minimizing of explosive charges will also prevent adverse impact to the surrounding environment.

5) River bed modification, The diversion structure will be approximately one meter high and will be comparable in size to many of the existing rock diversion structures already in place along the river for irrigation water diversion. This additional structure may have a short term effect on rock transport during flooding , but not in the long term. Such short term effects will have no geological significance in the stream bed, The change in water flow due to the presence of the hydro system is orders of magnitude smaller than the natural fluctuations in the stream and are not likely to have noticeable effect on the river bed structure.

6) Communicable disease. Mosquito borne diseases are not present in this high altitude, cold winter site. Water borne diseases are limited to infections transported form human habitation upstream There will be no ponding or areas of water which provide new types of habitat for insect borne or water borne diseases, therefore there is not likely to be any change in the type or

frequency of diseases due to the presence of the hydro facility.

7) Potable water availability, There are no areas between the intake and outfall sites which are commonly used for the supply of potable water. The hydro facility will not affect the quality of the water, therefore no impact at the village or downstream will occur.

8) Agriculture. The village leadership has clearly stated that irrigation water has strong priority over energy production. Should stream flow fall to the point where there is insufficient water for both activities, water will first be diverted for irrigation. It is likely that except in the most severe low flow conditions, that the power plant will be operated a few hours each evening thereby making all the stream water available for irrigation except for hose hours. In very dry conditions, the plant will be shut down and all water used for irrigation.

9) Air pollution, By converting from kerosene lights to electric lights, a reduction in pollution in homes will occur.

10) Water and ground pollution, No change in water or ground pollution is anticipated after the initial construction phase is completed, During the construction phase, non-polluting sanitation areas for the workers should be provided to prevent increased pollution of the stream which will effect downstream villages.

11) Micro-climate. Since the change in stream flow is limited to less than one kilometer of its length and irrigation will continue along that port of the stream, no change in micro-climate is likely.

(3) Indirect Environmental Effects Check List

1) Culture, The use of television in these villages is very limited due to the need to frequently carry a car battery many kilometers by donkey for charging, It can be expected that the presence of television in the village will dramatically increase with the availability of a local electricity supply. Based on the experience in other countries, the presence of electric lights can be expected to increase the quality of education and the amount of production of local handicrafts. It also may shift the social activities further into the evening hours. There is no evidence in other developing countries to show that the presence of electricity reduces urban drift by young people, Indeed, there is evidence that it is increased through the contact with the outside world afforded by TV and through the increased economic pressure on families to get money to purchase electrical appliances, There is evidence, however, that the presence of electricity increase the likelihood that people will ultimately return to the village, particularly retired government workers, This return of skilled, relatively wealthy older persons has been seen to significantly increase economic activity in rural villages and to stabilize village populations for the long term.

2) Economic development. Village leadership indicated that there were no plans for the economic use of the power form the small hydro facility in the near term. There may be some economic development through increased production of handicraft goods by that is not likely to have a great effect on the overall village economy.

(4) Conclusions from the Environmental Impact Assessment

Since the Adardour site is located at the extreme upper reaches of the river at some distance from the nearest trunk road and in rugged terrain, it is anticipated that some difficulty in transport of material and equipment for construction will be encountered. However, site reconnaissance indicated that no significant impact to the environment would occur as a result of scheme implementation. In the long term, the change in village life style and economic development is anticipated to have a favorable impact on living standards.

8.3 Arg Scheme

(1) General Description

The Arg site will make use of maximum generating discharge of 0.18 m^3/s and head of 25 m to produce a maximum output of 30 kW. Power supply will be to 3 villages.

Firm discharge of 0.097 m^3/m (90% of annual discharge) is available for 329 days out of the year, and ultimate generating discharge is adjusted on the basis of actual power demand vis a vis river discharge. Also, since minimum discharge (discharge available for 355 days of the year) is 0.068 m^3/s, it is anticipated that power demand may not be met for 26~36 days out of the year as in the case of the Adardour scheme. During such period, it will be necessary for households to use the conventional butane gas, candles, etc. for lighting purposes.

The system requires the construction of a concrete water diversion dam with a concrete intake chamber and steel flow gates, a 1,175 km head race of rock and cement, a concrete head tank and a steel penstock assembly. The head race will be constructed along the contour occupied by an existing irrigation channel. The project will restore the channel and increase its water carrying capacity so it can carry adequate water both for irrigation and for the power system. The proposed penstock if 350 mm in diameter and will have a length of 84 meters. The turbine, generator and switch gear will be housed in a building of approximately 12 m^2 in area The power will be transmitted at 3.3 kV, three phase, for a distance of approximately 4.4 km using wooden poles and local distribution to houses will require about 3.5 km of distribution line.

At the intake site, the minimum stream flow is estimated to be well below the system requirements, therefor the hydro system can not be operated at full power throughout the year. The reduction in stream flow due to the operation of the hydro plant will only appear between the intake and the location of the outfall from the power houses since the water is exhausted into the same stream as its intake.

The head race will be an improvement of an existing irrigation channel, much of which has been out of service for some time.

At the time of the site visit, several small streams join the main stream between the intake and outfall sites, therefore the percentage of stream flow reduction will be smaller moving downstream from the intake if the small streams continue to flow in the driest season.

Powerhouse and penstock route alignment are located in privately cultivated area which will require land acquisition from the current owners in order to implement the scheme.

(2) Environmental Assessment Checklist, Direct Effects

1) Land wildlife. Since the area has been in continuous, intensive cultivation for hundreds of years, local wildlife has accommodated to the presence of man and his works. The construction of the micro-hydro facility can be expected to drive local land wildlife up or down the stream temporarily but there will be no significant change in habitats due to the presence of the facility and no long term impact on local land wildlife.

2) River wildlife. There are no fish. Only water insects and small amphibians have been seen to inhabit the stream at the site. Since (a) the system will be controlled such that significant flow will remain in the stream at all times for the purposes of irrigation, and (b) the stream naturally swings from very low flow to very large flow, these small aquatic life forms are not likely to face a significant change in their environment.

3) Ground water. The ground water level could be affected along the 1.3 km area between the intake and the outfall of the hydro facility. This could affect vegetation in that are. However, the entire area is under irrigation and since irrigation water will have strong priority over the power production water, moderate changes in the flow in the stream bed itself are not likely to cause significant lowering of the ground water in the adjacent areas.

4) Geological. The left bank alignment of the headrace canal extends for 1,175 m, almost all of which will comprise rehabilitation and widening of existing irrigation canal. This rehabilitation work will be done manually, with no impact to the surrounding area.

5) River bed modification. The diversion structure will be approximately one meter high and will be comparable in size to many of the existing rock diversion structures already in place along the river for irrigation water diversion. This additional structure may have a short term effect on rock

transport during flooding, but not in the long term. Such short term effects will have no geological significance in the stream bed. The change in water flow due to the presence of the hydro system is orders of magnitude smaller than the natural fluctuations in the stream and are not likely to have noticeable effect on the river bed structure.

6) Communicable diseases. Mosquito borne diseases are not in this high altitude, cold winter site. Water borne diseases are limited to infections transported from human habitation upstream. There will be no pond or areas of water which provide new types of habitat for insect borne or water borne diseases, therefor there is not likely to be any change in the type or frequency of diseases due to the presence of the hydro facility.

7) Potable water availability. There are no areas between the intake and outfall sites which are commonly used for the supply of potable water. The hydro facility will not affect the quality of the water, therefore no impact at the village or downstream will occur.

8) Agriculture. The village leadership has clearly stated that irrigation water has strong priority over energy production. Should stream flow fall to the point where there is insufficient water for both activities, water will first be diverted for irrigation. It is likely that except in the most severe low flow conditions, that the power plant will be operated a few hours each evening thereby making all the stream water available for irrigation except for those irrigation. The power house is expected to be constructed on agricultural land, but the area is small and the effect on village agriculture not significant.

9) Air pollution. By converting from kerosene lights to electric lights, a small reduction in pollution within homes will occur.

10) Water and ground pollution. No change in water or ground pollution is anticipated after the initial construction phase is completed. During the construction phase, non-polluting sanitation areas for the workers should be provided to prevent increased pollution of the stream which will effect downstream villages.

11) Micro-climate. Since the change in stream flow is limited to less than one kilometer of its length and irrigation will continue along that part of the stream, no change in micro-climate is likely .

(3) Environmental Assessment Checklist, Indirect Effects

1) Culture. The use of television in these villages is very limited due to the need to frequently carry a car battery many kilometers by donkey for charging. It can be expected that the presence of television in the village will dramatically increase with the availability of a local electricity supply. Based on the experience in other countries, the presence of electric lights

can be expected to increase the quality of education and the amount of production of local handicrafts. It also may shift the social activities further into the evening hours. There is no evidence in other developing countries to show that the presence of electricity reduces urban drift by young people. Indeed, there is evidence that it is increased through the contact with the outside world afforded by TV and through the increased economic pressure on families to get money to purchase electrical appliances. There is evidence, however, that the presence of electricity increases the likelihood that people will ultimately return to the village, particularly retires government workers. This return of skilled, relatively wealthy older persons has been seen to significantly increase economic activity in rural villages and to stabilize village populations for the long term.

2) Economic development. There is the intent voiced by village leadership to establish a small wood working industry to take advantage of the economic possibilities of electricity supply. The actual type of production is not yet in focus for the village but if the intent is to use power tools to make furniture or other relatively large wooden items and if local trees are to be the source of wood, environmental problems could result. Should this industry significantly increase the use of local wood, it could have a seriously detrimental effect on the local forestation which is very limited in scope and very slow to recover.

(4) Conclusions from the Environmental Impact Assessment

The Arg scheme site is located 12 km upstream of Asni Commune Rurale, and has relatively good access compared with the Adardour site. Construction of generating facilities is not anticipated to have any significant impact on the environment. In the long term, the change in village life style and economic development is anticipated to have a favorable impact on living standards.

8.4 Tidsi Scheme

(1) General Description

The Tidsi site will make use of maximum generating discharge of 0.15 m^3/s and head of 16 m to produce a maximum output of 15 kW. Power supply will be to 2 villages.

Firm discharge of 0.044 m^3/m (90% of annual discharge) is available for 329 days out of the year, and ultimate generating discharge is adjusted on the basis of actual power demand vis a vis river discharge. Also, since minimum discharge (discharge available for 355 days of the year) is 0.021 m^3/s, it is anticipated that power demand may not be met for 26~36 days out of the year as in the case of the Adardour scheme. During such period, it will be necessary for households to use the conventional butane gas, candles, etc. for lighting purposes.

The system construction includes a small, concrete water diversion dam with intake chamber and gates, an 750 m head race, and a head tank and penstock assembly. The proposed penstock is 350 mm in diameter and will have a length of 34 meters. The turbine, generator and switch gear will be housed in a building of approximately 12 m^2 in area. The power will be transmitted at 3.3 kV, three phase, for a distance of approximately 2.5 km and local distribution to houses will require about 0.55 km of distribution line.

At the intake site, the minimum flow is estimated to be well below the system requirements, therefore the hydro system can not be operated at full power through out the year. The reduction in stream flow due to the operation of the hydro plant will only appear between the intake and the location of the outfall from the power house since the water is exhausted into the same stream as its intake.

Between the intake and outfall there are four turnout structures for diverting water into irrigation channels which serve downstream agricultural areas.

At the time of the site visit, several small streams were seen to join the main stream between the intake and outfall sites, therefore the percentage of stream flow reduction will be smaller moving downstream from the intake if the small streams continue to flow in the driest season.

The head race will follow the contour on the right bank facing downstream. It will pass through barren rock areas having low to moderately steep slopes. The rock structures are similar to those in the area of the access road which was constructed solely with hand tools and no blasting, so it appears reasonable that similar construction methods can be used for much of the head race base. However, since the head race must closely follow the contour, easy alternative routes are limited and some blasting will probably have to be done.

The power house site is proposed to occupy part of an agricultural field. The penstock and outfall components both will pass through non-agricultural areas of sparse grass and rock and will not require removal of trees or other significant changes in local vegetation.

The transmission and distribution lines can be routed such that no removal of trees or significant changes in the local vegetation will be required.

(2) Environmental Assessment Checklist, Direct Effects

1) Land wildlife. Since the area has been in continuous, intensive cultivation for hundreds of years, local wildlife has accommodated to the presence of man and his works. The construction of the micro-hydro facility can be expected to drive local land wildlife up or down the stream temporarily but there will be no significant change in habitats due to the presence of the facility and no long term impact on local land wildlife.

2) River wildlife. There are no fish. Only water insects and small

amphibians have been seen to inhabit the stream at the site. Since (a) the system will be controlled such that significant flow will remain in the stream at all times for the purposes of irrigation, and (b) the stream naturally swings from very low flow to very large flow, these small aquatic life forms are not likely to face a significant change in their environment.

3) Ground water. The ground water level could be affected along the 0.8 km area between the intake and the outfall of the hydro facility. This could affect vegetation in that area. However, the entire area is under irrigation and since irrigation water will have strong priority over the power production water, moderate changes in the flow in the stream bed itself are not likely to cause significant lowering of the ground water in the adjacent areas.

4) Geological. The headrace alignment will entail excavation of existing irrigation canal at its upper reaches. At total of 750 m of new, open concrete canal will be constructed. The penstock will be routed along a ridge from the terminus of the headrace canal. Construction of these facilities is in are of little vegetal cover, and can be accomplished manually. The rock outcropping at the site is weathered and it is assumed that excavation will be possible without the use of explosives. Accordingly, no impact to the surroundings from construction works is envisioned.

5) River and modification. The diversion structure will be approximately one meter high and will be comparable in size to many of the existing rock diversion structures already in place along the river for irrigation water diversion. This additional structure may have a short term effect on rock transport during flooding, but not in the long term. Such short term effects will have no geological significance in the stream bed. The change in water flow due to the presence of the hydro system is orders of magnitude smaller than the natural fluctuations in the stream and are not likely to have noticeable effect on the river bed structure.

6) Communicable diseases. Mosquito borne diseases are not present in this high altitude, cold winter site. Water borne diseases are limited to infections transported from human habitation upstream. There will be no ponding or areas of water which provide new types of habitat for insect borne or water borne diseases, therefore there is not likely to be any change in the type or frequency of diseases due to the presence of the hydro facility.

7) Portable water availability. There are no areas between the intake and outfall sites which are commonly used for the supply of portable water. The hydro facility will not affect the quality of the water therefore no impact at the village or downstream will occur.

8) Agriculture. As in the case of the other 2 sites, discharge for irrigation purposes will take precedence over that for hydropower. Where discharge is sufficient to meet both, diversion will be made solely for irrigation. During hours, particularly at night, where irrigation is not necessary it is planned to operate the hydropower facilities at whatever capacity is available.

9) Air pollution. By converting from kerosene lights to electric lights, a small reduction in pollution within homes will occur.

10) Water and ground pollution. No change in water or ground pollution is anticipated after the initial construction phase is completed. During the construction phase, non-polluting sanitation areas for the workers should be provided to prevent increased pollution of the stream which will effect downstream villages.

11) Micro-climate. Since the change in stream flow is limited to less than one kilometer of its length and irrigation will continue along that port of the stream, no change in micro-climate is likely.

(2) Environmental Assessment Checklist, Indirect Effects

1) Culture. The use of television in these villages is very limited due to the need to frequently carry a car battery many kilometers by donkey for charging. It can be expected that the presence of television in the village will dramatically increase with the availability of a local electricity supply. Based on the experience in other countries, the presence of electric lights can be expected to increase the quality of education and the amount of production of local handicrafts. It also may shift the social activities further into the evening hours. There is no evidence in other developing countries to show that the presence of electricity reduces urban drift by young people. Indeed, there is evidence that it is increased through the contact with the outside world afforded by TV and through the increased economic pressure on families to get money to purchase electrical appliances. There is evidence, however, that the presence of electricity increases the likelihood that people will ultimately return to the village, particularly retired government workers. This return of skilled, relatively wealthy older persons has been seen to significantly increase economic activity in rural villages and to stabilize village populations for the long term.

2) Economic development. There is the intent voiced by village leadership to establish a small wood working industry to take advantage of the economic possibilities of electricity supply. The actual type of production is not yet in focus for the village but if the intent is to use power tools to make furniture or other relatively large wooden items and if local trees are to be the source of wood, environmental problems could result. Should this industry significantly increase the use of local wood, tree felling could

increase (with resultant need for reforestation), posing a potential impact to the environment. Consequently, development in this regard must managed so as to prevent such negative impact.

(4) Conclusions from the Environmental Impact Assessment

Since the Tidsi site, like Adardour, is located at the extreme upper reaches of the river at some distance from the nearest trunk road and in rugged terrain (access requires crossing elevation of 1,800 m), it is anticipated that some difficulty in transport of material and equipment for construction will be encountered. However, site reconnaissance indicated that no significant impact to the environment would occur as a result of scheme implementation. In the long term, the change in village life style and economic development is anticipated to have a favorable impact on living standards.

VOL. II CHAPTER 9
PROJECT COST ESTIMATE

CHAPTER 9 PROJECT COST ESTIMATE

9.1 Cost Estimate Criteria

Criteria applied in preliminary project cost estimate are as follows:

(1) Prices are as of the end of May 1997.

(2) Exchange rate:

US$ 1.0 = DH 9.31 (Dirhams)
US$ 1.0 = ¥ 115.0

(3) Project works will all be carried out by contract. Contractors will provide all necessary construction equipment and temporary facilities, and include depreciation for the same within the contract cost.

(4) It is assumed that the executing agency for the Project will be the Renewable Energy Development Center (CDER) of the Ministry of Energy and Mines (MEM). As such the Project will be a government project, and subject to tax and duty exemptions on imported equipment and materials.

(5) It is expected that the relevant taxes and duties would be paid in the case of local procurement of equipment and materials, and the local sub-contracting of works.

- Equipment and material prices: include value added tax
- Sub-contracted works: include an extra 20% over the actual cost of works

(6) Costs for equipment and civil works were calculated based on market price survey, with reference to project implementation plan, work quantities for each category of construction work, and relevant unit costs. Correlation cross check was also made with performance on past similar projects in Morocco.

(7) Installation cost for domestically procured equipment includes both actual installation works and inland transportation to the sites.

(8) Import cost for equipment is based on market prices (FOB). Packing and transport cost (including marine and inland transport, off loading, storage costs, etc.) assumes 20% of FOB price. Inland transportation is assumed at 5% of the total packing and transport cost.

(9) Engineering fee is assumed at 10% of equipment cost, transport and installation cost and civil works cost.

(10) Physical contingency cost is assumed at 10% of equipment cost, transport and installation cost, civil works cost and engineering fee.

(11) Interest and price increases during the project construction period have not been taken into consideration.

(12) Foreign currency portion and local currency portion comprise the following:

- Foreign currency portion : imported equipment and material cost, marine transport, engineering fee, physical contingency

- Local currency portion : civil construction works, power transmission and distribution facilities for construction power, installation cost, taxes and duties, engineering fee, physical contingency

9.2 Construction Unit Cost

9.2.1 Standard Unit Costs

On the basis of data obtained during the 3rd phase field survey, market prices, takes, transport costs and unit costs for similar construction works as of May 1997 were computed. Principal standard unit costs are as follows:

(1) Labor Wages

Labor is to recruited by the local contractor from area villages. Base wages differ depending on occupation and content of construction work. Standard labor wages (8 hours per work day) as indicated by data from the Moroccan Labor Association are as follows:

Occupation	Wage (DH)
Chef d'equipe	134.00
Terrassier	64.00
Coffreur	68.00
Ferailleur	65.00
Chaudronier	67.00
Macon	66.00
Peintre	100.00
Electricier	120.00
Mecanicier	150.00
Mineur	100.00
Operateur les engine lourd	80.00
Operateur les engine legere	96.00

Under project cost estimation, the above wages are multiplied by a factor of two to take into account social insurance, transport to and from sites, lodging costs, etc.

(2) Engineer Wages

Engineer wages are indicated in terms of monthly remuneration as is the standard practice. These are as follows:

Occupation	Wage (DH)
Ingenieur experience 10 ans	30,000.00
Ingenieur experience 5 ans	20,000.00
Arpenteur experience 5 ans	10,000.00
Arpenteur ajoint	10,000.00
Secretaire	7,500.00
Dactylo	3,000.00
Chauffeur de voiture grande	4,000.00
Chauffeur de voiture normal	3,000.00

The above do not include social insurance charges, nor various other in-situ costs (transport to and from sites, lodging, etc.)

(3) Transport Cost

Marine transport costs are packing and transport up to the nearest port (Casablanca).

Inland transport to the sites will be by either rail or road (truck). In either case, transport would be sub-contracted locally. Rail transport would be up to Marrakech station, from where final conveyance to the sites would be by truck. Transport unit costs to the sites are as follows:

Marine transport:

Transport cost:	US$ 156/ton
Packing cost:	US$ 88/(m^3) ton
Handling:	US$ 52/ton

Overland transport:

		Casablanca~Marrakech	Marrakech~site
1)	Rail transport (distance)	240 km	3~5 ton truck
	Transport cost	DH 279.6/ton	DH 800~1000/truck load
	Insurance	2% of material/equipment price	
	Handling	DH 2.5 ton	
1)	Truck transport (distance)	237 km	
	Transport cost	DH 118.7/ton	small truck where required
	Insurance	3% of material/equipment price	
	Handling	DH 2.5 ton	

Taking into consideration the above, and performance on other similar projects, 20% has been factored into equipment cost for transportation.

(4) Main Materials

1) Cement

Domestically produced cement is being used in high rise construction as well, and poses no problems in terms of quality and strength. Two types of cement are available at the following prices:

Cement (35)	DH 39.0/sac (50 kg)
Cement (45)	DH 43.0/sac (50 kg)

2) Steel

Steel will be used under the Project for re-bar and penstock pipe. Re-bar will be domestically produced material, while penstock pipe steel will be imported from nearby off-shore.

Re-bar:	
T-12	DH 60.0 / 12 m
T-10	DH 40.0 / 12 m
T-8	DH 26.0 / 12 m
Steel pipe:	
ø 350 mm	DH 500 / m

(5) Mechanical Facilities

This will mainly comprise electro-mechanical equipment including turbines, generators, etc. and transmission / distribution facilities. Of these, turbines, generators and appurtenant equipment will be procured from offshore and cost of the same includes both marine and overland transport. Import duties are not considered in light of the fact that the envisioned project is a government one and would be assumed to be exempt from such duties.

The major part of transmission / distribution facility materials and equipment can be procured locally (even that part which would be imported, is considered as domestically procured items). A 20% value added tax (VAT) is factored into the cost of material and equipment under this category).

9.2.2 Unit Cost by Construction Work Category

On the basis of the above standard unit costs, unit costs by construction work category are as indicated in Table 9.2-1.

Table 9.2-1 Unit Costs by Construction Work Category

(unit : DH)

Work Item	Specification	Unit	Unit Price
Excavation	Common	m3	60.00
Excavation	Rock	m3	190.00
Concrete	C=210 kg/ m3	m3	1300.00
Concrete	C=350 kg/ m3	m3	1530.00
Steel bar arrangement		kg	12.00
Wet masonry		m3	500.00
Mortar lining	t= 5cm	m2	90.00
Cobble stone	t= 20cm	m2	60.00
Rubble stone	t= 20cm	m2	60.00
Banking		m3	250.00
Bockfill		m3	150.00
Precast cover concrete	t= 10cm	m2	290.00
Housing work		m2	6500.00
Steel conduit	D= 350mm	m	1750.00
Steel conduit	D= 300mm	m	1700.00
Steel conduit	D= 200mm	m	1650.00
Steel gate	1.0m x 1.0m	LS	4000.00
Bar screen	0.7m x 1.5m	LS	5000.00

9.3 Project Cost

9.3.1 Civil Works Construction Cost

In the case of civil works construction cost for the 3 micro-hydropower sites, work quantities were computed from 1/500 scale topomapping, and direct cost calculated on the basis of the above described construction unit costs. Indirect cost (overhead) takes into consideration common temporary facility cost, transport cost, in-situ engineering fee, in-situ administrative office operating cost, and overall project management costs (in calculating the said indirect cost, reference was made to past performance on similar projects).

Table 9.3-1 indicates the breakdown of civil works construction cost for each site.

Table 9.3-1 Civil Works Construction Cost for Each Site

Scheme	Adardour	Arg	Tidsi
1) Direct cost:			
Intake	135	123	136
Headrace	1,156	1,767	970
Headtank	147	145	156
Penstock	223	219	124
Power house	150	157	160
Tailrace	182	48	40
Total	1,993	2,459	1,586
2) Indirect cost:			
Direct cost × 60%	1,196	1,475	952
Grand total	3,189	3,934	2,538

9.3.2 Equipment Cost

Costs for turbine, generator and transmission / distribution facilities have been calculated under equipment cost. Of these, turbine, generator and appurtenant equipment are to be procured from off-shore. Transmission / distribution facilities are to be procured locally. Purchase prices in the case of off-shore procurement are FOB, and purchase prices in the case of local procurement are the prevailing domestic market prices.

Table 9.3-2 indicates a breakdown of equipment cost for each site.

Table 9.3-2 Equipment Cost (1/3)

Adardour Power station

Rate: 1.0US$/9.31DH/115¥

Item	Specification	Qty.	Unit Cost (¥)	Total (US$ 10^3)
Cross flow turbine	Head=37m,Q(Max)=0.11m3/S, P=26kW, Speed=1000rpm,	1 set	3,500,000	30.4
Generator	3Phase Synchronous Output=32.5kVA, Voltage=400V, Ampere=47A, Power factor=0.8, Speed=1000rpm, Frequency=50Hz	1 set	1,500,000	13.0
Control panel	Tuebine and Generator controlled with protection units, Dummy load governor, etc ,	1 set	3,800,000	33.0
Inlet valve	Butterfly Type	1 set	400,000	3.5
Transformer	Voltage=400V/3300V, Capacity=50kVA	1 set	750,000	6.5
Pump reversible Turbine	Head=37.8m,Q(Max)=0.032m3/S, P=7.02kW, Speed=1000rpm,	1 set	1,918,000	16.7
Generator	3Phase Synchronous,Output=9kVA, Voltage=400V, Ampere=13A, Power factor=0.8, Speed=1000rpm, Frequency=50Hz	1 set	1,078,000	9.4
Control panel	Tuebine and Generator controlled with protection units, Dummy load governor, etc.,	1 set	1,900,000	16.5
Inlet valve	Butterfly Type	1 set	250,000	2.2
Transmission line	Electric wire 3 Phase,25mm2, Aliminum	1.55 km	1,359,000	18.3
	Pole Material =Wood,Voltage=3300V	31 nos	Included in the above	
Distribution line	Electric wire 3phase 4wire 34mm2 CV,	2,666 m	1,359	31.5
	Pole Material =Wood, Voltage=400/220V	53 nos	Included in the above	
	Pole Trans Voltage 3300/400/220V, Capacity=15 kVA	4 nos	61,000	2.1
Installation	Installed for Adardour power station	1 lot	4,000,000	34.8
House wiring (including fixtures)		162 ouse	32,200	45.4
	Total			263.4

Table 9.3-2 Equipment Cost (2/3)

Arg Power station

Rate: 1.0US$/9.31DH/115¥

Item	Specification	Qty.		Unit Cost (¥)	Total (US$ 10^3)
Cross flow turbine	Head=25m,Q(Max)=0.18m3/S, P=30kW, Speed=1000rpm,	1	set	3,000,000	26.1
Generator	3Phase Synchronous Output=37.5kVA, Voltage=400V, Ampere=54A, Power factor=0.8, Speed=1000rpm, Frequency=50Hz	1	set	1,800,000	15.7
Inlet valve	Butterfly Type	1	set	350,000	3.0
Control panel	Turbine and Generator controlled with protection units, Dummy load governor, etc ,	1	set	3,300,000	28.7
Transformer	Voltage=400V/3300V, Capacity=49kVA	1	set	750,000	6.5
Transmission line	Electric wire 3 Phase,25mm2, Aliminum	4.4	km	1,359,000	52.0
	Pole Material =Wood,Voltage=3300V	88	nos	Included in the above	
Distribution line	Electric wire 3phase 4wire 34mm2 CV,	3,170	m	1,359	37.5
	Pole Material =Wood, Voltage=400/220V	63	nos	Included above	
	Pole Trans Voltage 3300/400/220V, Capacity=15 kVA	4	nos	61,000	2.1
Installation	Installed for Arg power station	1	lot	3,000,000	26.1
House wiring (including fixtures)		223	ouse	32,200	62.4
	Total				260

Table 9.3-3 Equipment Cost (3/3)

Tidsi Power station

Rate: 1.0US$/9.31DH/115¥

Item	Specification	Qty.		Unit Cost (¥)	Total (US$ 10^3)
Cross flow turbine	Head=15m,Q(Max)=0.15m3/S, P=14kW, Speed=750rpm,with gear box	1	set	3,000,000	26.1
Generator	3Phase Synchronous Output=17.5kVA, Voltage=400V, Ampere=25A, Power factor=0.8, Speed=1000rpm, Frequency=50Hz	1	set	1,000,000	8.7
Inlet valve	Turbine and Generator controlled with protection units, Dummy load governor, etc ,	1	set	2,800,000	24.3
Control panel	Butterfly Type	1	set	300,000	2.6
Transformer	Voltage=400V/3300V, Capacity=24kVA	1	set	700,000	6.1
Generator	Head=15.8m,Q(Max)=0.0375m3/S,P=3.2kW, Speed=1000rpm,	1	set	994,000	8.6
	3Phase Synchronous Output=4kVA, Voltage=400V, Ampere=6A, Power factor=0.8, Speed=1000rpm, Frequency=50Hz	1	set	770,000	6.7
Control panel	Butterfly Type	1	set	250,000	2.2
	Turbine and Generator controlled with protection units, Dummy load governor, etc ,	1	set	1,900,000	16.5
	Electric wire 3 Phase,25mm2, Aliminum	2.5	km	1,359,000	29.5
Inlet valve	Pole Material =Wood,Voltage=3300V	50	nos	Included in the above	
Tranmission line	Electric wire 3phase 4wire 34mm2 CV,	1,350	m	1,359	16.0
	Pole Material =Wood, Voltage=400/220V	27	nos	Included in the above	
Distribution line	Pole Trans Voltage 3300/400/220V, Capacity=10 kVA	2	nos	61,000	1.1
Installation	Installed for Tidsi power station	1	lot	3,500,000	30.4
House wiring (including fixtures)		110	ouse	32,200	30.8
	Total				209.7

9.3.3 Project Cost

Overall Project cost is as indicated in Table 9.9-3 (including civil works cost, equipment cost, installation cost, packing and transport cost, tax, engineering fee and physical contingency).

Table 9.3-3 Overall Project Cost for Micro-hydropower Schemes

Rate US$ 1.0 / DH 9.31 / ¥ 115 (unit US$ 10³)

	Adardour (26 kW)			Arg (30 kW)			Tidsi (15 kW)			Project total (71 kW)		
	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
Construction item												
1. Construction cost												
1-1 Civil works												
(1) Direct cost		214	214		264	264		170	170		648	648
(2) Indirect cost	38	90	128	47	111	158	31	71	102	116	272	388
Sub total	38	304	342	47	375	422	31	241	272	116	920	1,036
1-2 Equipment												
(3) Generating facilities												
a. Turbine / generator	70		70	42		42	50		50	162		162
b. Appurtenant facilities	55		55	32		32	46		46	133		133
Subtotal	125		125	74		74	96		96	295		295
(4) Transmission / distribution facilities												
a. Transmission facilities		25	25		59	59		35	35		119	119
b. Distribution facilities		79	79		102	102		48	48		229	229
Subtotal		104	104		161	161		83	83		348	348
(5) Installation		35	35		26	26		31	31		92	92
(6) Packing / transport (FC x 20%)	24	1	25	14	1	15	18		18	56	2	58
Total: (3)~(6)	149	140	289	88	188	276	114	114	228	351	442	793
Total: (1)~(6)	187	444	631	135	563	698	145	355	500	467	1,362	1,829
2. Tax (VAT) ((1) + (2) + (4) + (5)+(6) x 0.05) x 20%		89	89		113	113		71	71		272	272
3. Engineering fee (1)~(6) x 10%	19	44	63	14	56	70	15	36	51	48	136	184
4. Physical contingency (1) + (3) x 10%	21	49	70	15	62	77	16	39	55	52	150	202
5. Total Project cost	227	626	853	164	794	958	176	502	678	570	1,918	2,488

VOL. II CHAPTER 10
FINANCIAL AND ECONOMIC EVALUATION

CHAPTER 10 FINANCIAL AND ECONOMIC EVALUATION

10.1 Evaluation Methodology

(1) Financial Evaluation

The same methodology as applied in Volume I was adopted for financial evaluation.

1) Project life is assumed at 30 years

2) In calculating the monthly cost to be paid by users and the per kWh cost of electricity, recovery ratios for initial investment were considered for cases of 100%, 75%, 50%, 25% and 0%. (Recovery indicates the proportion of total initial investment to be factored into the foregoing costs.)
3) Discount rates of 0%, 3%, 6% and 9% were applied to net present value (NPV).
4) Cost for power facility consumption by public facilities is calculated as cost to be borne by the user.
5) Interest on initial investment was excluded from calculation; however, taxes are included in costs for equipment and materials to be procured locally as well as locally contracted construction works.

Calculation of Power Supply Cost:

1) Calculation of Monthly Payment to be Made by Each Household

Monthly payment by each household = (present value for initial investment) / (present value for number of users) + (present value for future cost [variable cost]) / (present value for number of users).

If initial investment is only for the first year of the Project, then present value is "initial investment × 1.00".

Cases for recovery rate of initial investment were set at 25% intervals from 0% to 100%, with calculation assuming application of the said rate from the outset. Calculation of variable cost does not include the US$ 2/month/household for CDER and user association costs.

2) Per kWh Cost Calculation

Once the monthly household payment has been calculated, dividing this by the forecast power utilization per household yields the per kWh cost of electricity. However, as discussed earlier, collection of fees based on the per kWh cost is impractical and this procedure has consequently been omitted.

Financial Calculation (profit and loss calculation):

For each case of recovery rate for initial investment, the monthly payment by each user household is modified accordingly to calculate income and expenditure for the 30 year life of the Project in order to determine the range within which the Project is financially profitable.

(2) Economic Evaluation (comparison with alternative electrification method)

Material, equipment and labor to be invested in the Project are converted to shadow prices prevailing in Morocco, and cost comparison (B/C analysis) made with the alternative electrification method (diesel generation).

Where benefit (total cost for diesel generation) is greater than cost (total cost for micro-hydropower generation), it is concluded that adoption of micro-hydropower is economically advantageous.

10.2 Results of Evaluation

(1) Adardour Scheme

1) Financial Evaluation

Initial investment: US$ 852,000

Monthly household payment: US$ / month / user:

Initial investment recovery rate	Discount rate			
	0%	3%	6%	9%
100%	13.0	19.7	28.1	38.0
75%	10.1	15.1	21.5	28.9
50%	7.2	10.6	14.8	19.7
25%	4.3	6.0	8.1	10.8
0%	1.4	1.4	1.4	1.4

Results of financial calculation:

Since the initial investment in the case of micro-hydropower is high, the monthly household payment drops sharply as the target recovery rate on initial investment becomes lower. In the case of 0% recovery rate on initial investment, i.e. only variable cost is considered, the monthly household payment is US$ 1.4 / user.

In order to achieve a Financial Internal Rate of Return of 6%, it becomes necessary to collect fees from the individual user which correspond to a discount rate of 6% in the table above. If the user monthly payment is the average willing to pay amount of US$ 7 / month, this corresponds to an initial investment recovery rate of 20%. If the monthly payment is US$ 17.5 / month corresponding to the present household expenditure for lighting and battery charging, then the initial investment recovery rate is 59%.

2) Economic Evaluation

In comparison to diesel generation at a discount rate of 0%, B/C is low at 0.33 and in terms of a strictly economic evaluation standpoint the justification for implementation of the micro-hydropower scheme is correspondingly low and a viable Economic Internal Rate of Return is not achievable.

Even for the case of a 2 fold increase in fuel cost for diesel generation at a discount rate of 0%, B/C is 0.45 and a substantial gap remains between the two methods of electrification strictly in terms of economic advantage.

(2) Arg Scheme

1) Financial Evaluation

Initial investment: US$ 957,000

Monthly household payment: US$ / month / user:

Initial investment recovery rate	Discount rate			
	0%	3%	6%	9%
100%	11.7	17.9	25.6	34.7
75%	9.0	13.6	19.5	26.3
50%	6.3	9.4	13.3	17.8
25%	3.6	5.2	7.1	9.4
0%	1.0	1.0	1.0	1.0

Results of financial calculation:

Since the initial investment in the case of micro-hydropower is high, the monthly household payment drops sharply as the target recovery rate on initial investment becomes lower. In the case of 0% recovery rate on initial investment, i.e. only variable cost is considered, the monthly household payment is US$ 1.0 / user.

In order to achieve a Financial Internal Rate of Return of 6%, it becomes necessary to collect fees from the individual user which correspond to a discount rate of 6% in the table above. If the user monthly payment is the average willing to pay amount of US$ 7 / month, this corresponds to an initial investment recovery rate of 25%. If the monthly payment is US$ 17.5 / month corresponding to the present household expenditure for lighting and battery charging, then the initial investment recovery rate is 67%.

2) Economic Evaluation

In comparison to diesel generation at a discount rate of 0%, B/C is low at 0.39 and in terms of a strictly economic evaluation standpoint the justification for implementation of the micro-hydropower scheme is correspondingly low and a viable Economic Internal Rate of Return is not achievable.

Even for the case of a 2 fold increase in fuel cost for diesel generation at a discount rate of 0%, B/C is 0.53 and a substantial gap remains between the two methods of electrification strictly in terms of economic advantage.

(3) Tidsi Scheme

1) Financial Evaluation

Initial investment: US$ 677,000

Monthly household payment: US$ / month / user:

Initial investment recovery rate	Discount rate			
	0%	3%	6%	9%
100%	15.8	23.9	34.2	46.1
75%	12.3	18.4	26.1	35.0
50%	8.8	12.9	18.0	24.0
25%	5.3	7.3	9.9	12.9
0%	1.7	1.8	1.8	1.8

Results of financial calculation:

Since the initial investment in the case of micro-hydropower is high, the monthly household payment drops sharply as the target recovery rate on initial investment becomes lower. In the case of 0% recovery rate on initial investment, i.e. only variable cost is considered, the monthly household payment is US$ 1.7 / user.

In order to achieve a Financial Internal Rate of Return of 6%, it becomes necessary to collect fees from the individual user which correspond to a discount rate of 6% in the table above. If the user monthly payment is the average willing to pay amount of US$ 7 / month, this corresponds to an initial investment recovery rate of 16%. If the monthly payment is US$ 17.5 / month corresponding to the present household expenditure for lighting and battery charging, then the initial investment recovery rate is 50%.

2) Economic Evaluation

In comparison to diesel generation at a discount rate of 0%, B/C is low at 0.34 and in terms of a strictly economic evaluation standpoint the justification for implementation of the micro-hydropower scheme is correspondingly low and a viable Economic Internal Rate of Return is not achievable.

Even for the case of a 2 fold increase in fuel cost for diesel generation at a discount rate of 0%, B/C is 0.44 and a substantial gap remains between the two methods of electrification strictly in terms of economic advantage.

Table 10.1 Financial and Economic Evaluation for Adardour Scheme

Name of Village	Number of Household		Expected Capacity	
Adardour	in 1996	160	in 2010 (kW)	20.3
	in 2010	189	Planned Capacity	26

Financial Analysis

Fixed Cost (US$)

Turbine/Generator	150,000	Tax	88,600
Civil Cost (Domestic)	339,000	Supervisor Fee	63,100
Civil Cost (Foreign)	38,000	Contingency	69,410
Trans/Distribution	60,300		
Conection Cost	43,700	Total	852,110

Variable Cost

Maintenance Cost	1% for Turbine/Generator Cost	
Person for Maintenance	100US$/month	
	Total (30years)	99,720

Monthly Payment per Household (US$/Household/month)

Discount Rate		0%	3%	6%	9%
Rate of Initial Investment	100%	13.0	19.7	28.1	38.0
	75%	10.1	15.1	21.5	28.9
	50%	7.2	10.6	14.8	19.7
	25%	4.3	6.0	8.1	10.6
	0%	1.4	1.4	1.4	1.4

Profit and Loss Table (1,000US$)

Discount Rate / Monthly Payment (US$/H.H)	Part of Investme	0%	3%	6%	9%
4	100%	-659.5	-730.9	-769.9	-792.5
	75%	-459.2	-530.6	-569.5	-592.2
	50%	-241.9	-313.3	-352.3	-374.9
	25%	-24.7	-96.0	-135.0	-157.7
	0%	192.6	121.2	82.2	59.6
7	100%	-457.2	-608.3	-691.1	-739.5
	75%	-239.9	-391.0	-473.9	-522.3
	50%	-22.7	-173.8	-256.6	-305.0
	25%	194.6	43.5	-39.4	-87.7
	0%	411.8	260.8	177.9	129.5
10	100%	-238.0	-468.7	-595.5	-669.8
	75%	-20.7	-251.5	-378.2	-452.3
	50%	196.6	-34.2	-160.9	-235.1
	25%	413.8	183.0	56.3	-17.8
	0%	631.1	400.3	273.6	199.5
14	100%	54.4	-282.7	-467.9	-576.3
	75%	271.8	-65.4	-250.6	-359.1
	50%	488.9	151.8	-33.4	-141.8
	25%	706.1	369.1	183.9	75.4
	0%	923.4	586.3	401.1	292.7

Economic Analysis

	Conversion Factor			
Fixed Cost (US$)				
Turbine/Generator	0.9	135,720	Tax	0
Civil Cost (Domestic)	0.66	223,740	Supervisor Fee	0
Civil Cost (Foreign)	0.66	25,080	Contingency	0
Trans/Distribution	0.74	44,622		
Conection Cost	0.74	32,338	Total	461,500

Variable Cost			
Maintenance Cost	0.5	1% for Turbine/Generator Cost	
Person for Maintenance	0.5	100US$/month	
		Total (20years)	35,738

Alternative Measure (Diesel Generation)

Fixed Cost				
Engine/Generator	0.9	9,001	Tax	0
Civil Cost	0.66	2,086	Supervisor Fee	0
Trans/Distribution	0.74	18,500	Contingency	0
Conection Cost	0.74	32,338		
			Total	61,924

Variable Cost			
Maintenance Cost	0.5	5% for Engine/Generator Cost	
Overtrial Cost	0.7	50% for Engine/Generator Cost every 5 years	
Person for Maintenance	0.5	200US$/month	
		Total (20years)	106,686

B/C Analysis

Discount Rate	0%	3%	6%	9%
Benefit (Cost of Diesel Generation)	168,599	140,532	121,858	109,050
Cost (Cost of Microhydro Gen.)	515,973	496,847	436,169	479,813
B/C	0.33	0.28	0.25	0.23

Sensibility Analysis (Fuel Cost hikes Two times)

Discount Rate	0%	3%	6%	9%
Benefit (Cost of Diesel Generation)	233,283	188,101	158,136	137,636
Cost (Cost of Microhydro Gen.)	515,973	496,847	486,169	479,813
B/C	0.45	0.38	0.33	0.29

Table 10.2 Financial and Economic Evaluation for Arg Scheme

Name of Village	Number of Household		Expected Capacity	
Arg	in 1996	195	in 2010 (kW)	25.4
	in 2010	231	Planned Capacity	30

Financial Analysis

Fixed Cost (US$)

Turbine/Generator	89,000	Tax	112,400
Civil Cost (Domestic)	401,000	Supervisor Fee	69,800
Civil Cost (Foreign)	47,000	Contingency	76,780
Trans/Distribution	107,400		
Conection Cost	53,600	Total	956,980

Variable Cost

Maintenance Cost	1% for Turbine/Generator Cost	
Person for Maintenance	100US$/month	
	Total (30years)	85,580

Monthly Payment per Household (US$/Household/month)

Discount Rate		0%	3%	6%	9%
Rate of Initial Investment	100%	11.7	17.9	25.8	34.7
	75%	9.0	13.6	19.5	26.3
	50%	6.3	9.4	13.3	17.8
	25%	3.6	5.2	7.1	9.4
	0%	1.0	1.0	1.0	1.0

Profit and Loss Table (1,000US$)

Discount Rate / Monthly Payment (US$/H.H)	Part of Investme	0%	3%	6%	9%
4	100%	-686.2	-785.6	-840.2	-872.0
	75%	-446.9	-546.4	-600.9	-632.7
	50%	-207.7	-307.2	-361.7	-393.5
	25%	31.6	-67.9	-122.4	-154.3
	0%	270.8	171.3	118.8	85.0
7	100%	-418.9	-615.5	-720.5	-786.7
	75%	-179.6	-376.3	-484.3	-547.5
	50%	59.6	-137.0	-245.1	-308.2
	25%	298.6	102.2	-5.8	-69.0
	0%	538.1	341.4	283.4	170.2
10	100%	-151.6	-445.4	-606.9	-701.5
	75%	87.7	-206.2	-867.7	-462.2
	50%	326.9	33.1	-123.4	-223.0
	25%	566.2	272.3	110.8	16.3
	0%	805.4	511.6	350.1	255.5
14	100%	204.8	-218.6	-151.4	-587.8
	75%	441.1	20.6	-212.2	-348.6
	50%	683.3	259.9	27.1	-109.3
	25%	922.6	499.1	206.3	129.9
	0%	1,181.8	738.4	505.5	369.2

Economic Analysis

	Conversion Factor			
Fixed Cost (US$)				
Turbine/Generator	0.9	81,000	Tax	0
Civil Cost (Domestic)	0.66	264,660	Supervisor Fee	0
Civil Cost (Foreign)	0.66	31,020	Contingency	0
Trans/Distribution	0.74	79,476		
Conection Cost	0.74	39,664	Total	495,820

Variable Cost			
Maintenance Cost	0.5	1% for Turbine/Generator Cost	
Person for Maintenance	0.5	100US$/month	
		Total (20years)	48,431

Alternative Measure (Diesel Generation)

Fixed Cost				
Engine/Generator	0.9	10,048	Tax	0
Civil Cost	0.66	2,086	Supervisor Fee	0
Trans/Distribution	0.74	42,550	Contingency	0
Conection Cost	0.74	39,664		
			Total	94,347

Variable Cost			
Maintenance Cost	0.5	5% for Engine/Generator Cost	
Overtrial Cost	0.7	50% for Engine/Generator Cost every 5 years	
Person for Maintenance	0.5	200US$/month	
		Total (20years)	119,491

B/C Analysis

Discount Rate	0%	3%	6%	9%
Benefit (Cost of Diesel Generation)	213,619	182,171	161,249	146,900
Cost (Cost of Microhydro Gen.)	543,665	527,135	517,662	511,941
B/C	0.39	0.35	0.31	0.29

Sensibility Analysis (Fuel Cost hikes Two times)

Discount Rate	0%	3%	6%	9%
Benefit (Cost of Diesel Generation)	289,014	237,627	203,550	180,238
Cost (Cost of Microhydro Gen.)	543,665	527,135	517,602	511,941
B/C	0.53	0.45	0.39	0.35

Table 10.3 Financial and Economic Evaluation for Tidsi Scheme

Name of Village	Number of Household		Expected Capacity	
Tidisi	in 1996	105	in 2010 (kW)	13.1
	in 2010	125	Planned Capacity	15

Financial Analysis

Fixed Cost (US$)

Turbine/Generator	115,000	Tax	71,000
Civil Cost (Domestic)	272,000	Supervisor Fee	50,100
Civil Cost (Foreign)	31,000	Contingency	55,110
Trans/Distribution	54,100		
Conection Cost	28,900	Total	677,210

Variable Cost

Maintenance Cost	1% for Turbine/Generator Cost	
Person for Maintenance	100US$/month	
	Total (30years)	82,980

Monthly Payment per Household (US$/Household/month)

	Discount Rate	0%	3%	6%	9%
Rate of Initial Investment	100%	15.8	23.9	34.2	46.1
	75%	12.3	18.4	26.1	35.0
	50%	8.8	12.9	18.0	24.0
	25%	5.3	7.3	9.9	12.9
	0%	1.7	1.6	1.8	1.8

Profit and Loss Table (1,000US$)

Discount Rate / Monthly Payment (US$/H.H)	Part of Investme	0%	3%	6%	9%
4	100%	-568.3	-609.1	-631.3	-644.1
	75%	-399.0	-439.6	-462.0	-474.8
	50%	-229.7	-270.5	-292.7	-305.5
	25%	-60.4	-101.2	-123.4	-136.2
	0%	108.9	68.1	45.9	33.1
7	100%	-424.4	-517.5	568.5	-598.2
	75%	-255.1	-348.2	-399.2	-428.9
	50%	-85.8	-178.9	-229.9	-259.6
	25%	83.5	-9.6	-60.6	-90.3
	0%	252.9	159.7	108.7	79.0
10	100%	-280.4	-425.9	-505.7	-552.3
	75%	-111.1	-256.6	-336.4	-383.0
	50%	58.2	-87.3	-167.1	-213.7
	25%	227.5	82.0	2.2	-44.4
	0%	396.8	251.3	171.5	124.9
14	100%	-88.5	-303.7	-421.9	-491.1
	75%	80.8	-134.4	-252.6	-321.8
	50%	250.1	34.9	-83.3	-152.5
	25%	419.4	204.2	86.0	16.8
	0%	588.7	373.5	255.3	186.1

Economic Analysis

	Conversion Factor			
Fixed Cost (US$)				
Turbine/Generator	0.9	103,500	Tax	0
Civil Cost (Domestic)	0.66	179,520	Supervisor Fee	0
Civil Cost (Foreign)	0.66	20,460	Contingency	0
Trans/Distribution	0.74	40,034		
Conection Cost	0.74	21,386	Total	364,900

Variable Cost			
Maintenance Cost	0.5	1% for Turbine/Generator Cost	
Person for Maintenance	0.5	100US$/month	
		Total (20years)	44,560

Alternative Measure (Diesel Generation)

Fixed Cost				
Engine/Generator	0.9	6,125	Tax	0
Civil Cost	0.66	2,086	Supervisor Fee	0
Trans/Distribution	0.74	27,750	Contingency	0
Conection Cost	0.74	21,386		
			Total	57,347

Variable Cost			
Maintenance Cost	0.5	5% for Engine/Generator Cost	
Overtrial Cost	0.7	50% for Engine/Generator Cost every 5 years	
Person for Maintenance	0.5	200US$/month	
		Total (20years)	80,306

B/C Analysis

Discount Rate	0%	3%	6%	9%
Benefit (Cost of Diesel Generation)	137,434	116,360	102,338	92,719
Cost (Cost of Microhydro Gen.)	409,910	394,300	385,583	380,392
B/C	0.34	0.3	0.27	0.24

Sensibility Analysis (Fuel Cost hikes Two times)

Discount Rate	0%	3%	6%	9%
Benefit (Cost of Diesel Generation)	181,489	148,757	127,045	112,188
Cost (Cost of Microhydro Gen.)	409,910	394,300	305,583	380,392
B/C	0.44	0.38	0.33	0.29

VOL. II CHAPTER 11
CONCLUSIONS

CHAPTER 11 CONCLUSIONS

(1) The Adardour, Arg and Tidsi schemes which were targeted for prefeasibility study are considered to be the highest priority candidates out of the 7 schemes selected under the Master Plan Study, feature relatively good access, and are judged to be of high development maturity.

(2) Each scheme represents a minimized, run-of-river generating plan. Maximum outputs are 26 kW for Adardour, 30 kW for Arg and 15 kW for Tidsi. Available discharge during the low water season is small, resulting in small maximum generating discharges for the schemes of 0.11~0.18 m^3/s. Effective head as well is small at 15~30 m as a result of river gradient features. Nevertheless, the schemes are planned to supply as many villages as possible making maximum use of site potential.

(3) In order to minimize scheme construction cost, existing irrigation canals are to be used to the extent possible with appropriate widening of the same. Construction planning also calls for maximum utilization of local/domestic materials and equipment. Only turbine and generator equipment is to be procured from off-shore.

(4) The cross flow type turbine has been adopted for the schemes. However, due to extremely low discharge during the dry season in the case of Adardour and Tidsi, which results in a turbine efficiency rate making operation impossible, generating equipment is to be augmented by a <u>separate, reverse pump up turbine</u>.

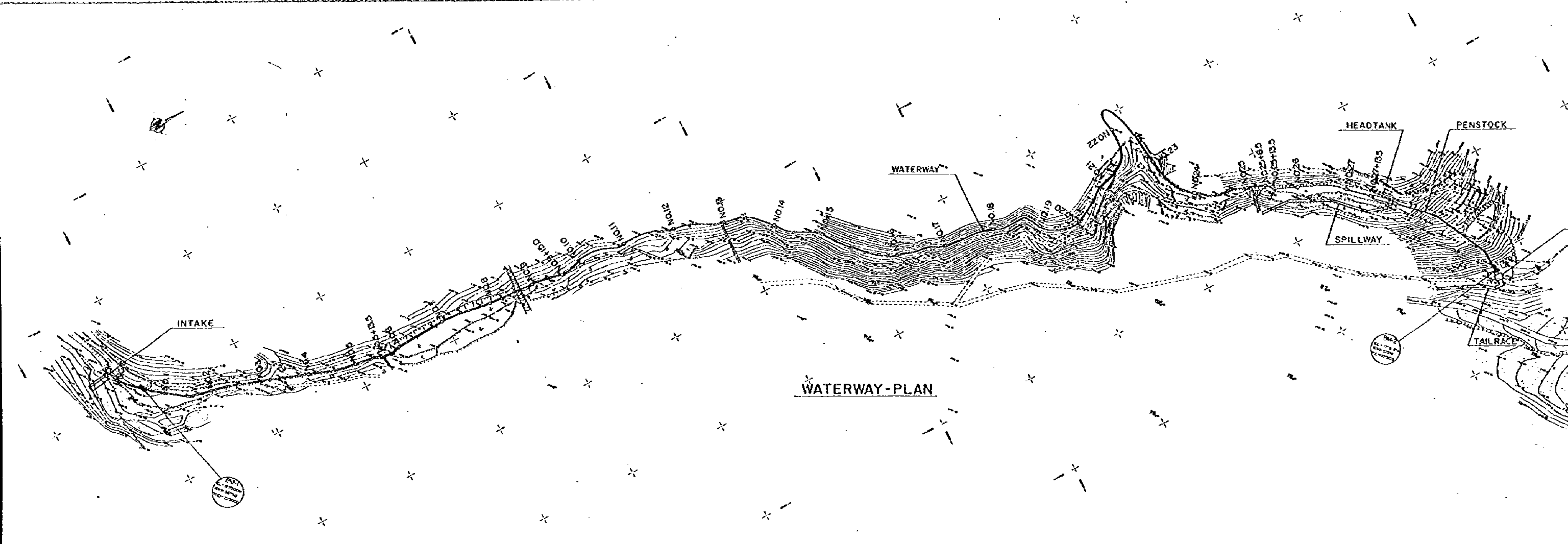
(5) In order to minimize transmission loss in the conveyance of power from the power house to the user households, generator voltage of 440 V is to be stepped up to 3.3 kV, and then stepped down by pole mounted transformers at the villages to 400 V / 220 V for final distribution to the user households.

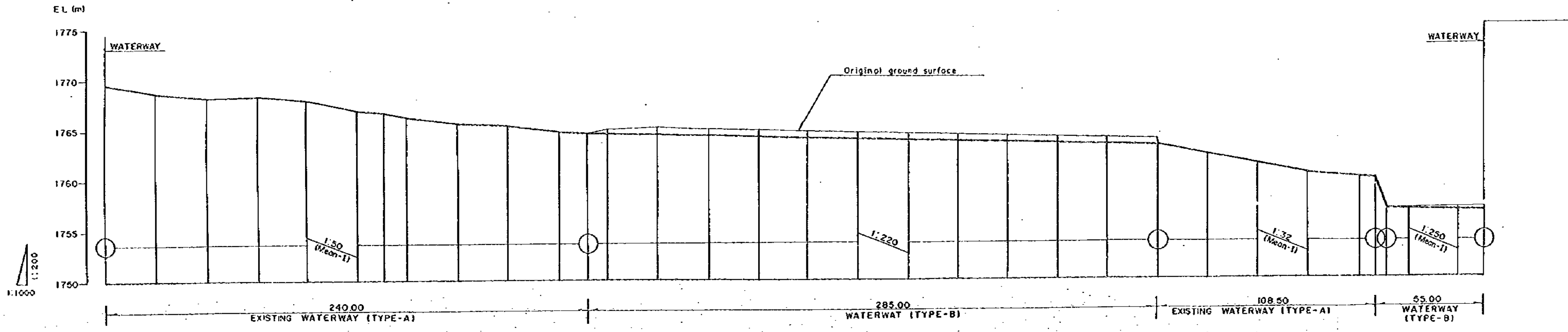
(6) It is concluded that no impacts would occur to the natural or social environment of a magnitude so as to preclude construction of the schemes. However, due to the close interlinkage with existing irrigation canals, the schemes must be implemented under thorough consultation with villagers with regard to water use.

(7) On the basis of the results of financial analysis, monthly household payments in the case of an initial investment recovery rate of 0% are US$ 1.4/month/household for the Adardour scheme, US$ 1.0/month/household for the Arg scheme and US$ 1.8/month/household for the Tidsi scheme. The average for the total 7 schemes under financial analysis in Volume I is US$ 1.2/month.

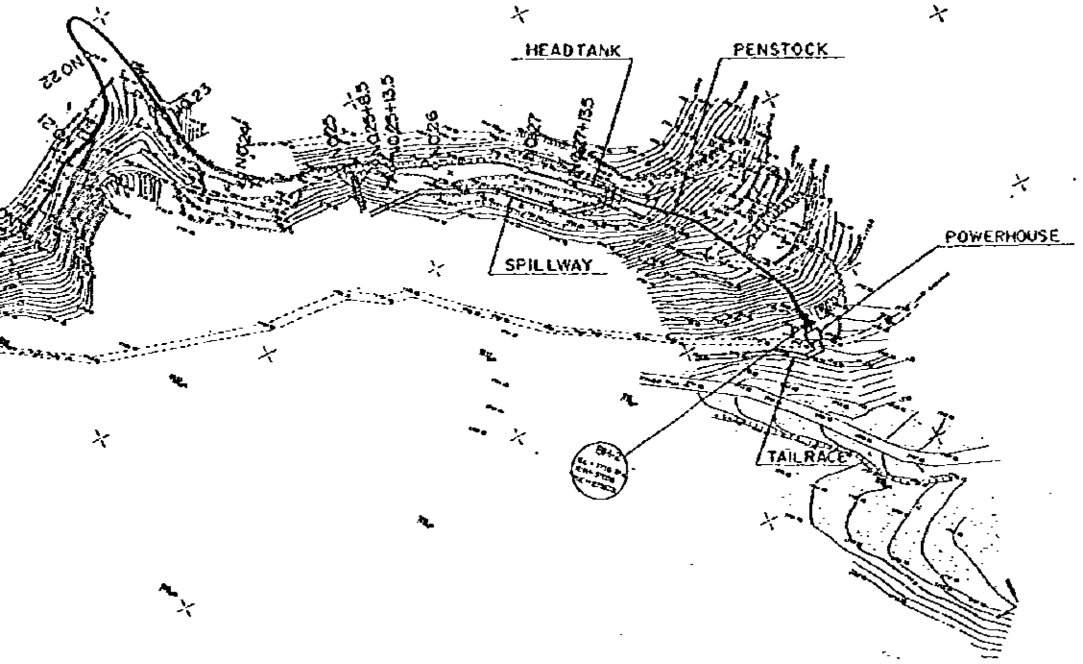
(8) Implementation schedule calls for 5 months for detailed design and contractor selection, and 16 months for actual construction (21 months overall). Total construction cost is estimated at US$ 2.5 million.

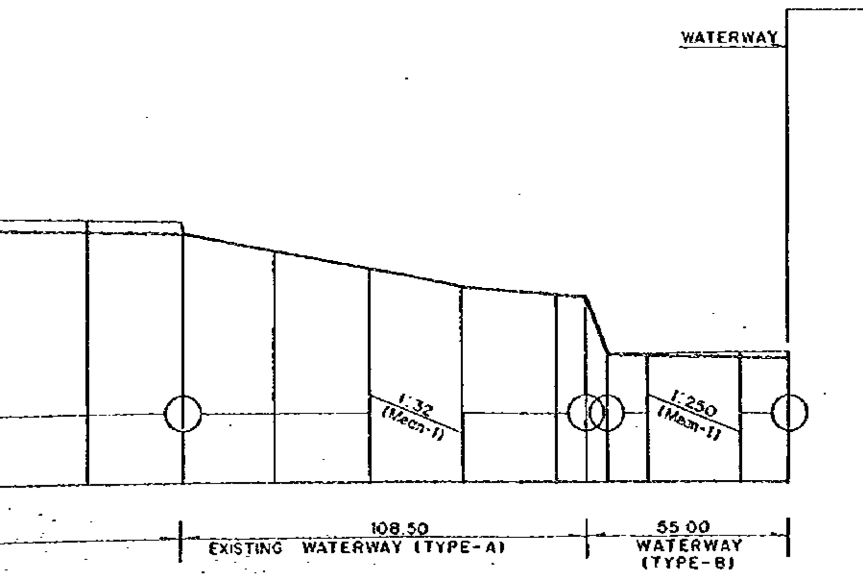
DRAWINGS

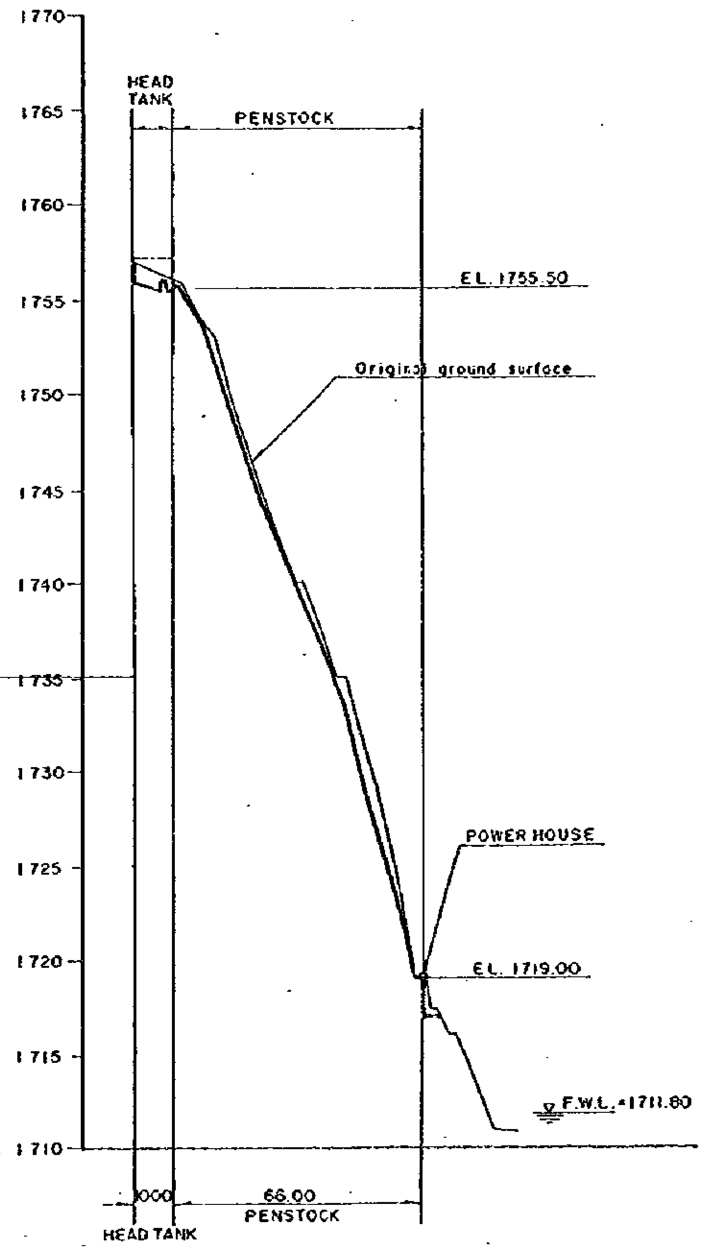




STATION NO.	GROUND HEIGHT	BED LEVEL	ACCUMULATIVE DISTANCE	DISTANCE
NO. 0	1769.40	1769.40	0.0	0.0
NO. 1	1768.56	1768.56	25.0	25.0
NO. 2	1768.09	1768.09	50.0	25.0
NO. 3	1768.33	1768.33	75.0	25.0
NO. 4	1767.89	1767.89	100.0	25.0
NO. 5	1766.79	1766.79	125.0	25.0
NO. 5 +13.5	1766.33	1766.33	138.5	13.5
NO. 6	1766.10	1766.10	150.0	11.5
NO. 7	1765.65	1765.65	175.0	25.0
NO. 8	1765.39	1765.39	200.0	25.0
NO. 9	1764.74	1764.74	225.0	25.0
NO. 9 +15.0	1764.53	1764.53	240.0	15.0
NO.10	1765.00	1764.49	250.0	10.0
NO.11	1765.20	1764.38	275.0	25.0
NO.12	1765.00	1764.27	300.0	25.0
NO.13	1764.90	1764.15	325.0	25.0
NO.14	1764.80	1764.09	350.0	25.0
NO.15	1764.70	1763.94	375.0	25.0
NO.16	1764.60	1763.83	400.0	25.0
NO.17	1764.50	1763.71	425.0	25.0
NO.18	1764.40	1763.61	450.0	25.0
NO.19	1764.30	1763.50	475.0	25.0
NO.20	1764.20	1763.39	500.0	25.0
NO.21	1764.10	1763.24	525.0	25.0
NO.22	1762.32	1762.32	550.0	25.0
NO.23	1761.37	1761.37	575.0	25.0
NO.24	1760.40	1760.40	600.0	25.0
NO.25	1760.00	1760.00	625.0	25.0
NO.25 +8.5	1759.85	1759.85	633.5	8.5
NO.25 +13.5	1756.90	1756.85	638.5	5.0
NO.26	1756.90	1756.80	650.0	11.5
NO.27	1756.90	1756.70	675.0	25.0
NO.27 +13.5	1756.90	1756.65	688.5	13.5

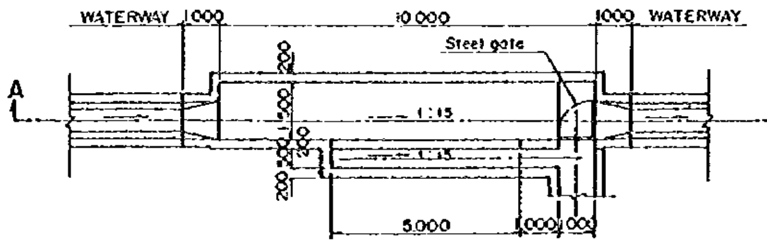




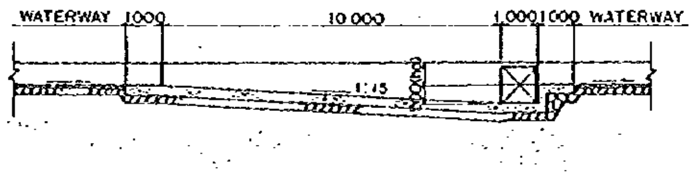


176420	176339	500.0	25.0	NO.20
1764.10	176324	525.0	25.0	NO.21
176232	176232	550.0	25.0	NO.22
1761.37	1761.37	575.0	25.0	NO.23
176040	176040	600.0	25.0	NO.24
176000	176000	625.0	25.0	NO.25
175985	175985	633.5	8.5	NO.25 +8.5
175690	175685	638.5	5.0	NO.25 +13.5
175690	1756.80	650.0	11.5	NO.26
175690	1756.70	675.0	25.0	NO.27
175690	1756.65	688.5	13.5	NO.27 +13.5
175690	175660	688.5	13.5	NO.27 +13.5
1756.10	1755.50	698.5	10.0	
1719.11	1719.00	764.5	66.0	

DIVERSION FACILITY

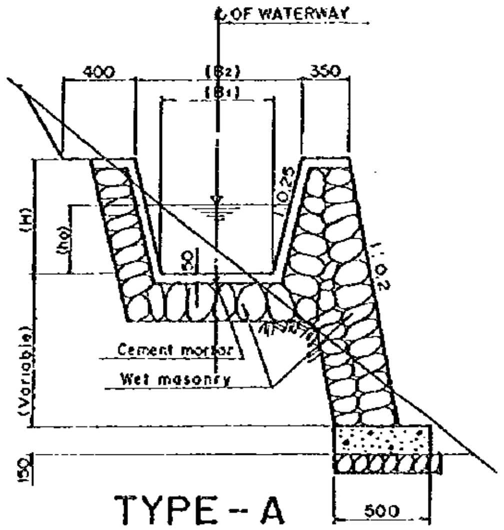


PLAN



SECTION A-A

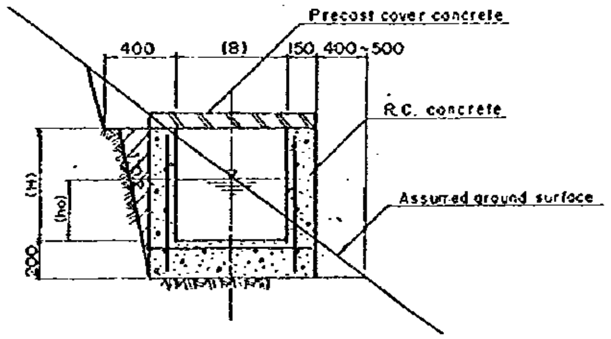
WATERWAY



TYPE - A
TYPICAL SECTION

Typical dimension:

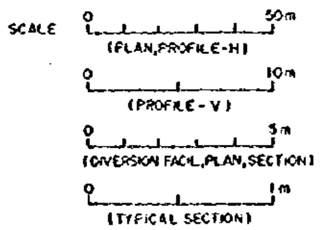
Item	Adardour	Arg	Tidsi
Qmax.	0.15	0.23	0.20
B1	0.60	0.60	0.60
B2	0.90	0.90	0.90
ho	0.40	0.40	0.40
H	0.60	0.60	0.60



TYPE - B
TYPICAL SECTION

Typical dimension: (unit-m)

	Adardour	Arg	Tidsi
Qmax(m³/s)	0.15	0.23	0.20
B	0.55	0.60	0.60
ho	0.25	0.32	0.32
H	0.55	0.60	0.60



MASTER PLAN STUDY ON DECENTRALIZED RURAL ELECTRIFICATION OF HAOUZ REGION IN KINGDOM OF MOROCCO

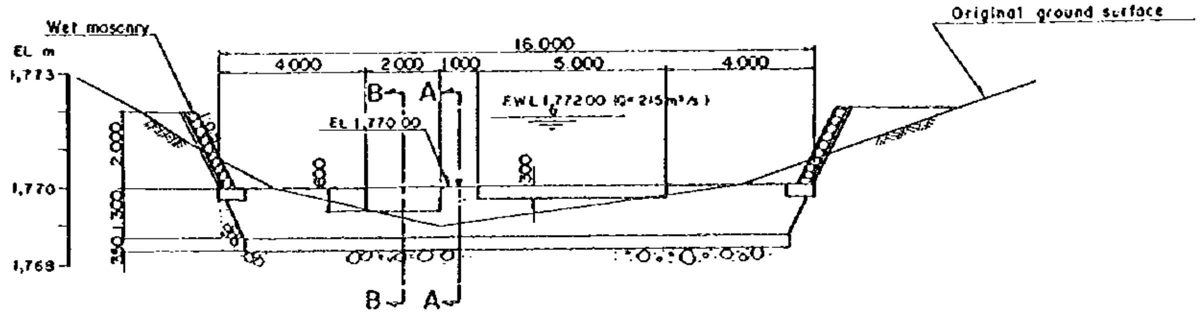
ADARDOUR - MICRO HYDRO POWER PLANT

WATERWAY
GENERAL PLAN AND PROFILE

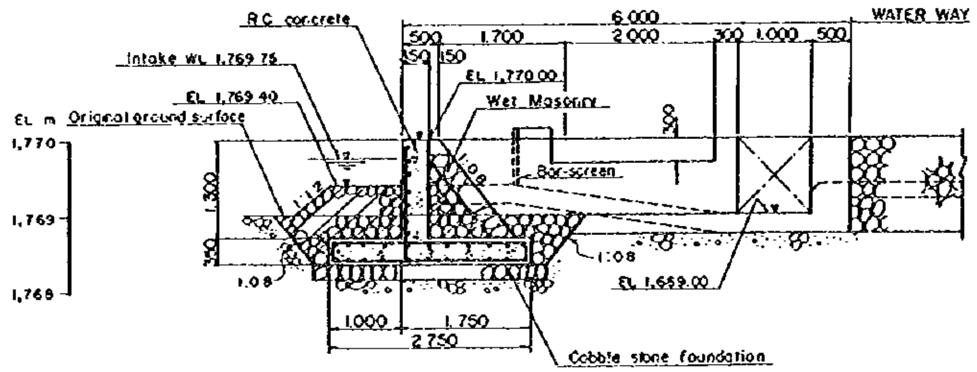
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

DWG.No.	MHC-01	DATE	SEP. 1997

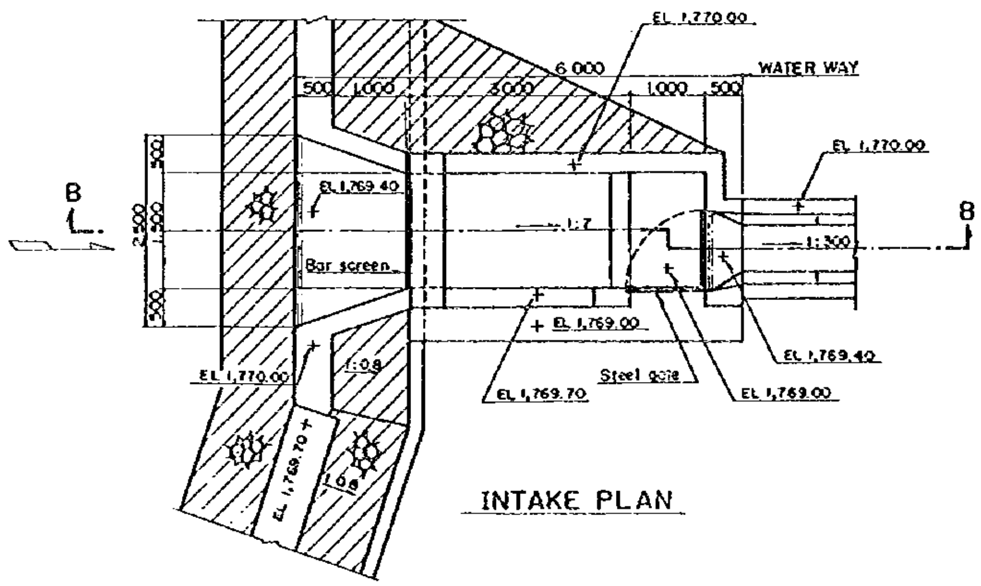
INTAKE



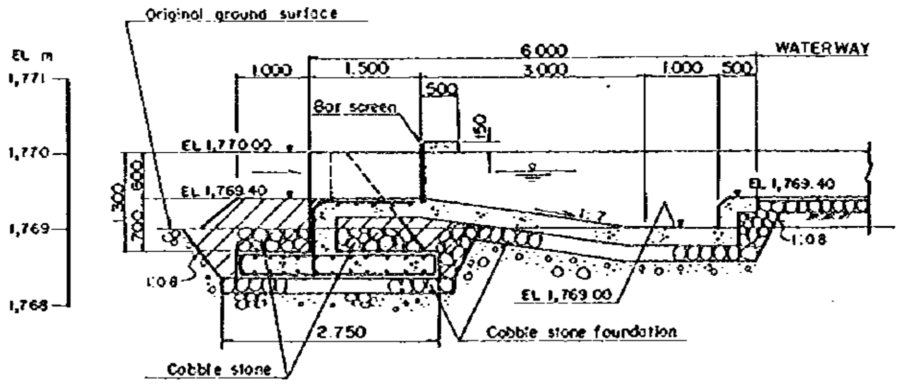
INTAKE WEIR (U.S VIEW)



SECTION A-A

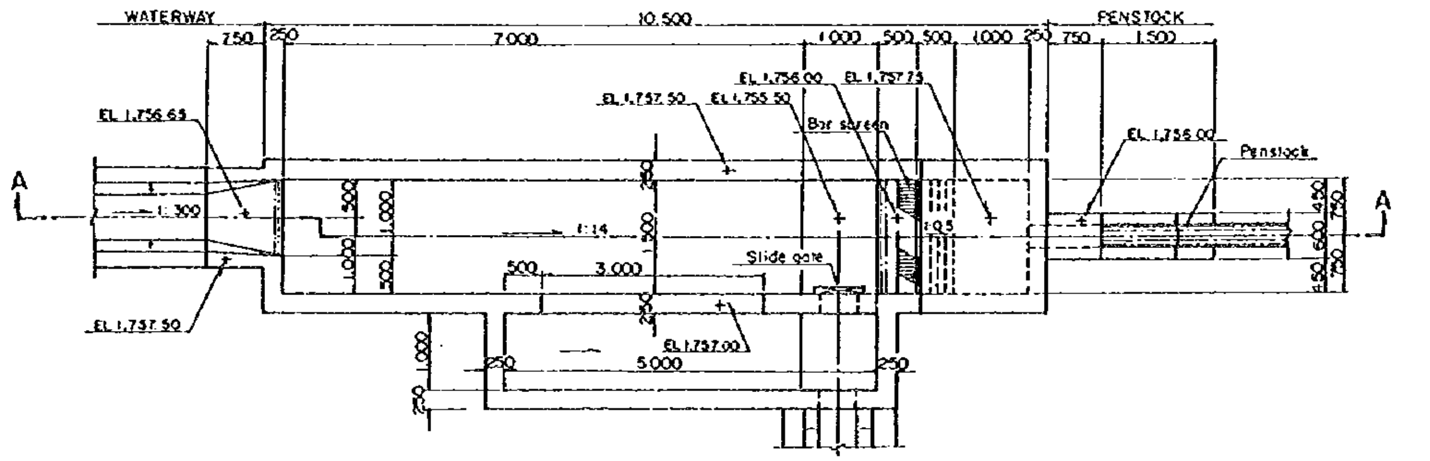


INTAKE PLAN

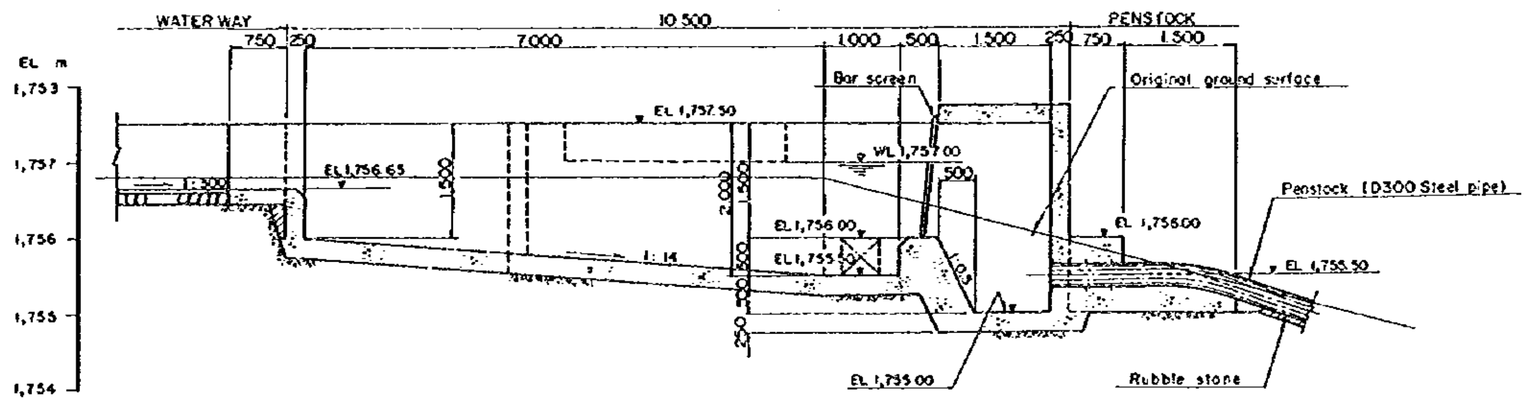


SECTION B-B

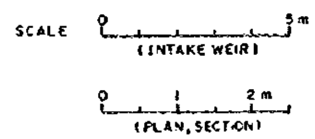
HEADTANK



PLAN



SECTION A-A



MASTER PLAN STUDY ON DECENTRALIZED RURAL ELECTRIFICATION OF HAOUZ REGION IN KINGDOM OF MOROCCO

ADARDOUR - MICRO HYDRO POWER PLANT

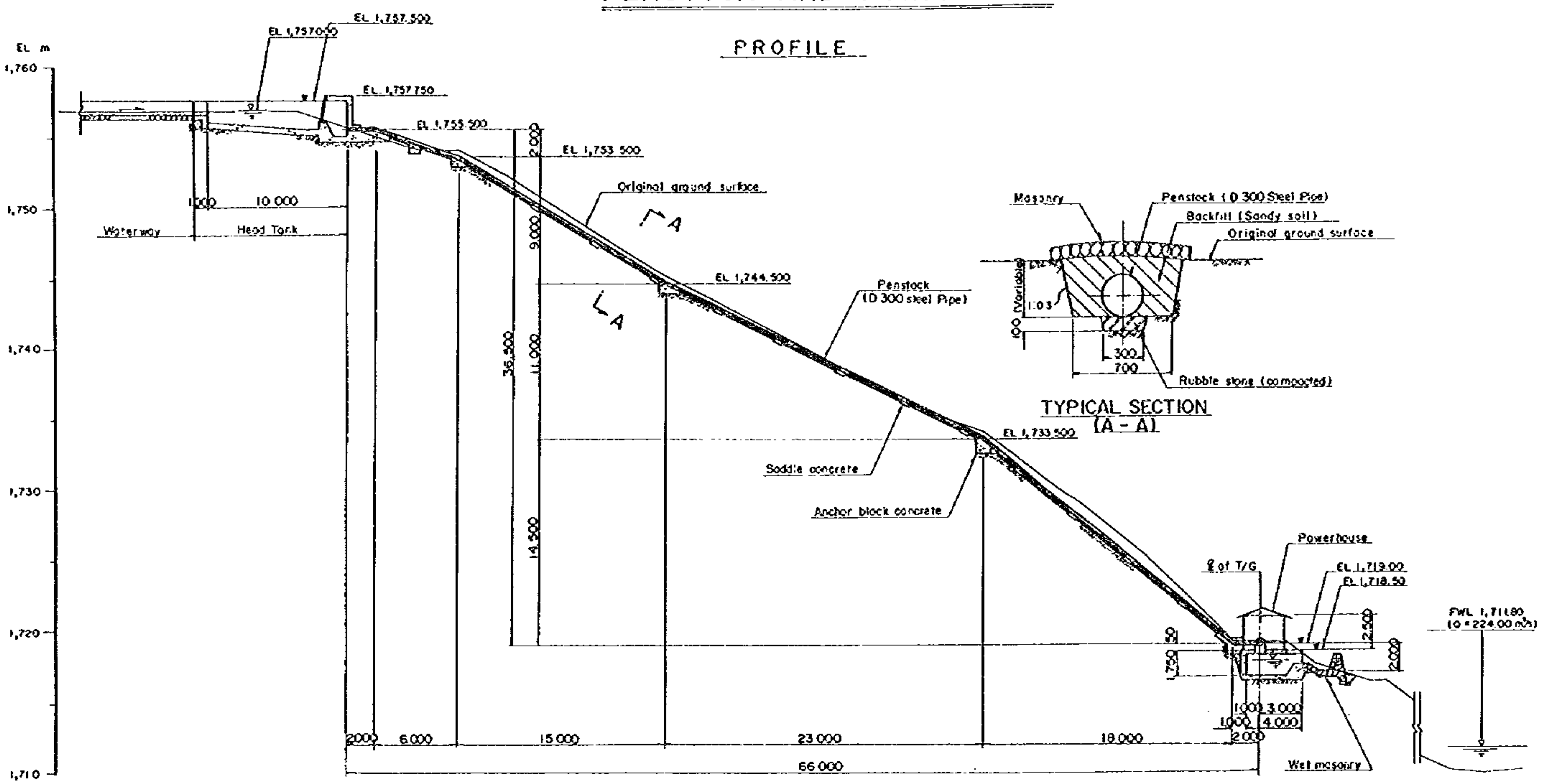
WATERWAY
PLAN AND TYPICAL SECTION

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

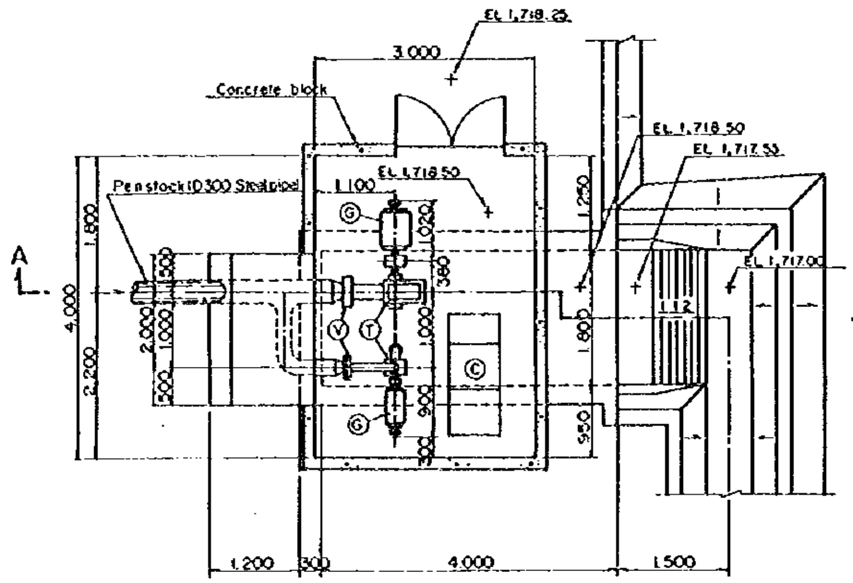
DWG.No.	MHC-02	DATE	SEP. 1997

PENSTOCK AND POWERHOUSE

PROFILE

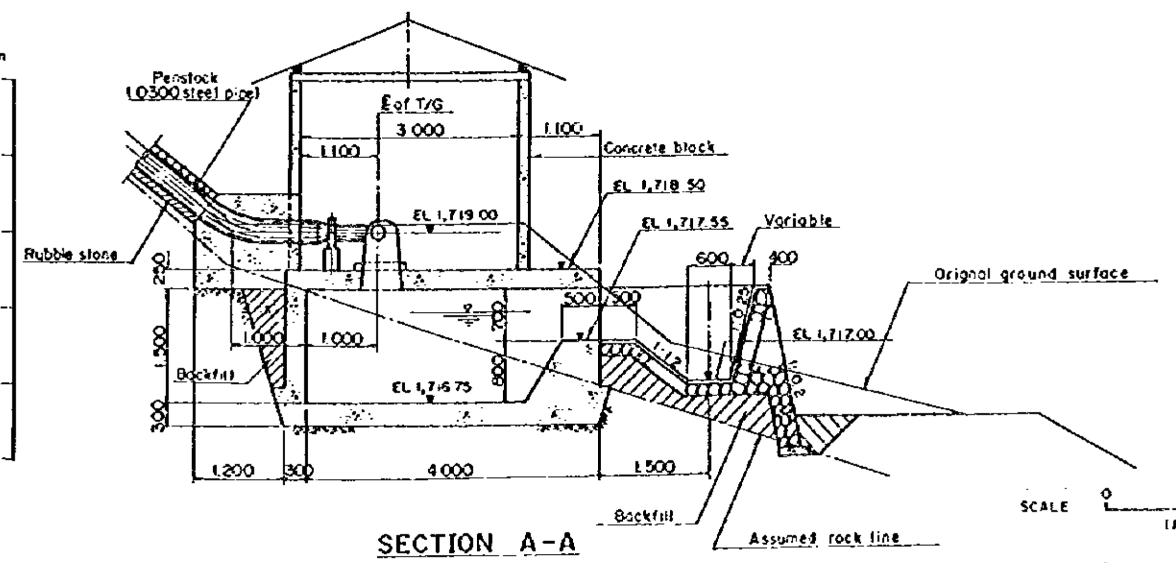


POWERHOUSE



PLAN

Ⓣ Turbine
Ⓖ Generator
Ⓥ Inlet valve
Ⓒ Control panel

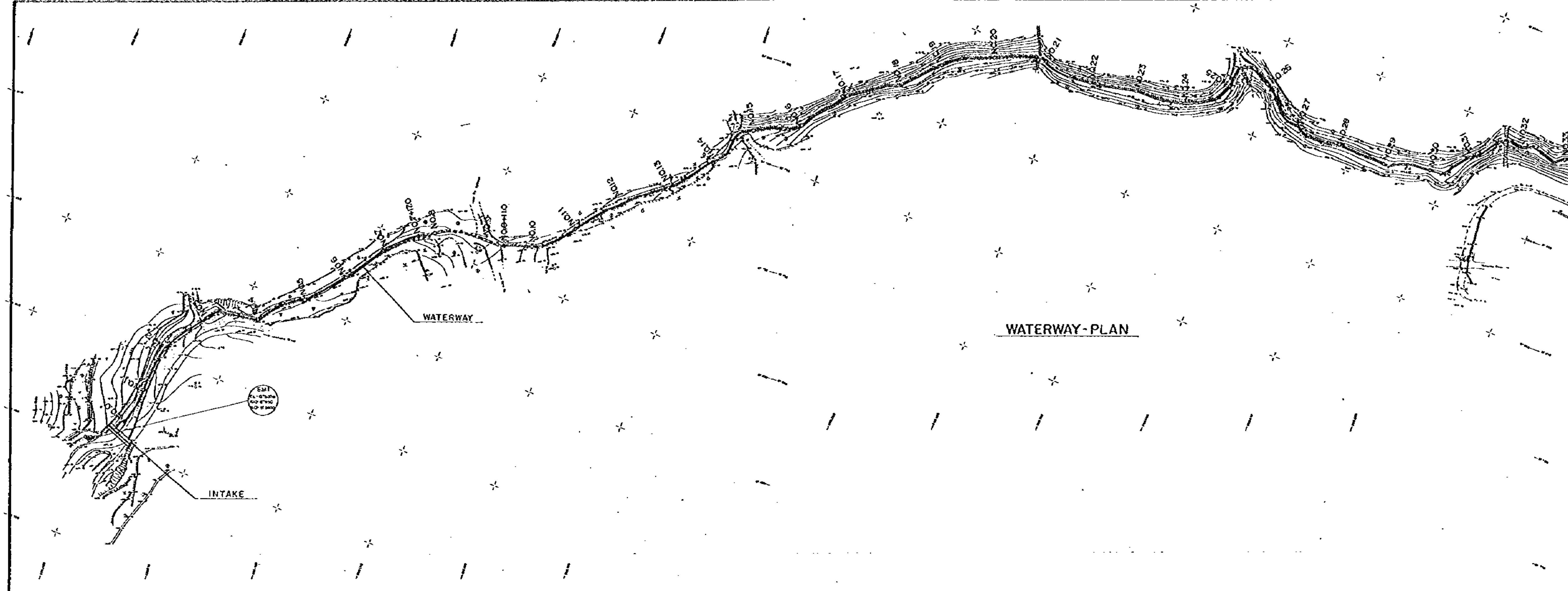


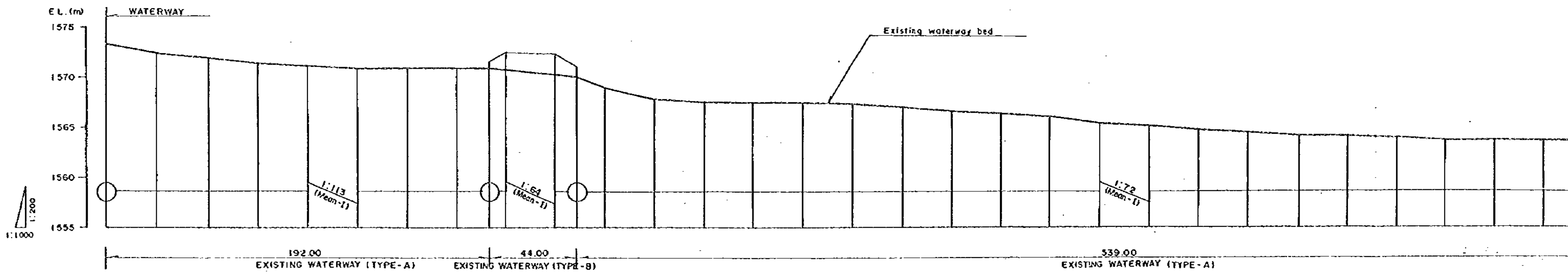
SECTION A-A

SCALE 0 — 10 m (PROFILE)

0 — 1 — 2 m (PLAN, SECTION)

MASTER PLAN STUDY ON DECENTRALIZED RURAL ELECTRIFICATION OF HAOUZ REGION IN KINGDOM OF MOROCCO			
ADARDOUR - MICRO HYDRO POWER PLANT			
PENSTOCK AND POWER HOUSE PROFIEL AND TYPICAL SECTION			
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)			
DWG.No.	MHC-03	DATE	SEP. 1997

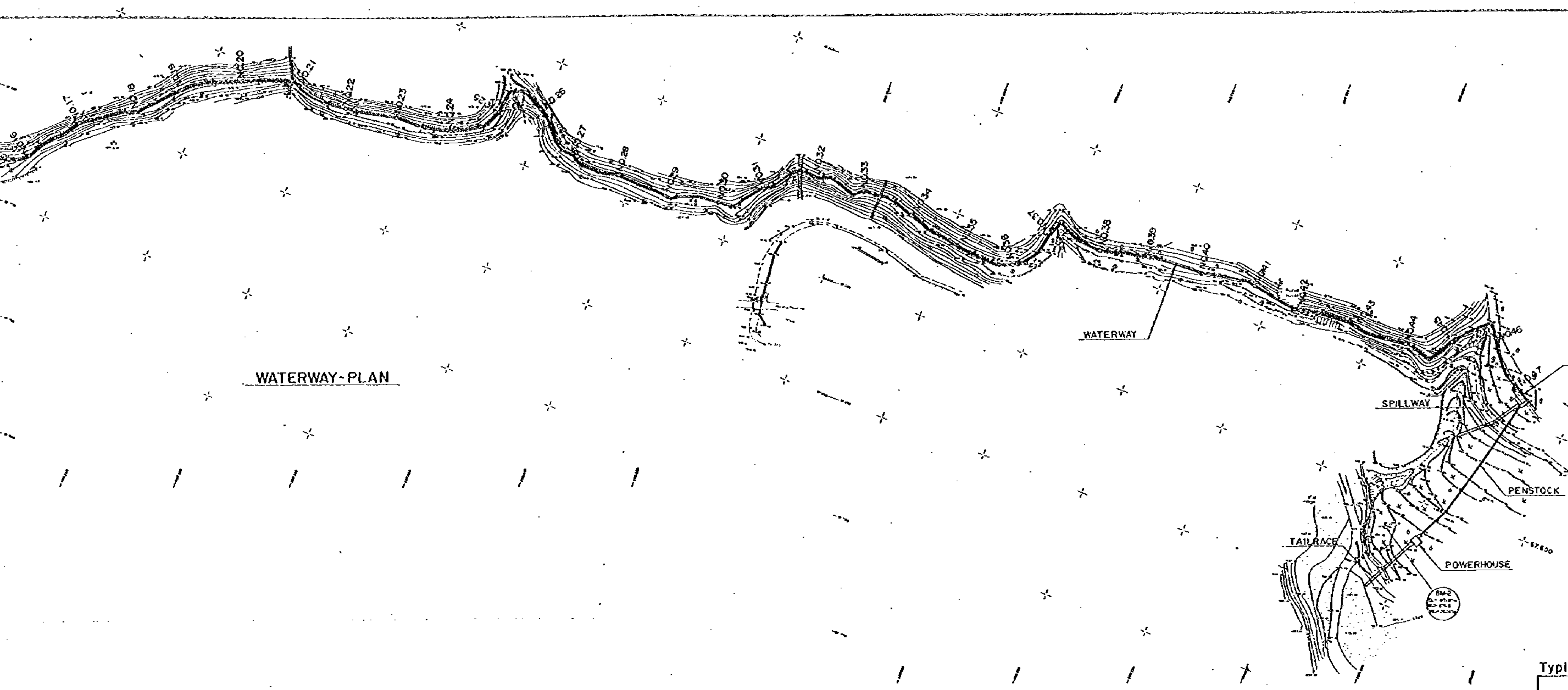


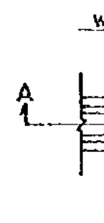


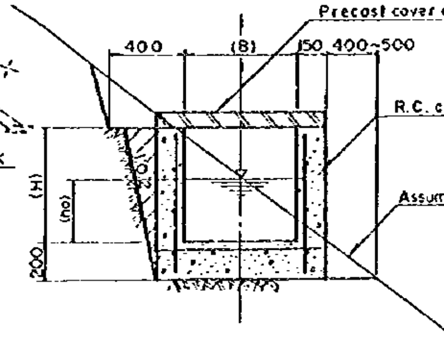
STATION NO.	NO. 0	NO. 1	NO. 2	NO. 3	NO. 4	NO. 5	NO. 6	NO. 7	NO. 7 +17.0	NO. 8	NO. 9
GROUND HEIGHT	1573.30	1572.39	1571.90	1571.41	1571.11	1570.95	1570.99	1570.95	1571.60	1572.55	1572.39
BED LEVEL	1573.30	1572.30	1571.90	1571.41	1571.11	1570.95	1570.99	1570.95	1570.90	1570.75	1570.21
ACCUMU-LATIVE DISTANCE	0.0	25.0	50.0	75.0	100.0	125.0	150.0	175.0	192.0	200.0	225.0
DISTANCE	0.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	17.0	8.0	25.0

STATION NO.	NO. 9 +11.0	NO.10	NO.11	NO.12	NO.13	NO.14	NO.15	NO.16	NO.17	NO.18	NO.19
GROUND HEIGHT	1571.07	1568.90	1567.86	1567.58	1567.44	1567.45	1567.28	1566.97	1566.60	1566.30	1565.95
BED LEVEL	1570.01	1568.90	1567.86	1567.58	1567.44	1567.45	1567.28	1566.97	1566.60	1566.30	1565.95
ACCUMU-LATIVE DISTANCE	236.0	250.0	275.0	300.0	325.0	350.0	375.0	400.0	425.0	450.0	475.0
DISTANCE	11.0	14.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0

STATION NO.	NO.20	NO.21	NO.22	NO.23	NO.24	NO.25	NO.26	NO.27	NO.28	NO.29
GROUND HEIGHT	1565.30	1565.07	1564.73	1564.56	1564.12	1564.06	1563.94	1563.63	1563.60	1563.63
BED LEVEL	1565.30	1565.07	1564.73	1564.56	1564.12	1564.06	1563.94	1563.63	1563.60	1563.63
ACCUMU-LATIVE DISTANCE	500.0	525.0	550.0	575.0	600.0	625.0	650.0	675.0	700.0	725.0
DISTANCE	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0



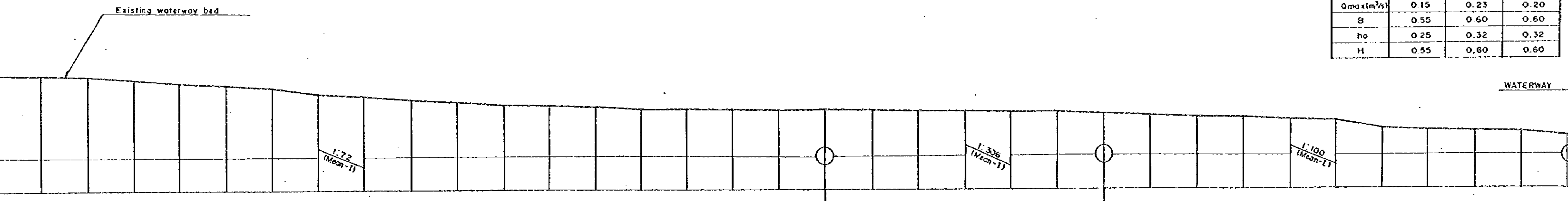




TYPE-B

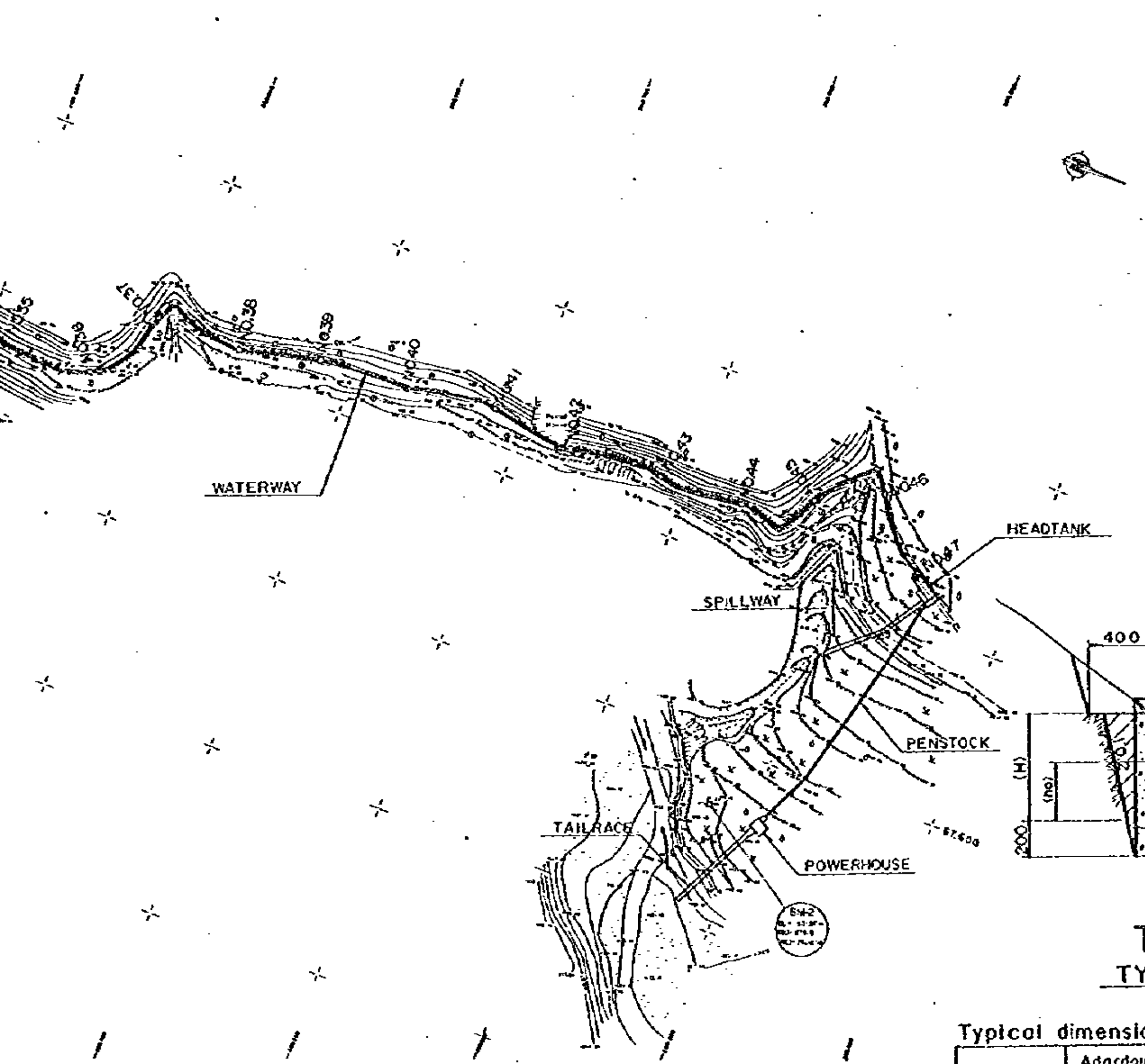
TYPICAL SECTION

Typical dimension:		(unit-m)	
	Adordour	Arg	Tidsi
Qmax(m³/s)	0.15	0.23	0.20
B	0.55	0.60	0.60
ho	0.25	0.32	0.32
H	0.55	0.60	0.60

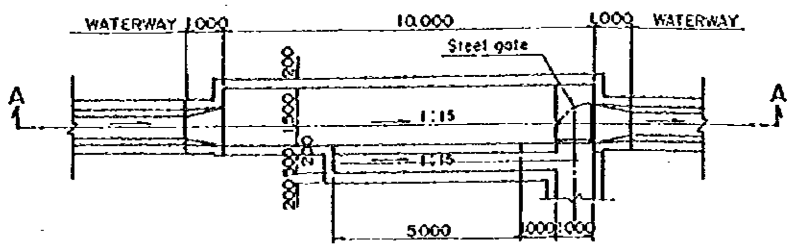


539.00 EXISTING WATERWAY (TYPE-A) | 150.00 WATERWAY (TYPE-B) | 252.00 EXISTING WATERWAY (TYPE-A)

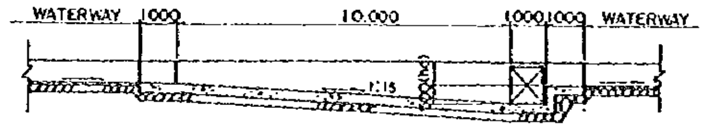
NO.14	25.0	350.0	1567.45	1567.45
NO.15	25.0	375.0	1567.28	1567.28
NO.16	25.0	400.0	1566.97	1566.97
NO.17	25.0	425.0	1566.60	1566.60
NO.18	25.0	450.0	1566.30	1566.30
NO.19	25.0	475.0	1565.95	1565.95
NO.20	25.0	500.0	1565.30	1565.30
NO.21	25.0	525.0	1565.07	1565.07
NO.22	25.0	550.0	1564.73	1564.73
NO.23	25.0	575.0	1564.56	1564.56
NO.24	25.0	600.0	1564.12	1564.12
NO.25	25.0	625.0	1564.06	1564.06
NO.26	25.0	650.0	1563.94	1563.94
NO.27	25.0	675.0	1563.63	1563.63
NO.28	25.0	700.0	1563.60	1563.60
NO.29	25.0	725.0	1563.63	1563.63
NO.30	25.0	750.0	1563.54	1563.54
NO.31	25.0	775.0	1563.61	1563.61
NO.32	25.0	800.0	1563.55	1563.55
NO.33	25.0	825.0	1563.42	1563.42
NO.34	25.0	850.0	1563.39	1563.39
NO.35	25.0	875.0	1563.34	1563.34
NO.36	25.0	900.0	1563.30	1563.30
NO.37	25.0	925.0	1563.12	1563.12
NO.38	25.0	950.0	1562.85	1562.83
NO.39	25.0	975.0	1562.70	1562.70
NO.40	25.0	1000.0	1562.64	1562.64
NO.41	25.0	1025.0	1562.44	1562.44
NO.42	25.0	1050.0	1562.29	1562.29
NO.43	25.0	1075.0	1561.44	1561.44
NO.44	25.0	1100.0	1561.32	1561.32
NO.45	25.0	1125.0	1561.10	1561.10
NO.46	25.0	1150.0	1561.04	1561.04
NO.47	25.0	1175.0	1560.39	1560.43



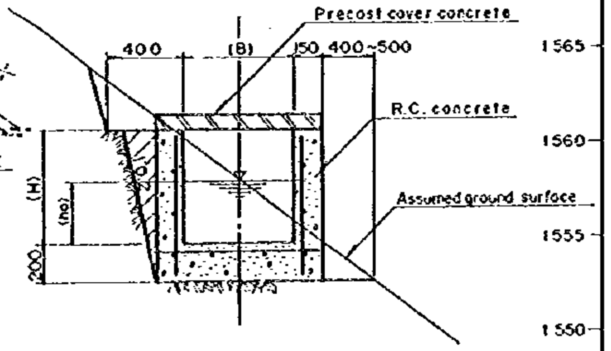
DIVERSION FACILITY



PLAN



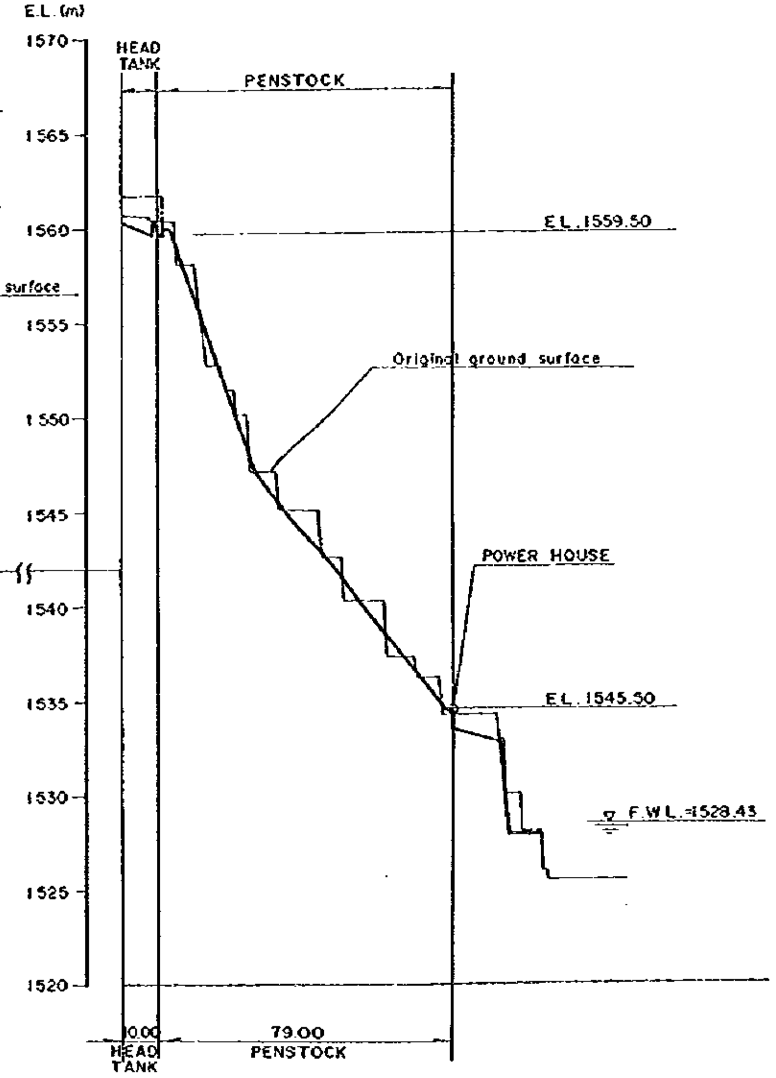
SECTION A-A

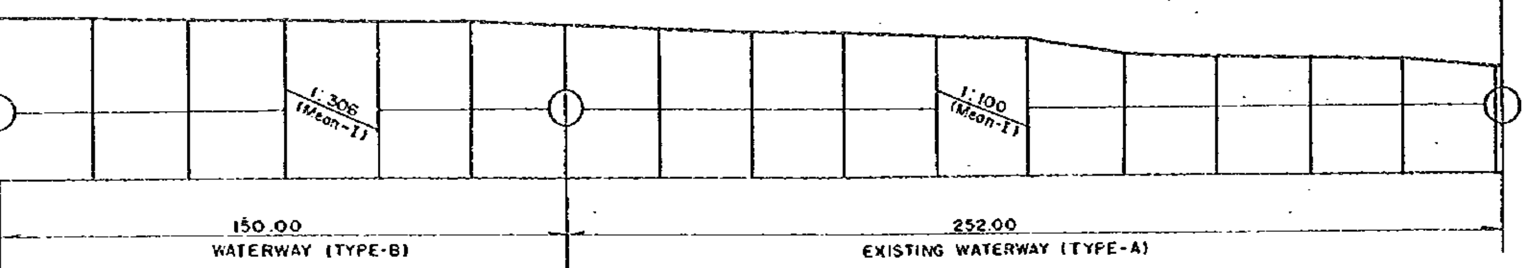


TYPE-B
TYPICAL SECTION

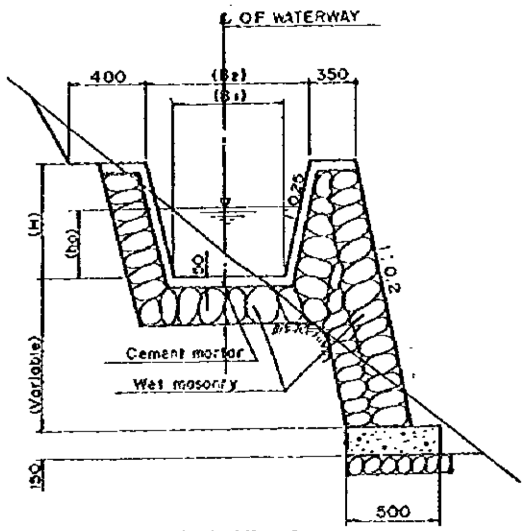
Typical dimension: (unit-m)

	Adardour	Arg	Tidsi
Qmax(m³/s)	0.15	0.23	0.20
B	0.55	0.60	0.60
ho	0.25	0.32	0.32
H	0.55	0.60	0.60





WATERWAY



TYPE-A
TYPICAL SECTION

Typical dimension:

Item	Adardour	Arg	Tidsi
Qmax.	0.15	0.23	0.20
B1	0.60	0.60	0.60
B2	0.90	0.90	0.90
ho	0.40	0.40	0.40
H	0.60	0.60	0.60

[illegible]	[illegible]	775.0	25.0	NO.31
1563.55	1563.55	800.0	25.0	NO.32
1563.42	1563.42	825.0	25.0	NO.33
1563.39	1563.39	850.0	25.0	NO.34
1563.34	1563.34	875.0	25.0	NO.35
1563.30	1563.30	900.0	25.0	NO.36
1563.12	1563.12	925.0	25.0	NO.37
1562.83	1562.83	950.0	25.0	NO.38
1562.70	1562.70	975.0	25.0	NO.39
1562.64	1562.64	1000.0	25.0	NO.40
1562.44	1562.44	1025.0	25.0	NO.41
1562.29	1562.29	1050.0	25.0	NO.42
1561.44	1561.44	1075.0	25.0	NO.43
1561.32	1561.32	1100.0	25.0	NO.44
1561.10	1561.10	1125.0	25.0	NO.45
1561.04	1561.04	1150.0	25.0	NO.46
1560.43	1560.59	1175.0	25.0	NO.47
1560.35	1560.60	1177.0	2.0	NO.47 +2.00
1560.35	1560.00	1177.0	2.0	NO.47 +2.00
1559.50	1559.50	1187.0	10.0	
1534.30	1534.50	1266.0	79.0	

SCALE

0 50m (PLAN, PROFILE-H)

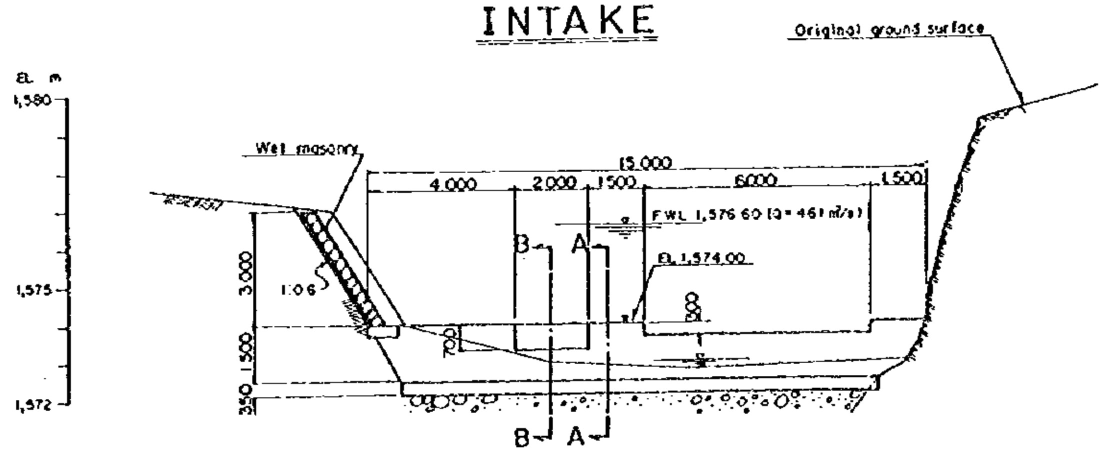
0 10m (PROFILE-V)

0 5m (DIVERSION FACIL. PLAN, SECTION)

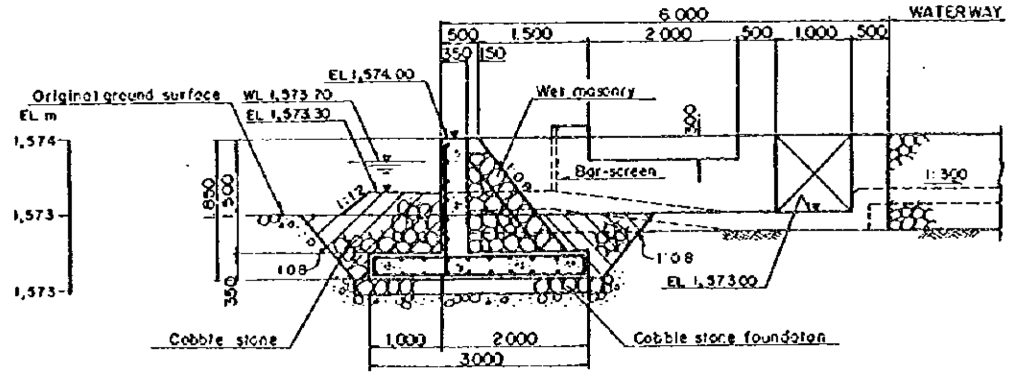
0 1m (TYPICAL SECTION)

MASTER PLAN STUDY ON DECENTRALIZED RURAL ELECTRIFICATION OF HAOUZ REGION IN KINGDOM OF MOROCCO	
ARG-MICRO HYDRO POWER PLANT WATERWAY GENERAL PLAN AND PROFILE	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	
DWG.No. MHC-04	DATE SEP. 1997

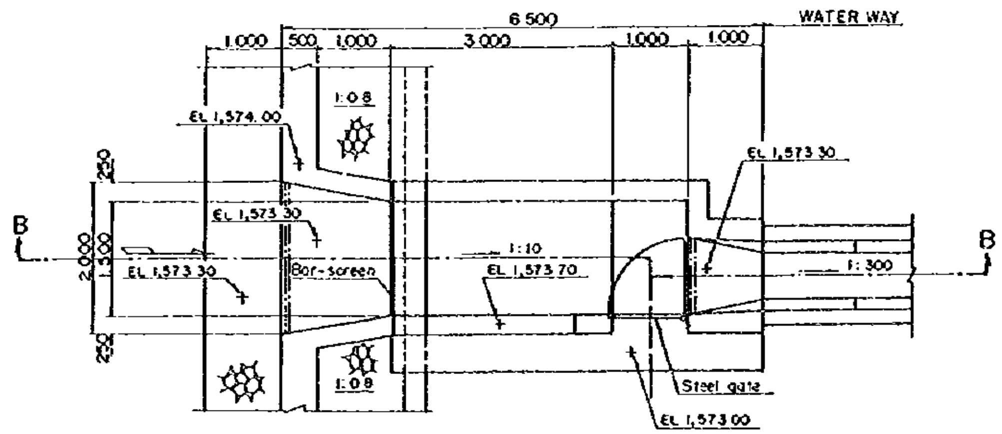
INTAKE



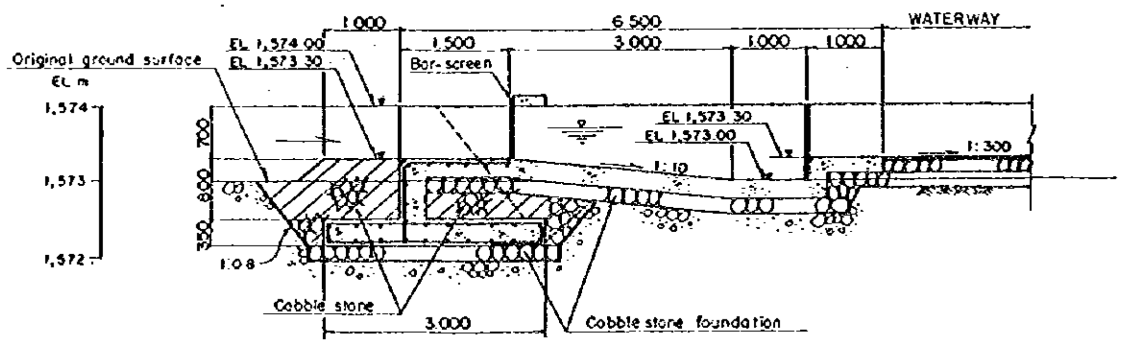
INTAKE WEIR (U.S VIEW)



SECTION A-A

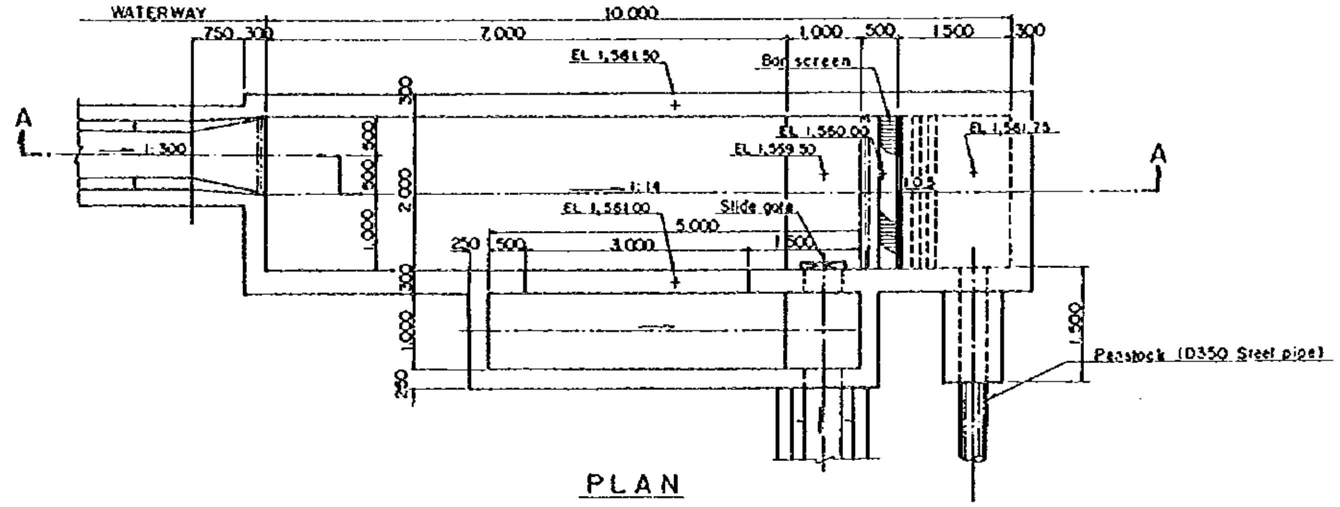


INTAKE PLAN

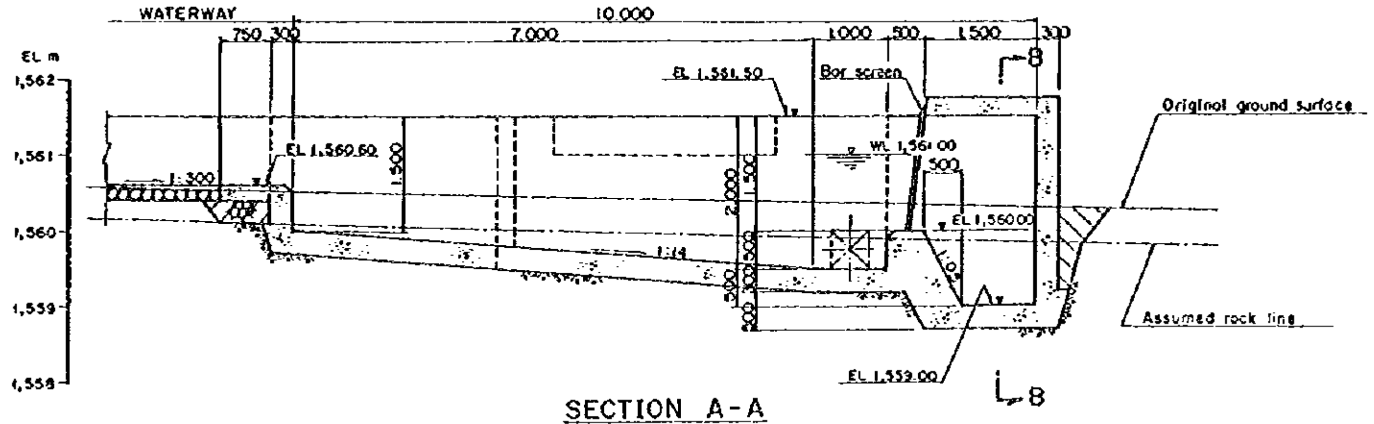


SECTION B-B

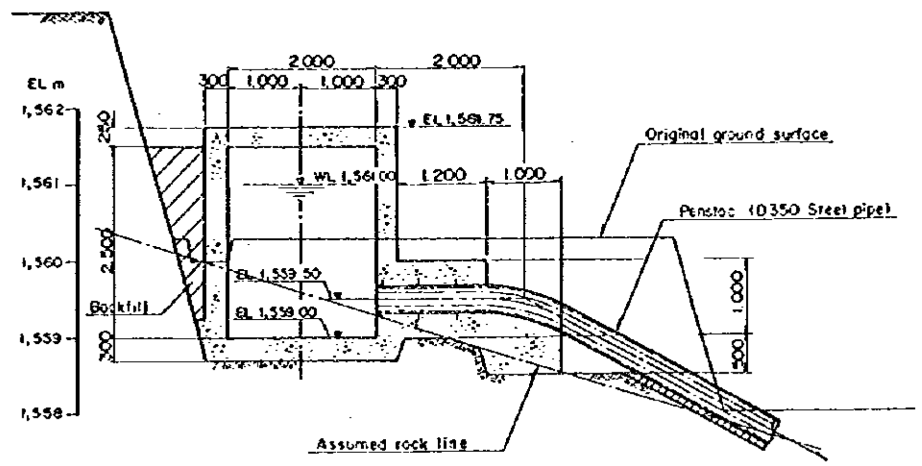
HEADTANK



PLAN



SECTION A-A



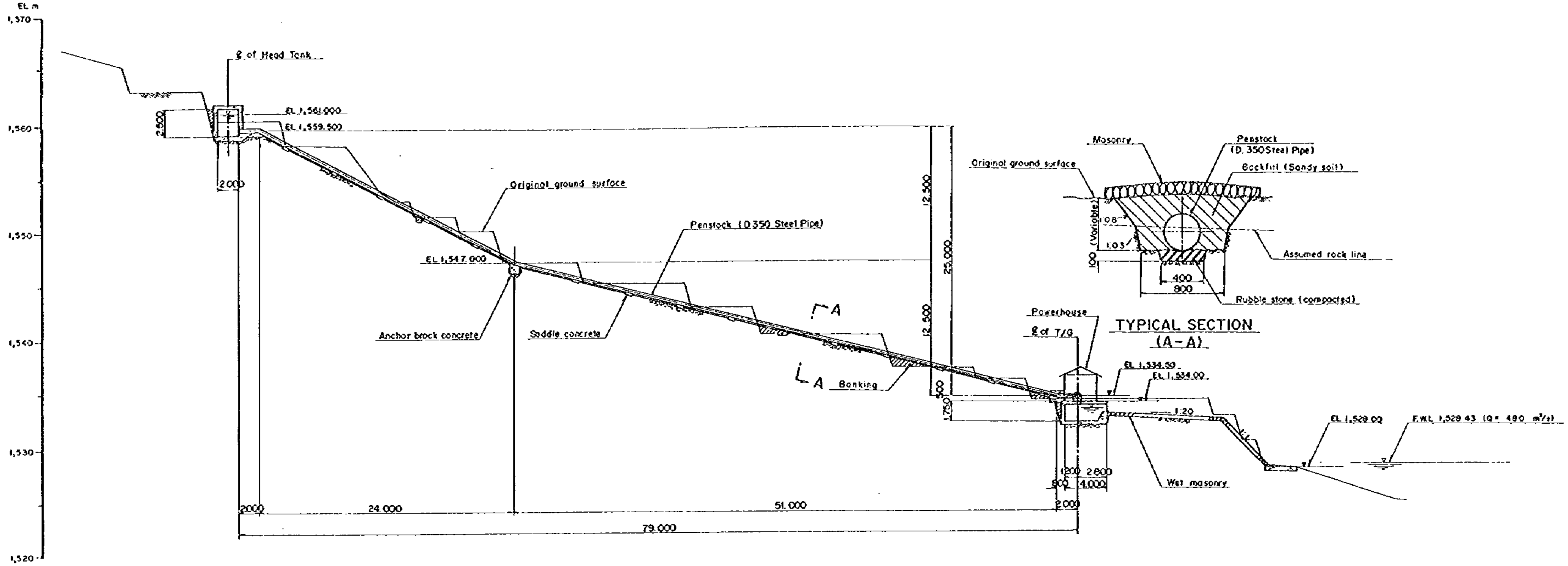
SECTION B-B

SCALE 0 — 5 m (INTAKE WEIR)

0 — 1 — 2 m (PLAN, SECTION)

MASTER PLAN STUDY ON DECENTRALIZED RURAL ELECTRIFICATION OF HAOUZ REGION IN KINGDOM OF MOROCCO			
ARG - MICRO HYDRO POWER PLANT WATERWAY PLAN AND TYPICAL SECTION			
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)			
DWG.No.	MHC-05	DATE	SEP. 1997

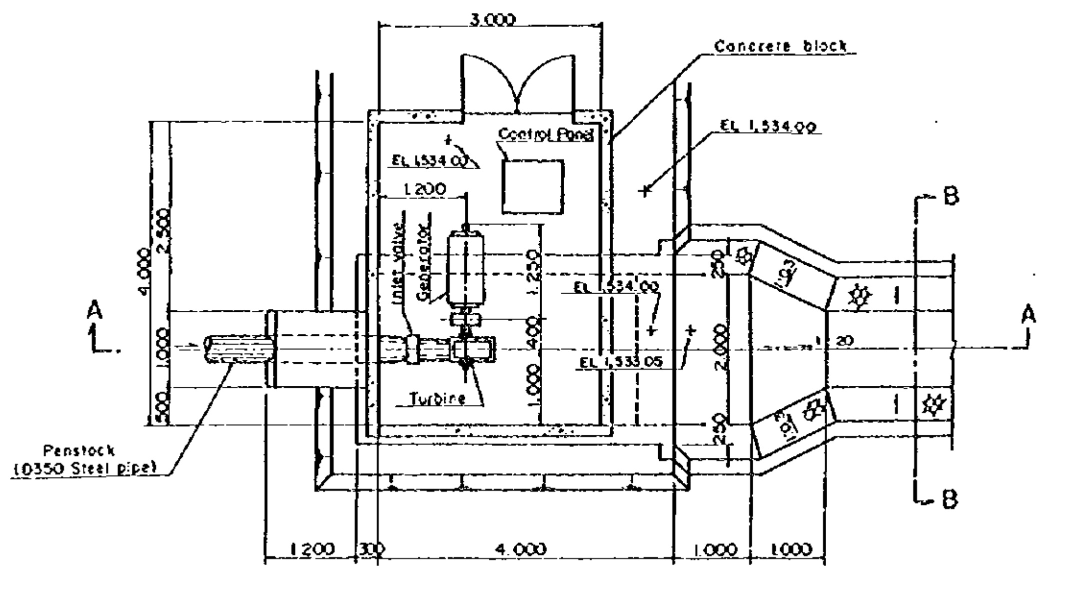
PENSTOCK AND POWERHOUSE



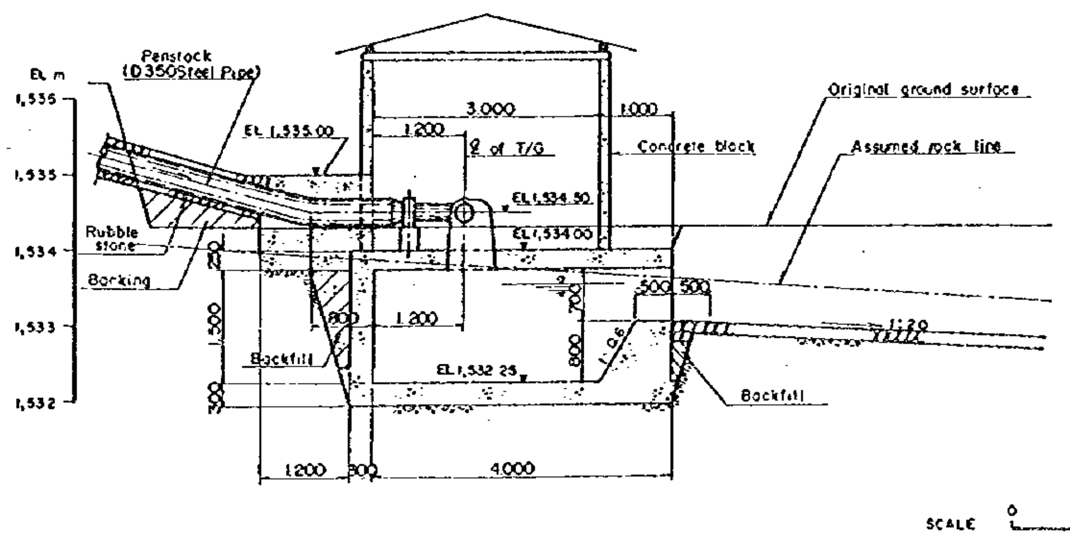
TYPICAL SECTION (A-A)

PROFILE

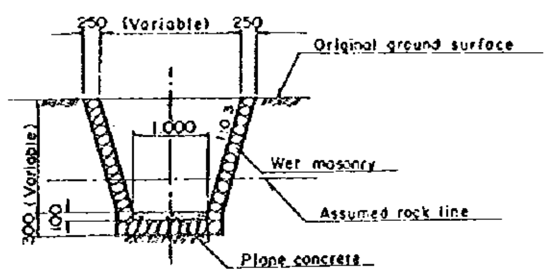
POWERHOUSE



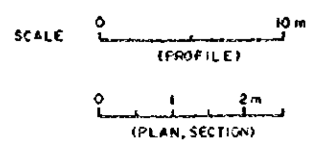
PLAN



SECTION A-A

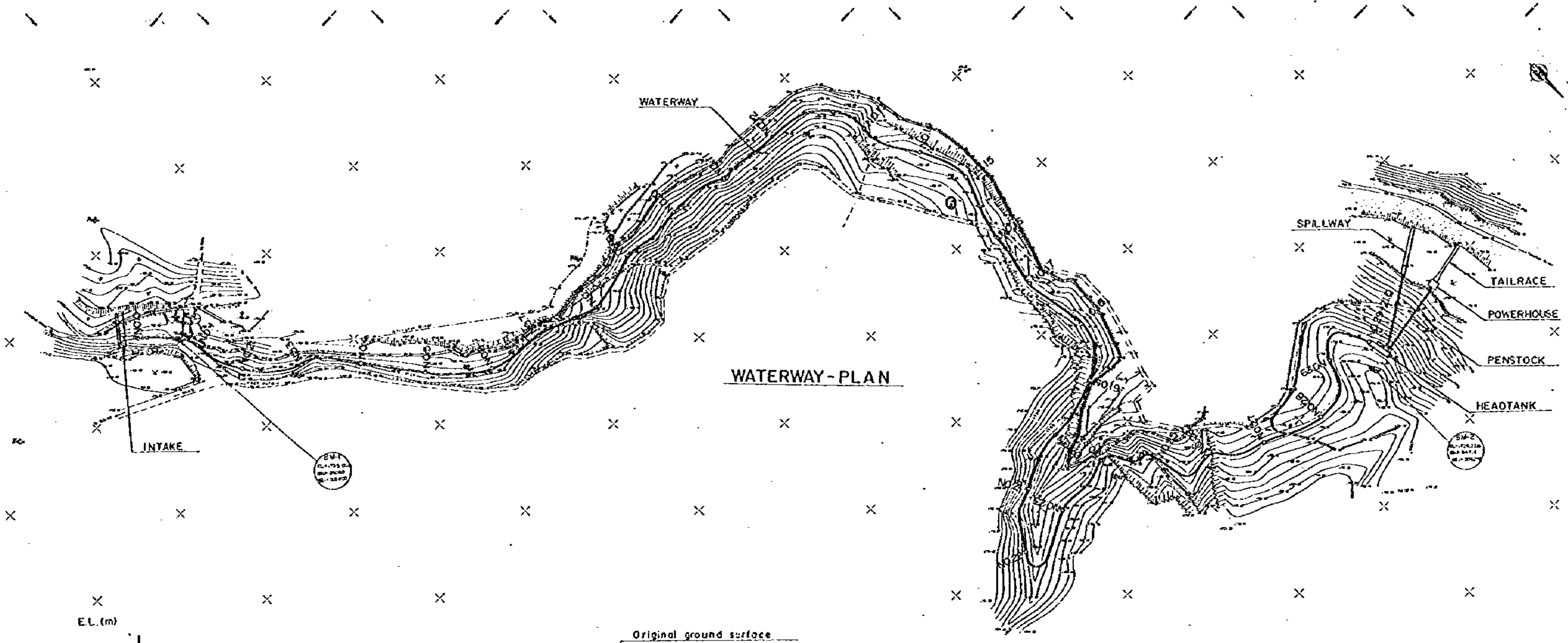


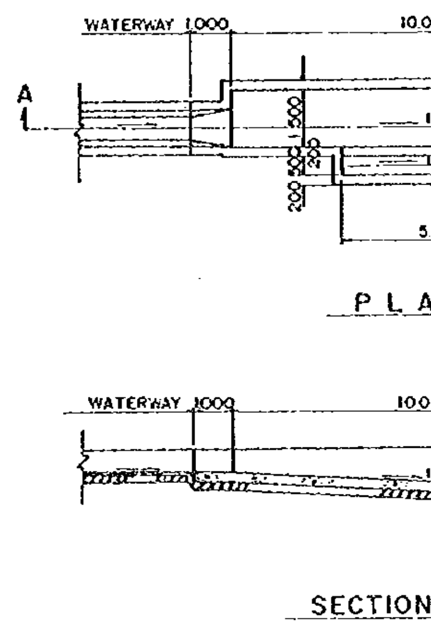
SECTION B-B

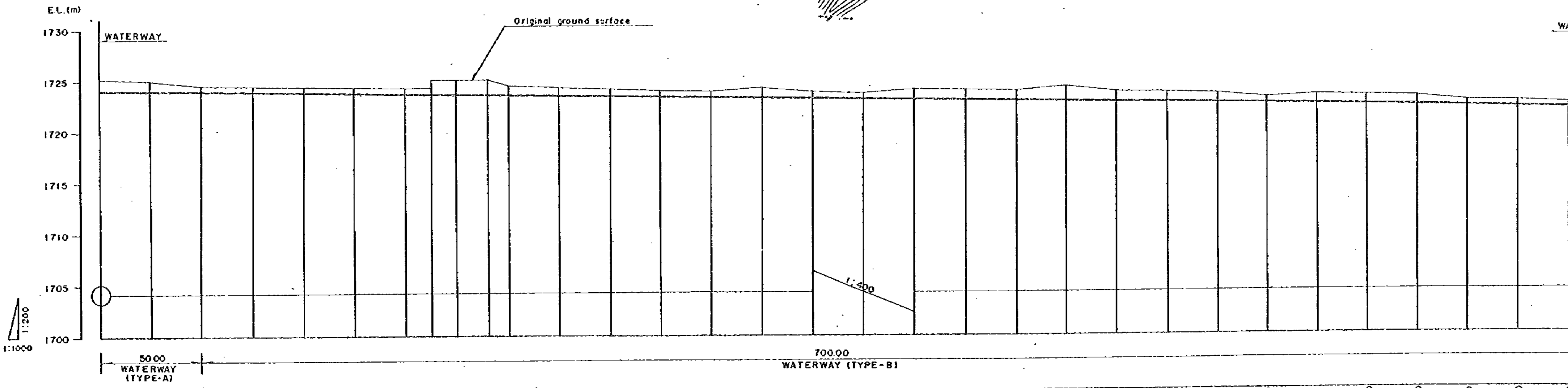


MASTER PLAN STUDY ON DECENTRALIZED RURAL ELECTRIFICATION OF HAOUZ REGION IN KINGDOM OF MOROCCO	
ARG - MICRO HYDRO POWER PLANT	
PENSTOCK AND POWER HOUSE PROFIEL AND TYPICAL SECTION	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	
DWG.No MHC-06	DATE SEP. 1997

DIVERSION

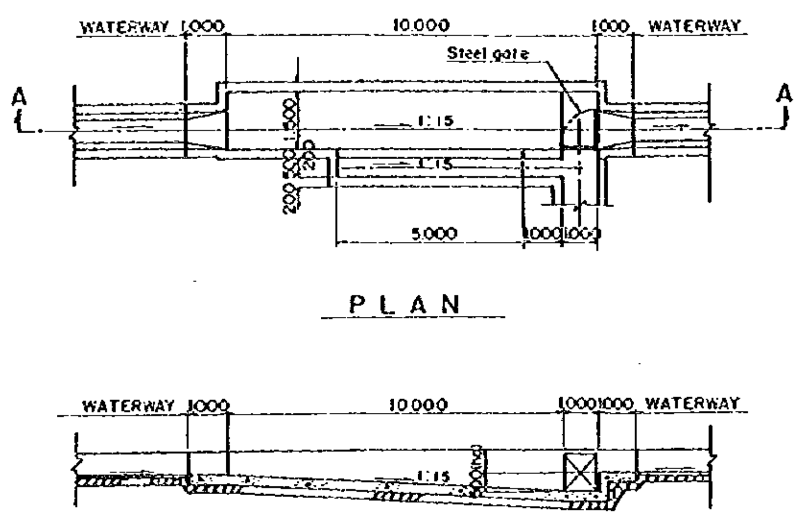




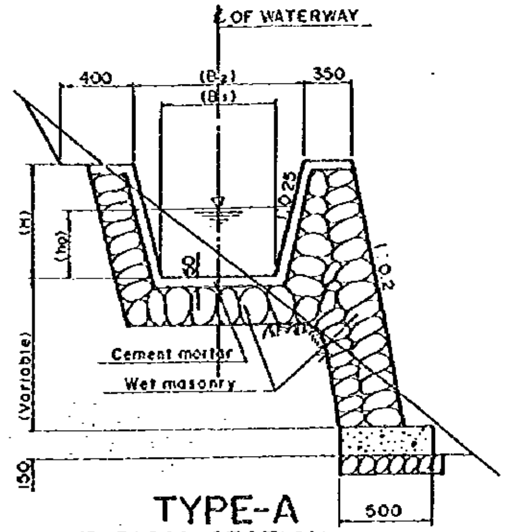


STATION NO.	GROUND HEIGHT	BED LEVEL	ACCUMULATIVE DISTANCE	DISTANCE
NO. 0	1725.20	1724.10	0.0	0.0
NO. 1	1725.00	1724.02	25.0	25.0
NO. 2	1724.50	1723.93	50.0	25.0
NO. 3	1724.40	1723.85	75.0	25.0
NO. 4	1724.30	1723.77	100.0	25.0
NO. 5	1724.30	1723.68	125.0	25.0
NO. 6	1724.20	1723.60	150.0	25.0
NO. 7	1725.00	1723.52	175.0	25.0
NO. 8	1724.50	1723.43	200.0	25.0
NO. 9	1724.10	1723.35	225.0	25.0
NO.10	1724.00	1723.27	250.0	25.0
NO.11	1723.80	1723.18	275.0	25.0
NO.12	1723.70	1723.10	300.0	25.0
NO.13	1724.00	1723.02	325.0	25.0
NO.14	1723.60	1722.93	350.0	25.0
NO.15	1723.50	1722.85	375.0	25.0
NO.16	1723.80	1722.77	400.0	25.0
NO.17	1723.70	1722.68	425.0	25.0
NO.18	1723.60	1722.60	450.0	25.0
NO.19	1724.00	1722.52	475.0	25.0
NO.20	1723.50	1722.43	500.0	25.0
NO.21	1723.40	1722.35	525.0	25.0
NO.22	1723.30	1722.27	550.0	25.0
NO.23	1722.80	1722.18	575.0	25.0
NO.24	1723.10	1722.10	600.0	25.0
NO.25	1723.00	1722.02	625.0	25.0
NO.26	1722.90	1721.93	650.0	25.0
NO.27	1722.40	1721.85	675.0	25.0
NO.28	1722.40	1721.77	700.0	25.0

DIVERSION FACILITY



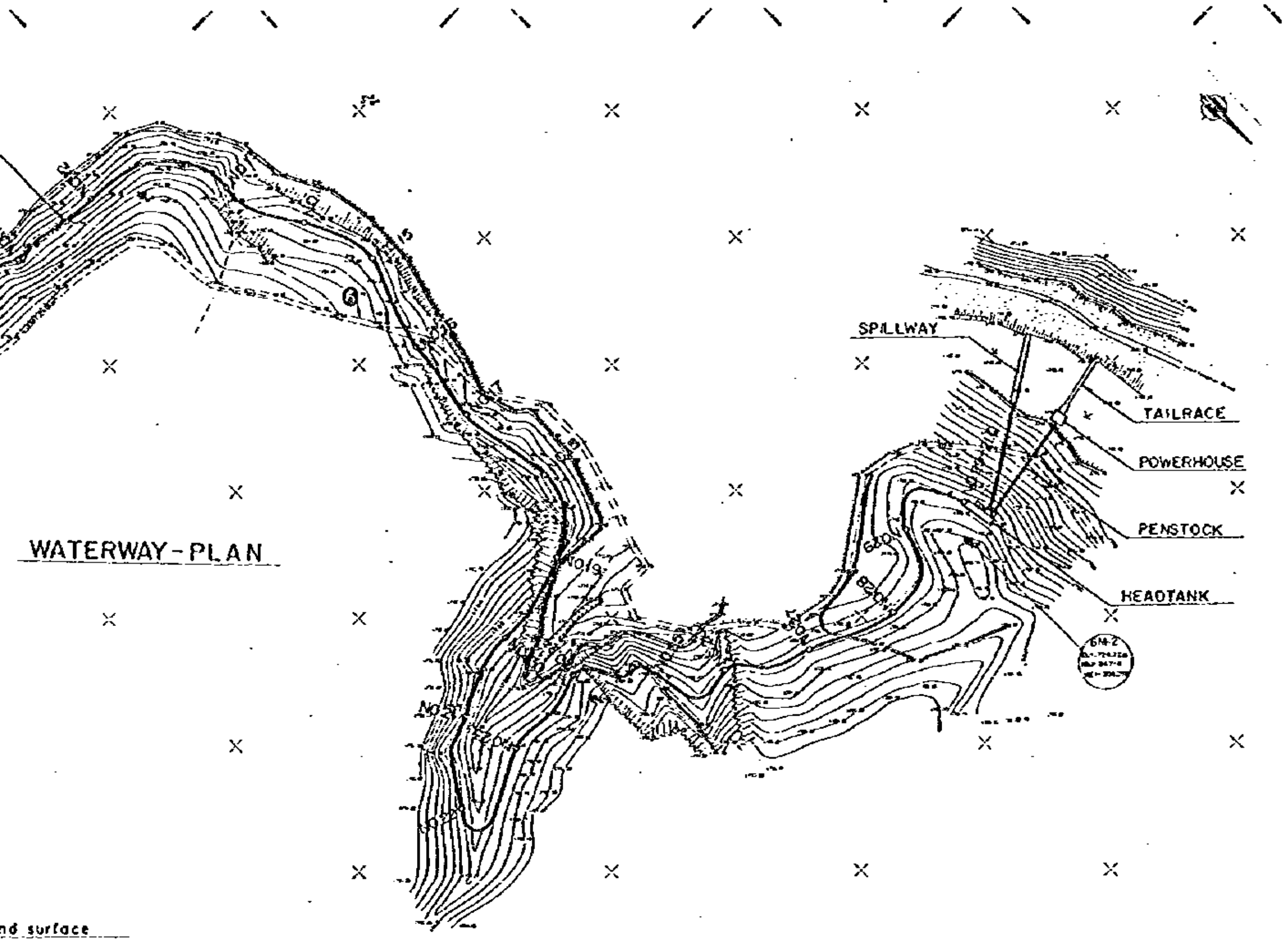
WATERWAY

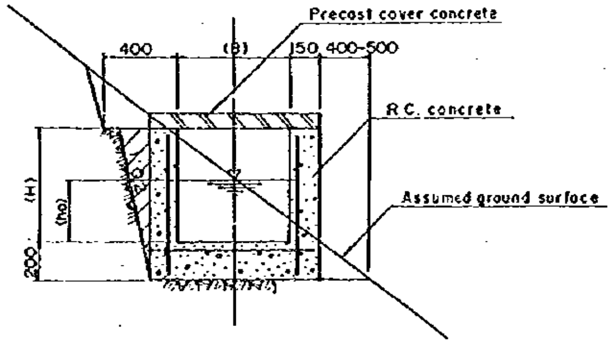


TYPE-A
TYPICAL SECTION

Typical demension:

Item	Adordour	Arg	Tidsi
Qmax.	0.15	0.23	0.20
B1	0.60	0.60	0.60
B2	0.90	0.90	0.90
ho	0.40	0.40	0.40
H	0.60	0.60	0.60

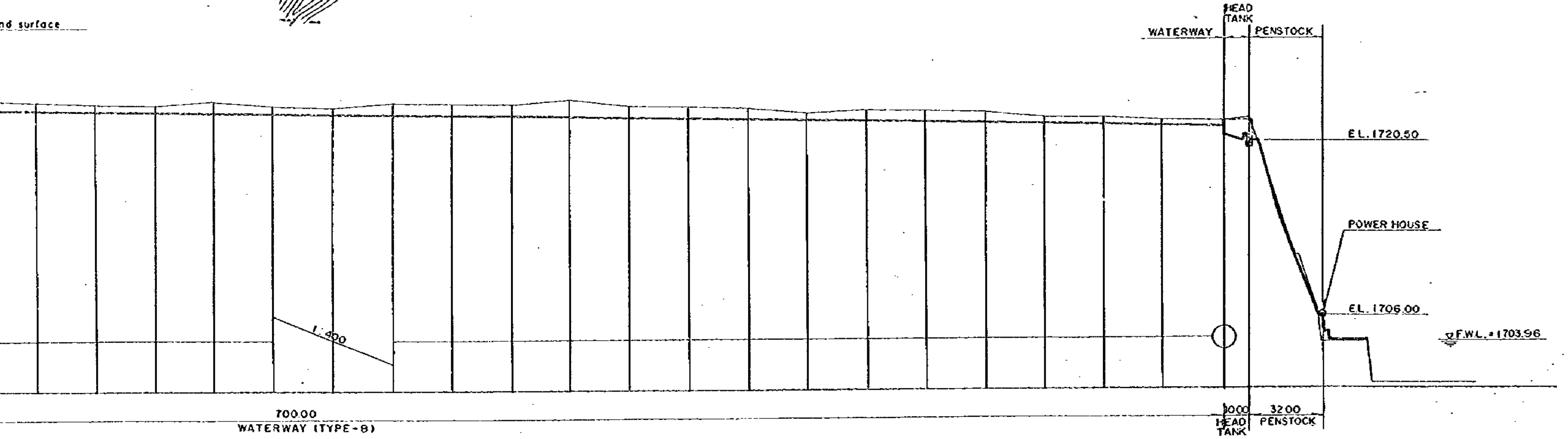




TYPE-B
TYPICAL SECTION

Typical demension: (unit-m)

	Adordour	Arg	Tidsi
Qmax(m³/s)	0.15	0.23	0.20
B	0.55	0.60	0.60
ho	0.25	0.32	0.32
H	0.55	0.60	0.60



Station	Interval	Distance	Bed elevation	Ground elevation
NO.10	25.0	250.0	1723.27	1724.00
NO.11	25.0	275.0	1723.18	1723.80
NO.12	25.0	300.0	1723.10	1723.70
NO.13	25.0	325.0	1723.02	1724.00
NO.14	25.0	350.0	1722.93	1723.60
NO.15	25.0	375.0	1722.85	1723.50
NO.16	25.0	400.0	1722.77	1723.80
NO.17	25.0	425.0	1722.68	1723.70
NO.18	25.0	450.0	1722.60	1723.60
NO.19	25.0	475.0	1722.52	1724.00
NO.20	25.0	500.0	1722.43	1723.50
NO.21	25.0	525.0	1722.35	1723.40
NO.22	25.0	550.0	1722.27	1723.30
NO.23	25.0	575.0	1722.18	1722.80
NO.24	25.0	600.0	1722.10	1723.10
NO.25	25.0	625.0	1722.02	1723.00
NO.26	25.0	650.0	1721.93	1722.90
NO.27	25.0	675.0	1721.85	1722.40
NO.28	25.0	700.0	1721.77	1722.40
NO.29	25.0	725.0	1721.68	1722.20
NO.30	25.0	750.0	1721.60	1722.10
	10.0	760.0	1720.50	
	32.0	792.0	1706.00	

SCALE
0 — 50m (PLAN, PROFILE-H)
0 — 10m (PROFILE-V)
0 — 5m (DIVERSION FACIL. PLAN, SECTION)
0 — 1m (TYPICAL SECTION)

MASTER PLAN STUDY ON DECENTRALIZED RURAL ELECTRIFICATION OF HAOUZ REGION IN KINGDOM OF MOROCCO

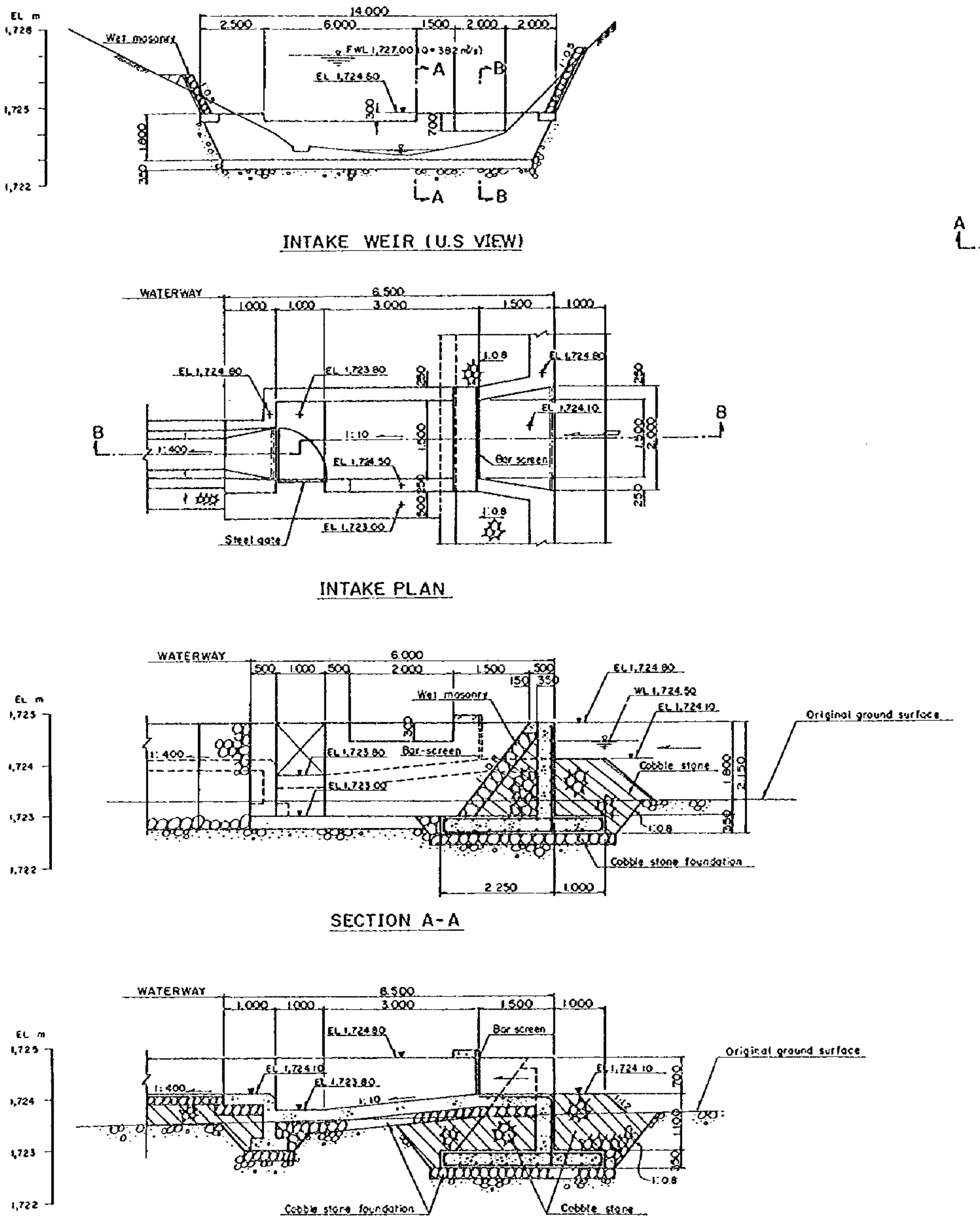
TIDSI - MICRO HYDRO POWER PLANT

WATERWAY GENERAL PLAN AND PROFILE

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

DWG.No. MHC-07 DATE SEP. 1997

INTAKE



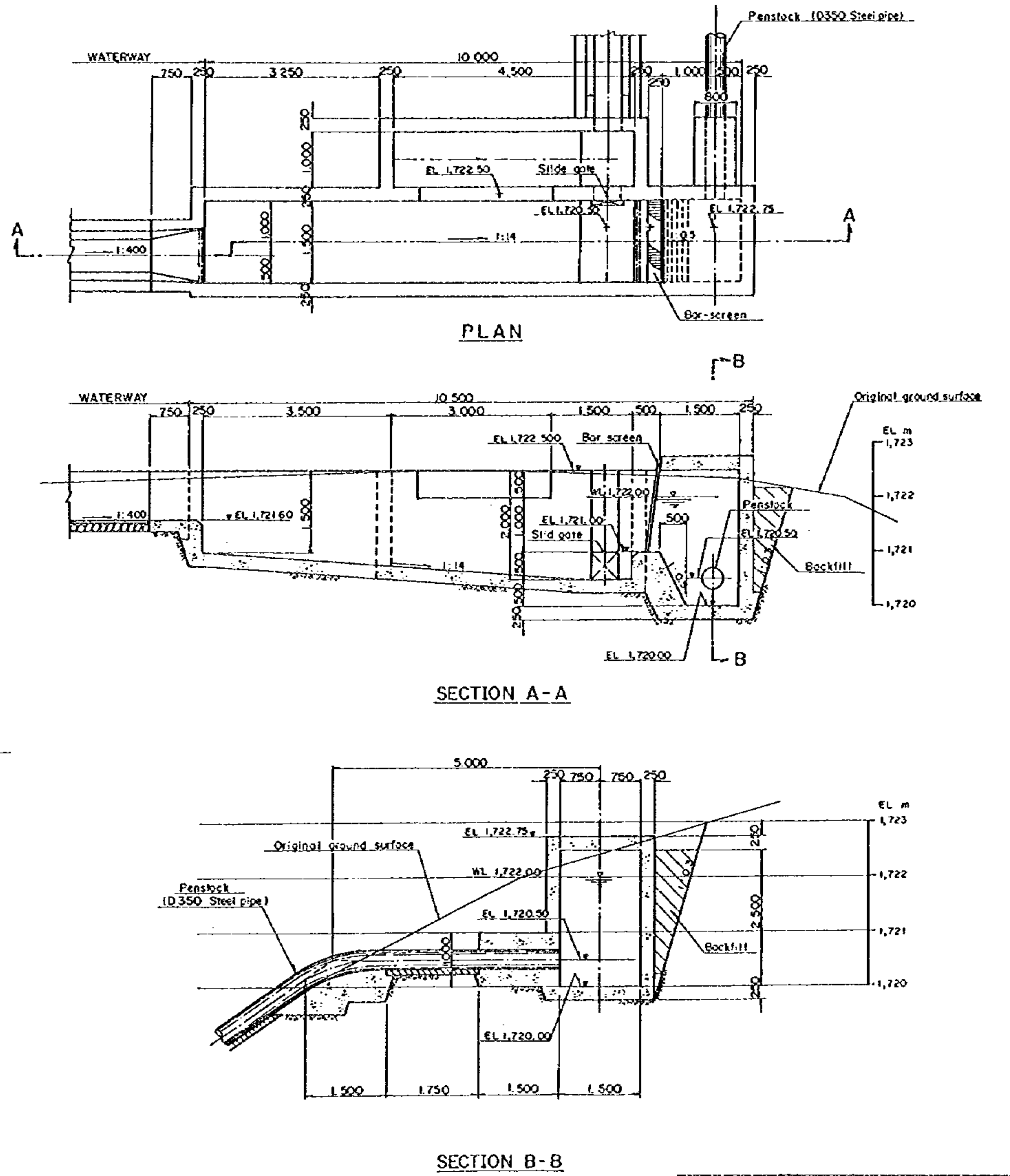
INTAKE WEIR (U.S VIEW)

INTAKE PLAN

SECTION A-A

SECTION B-B

HEADTANK



PLAN

SECTION A-A

SECTION B-B

SCALE 0 — 5m (INTAKE WEIR)

0 — 1 — 2m (PLAN, SECTION)

MASTER PLAN STUDY ON DECENTRALIZED RURAL ELECTRIFICATION OF HAOUZ REGION IN KINGDOM OF MOROCCO

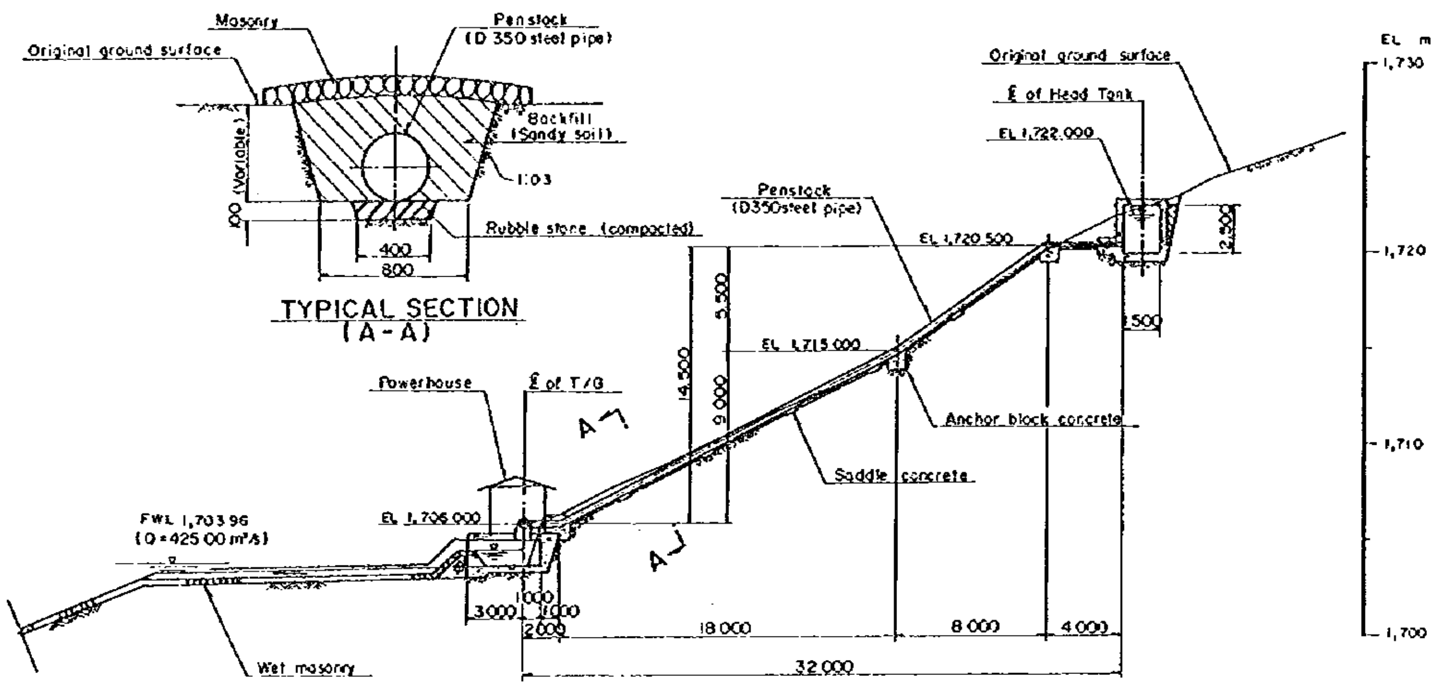
TIDSI - MICRO HYDRO POWER PLANT

WATERWAY
PLAN AND TYPICAL SECTION

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

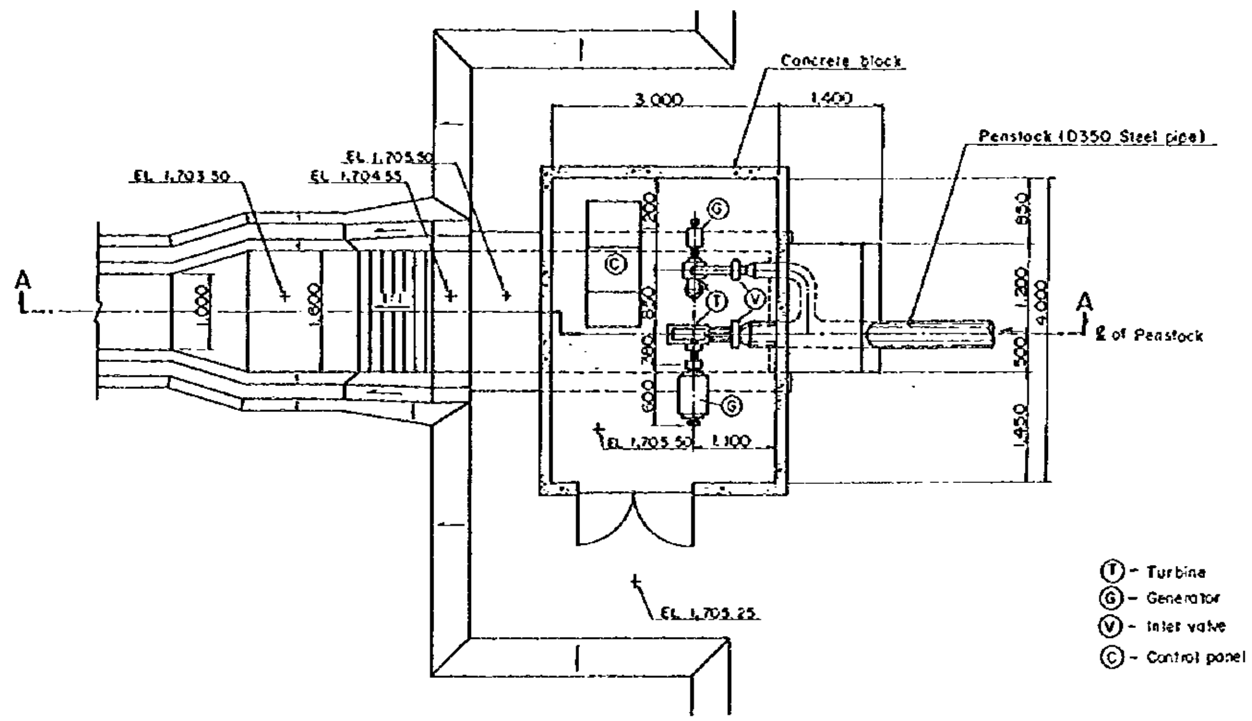
DWG No.	MHC-08	DATE	SEP. 1997

PENSTOCK AND POWERHOUSE

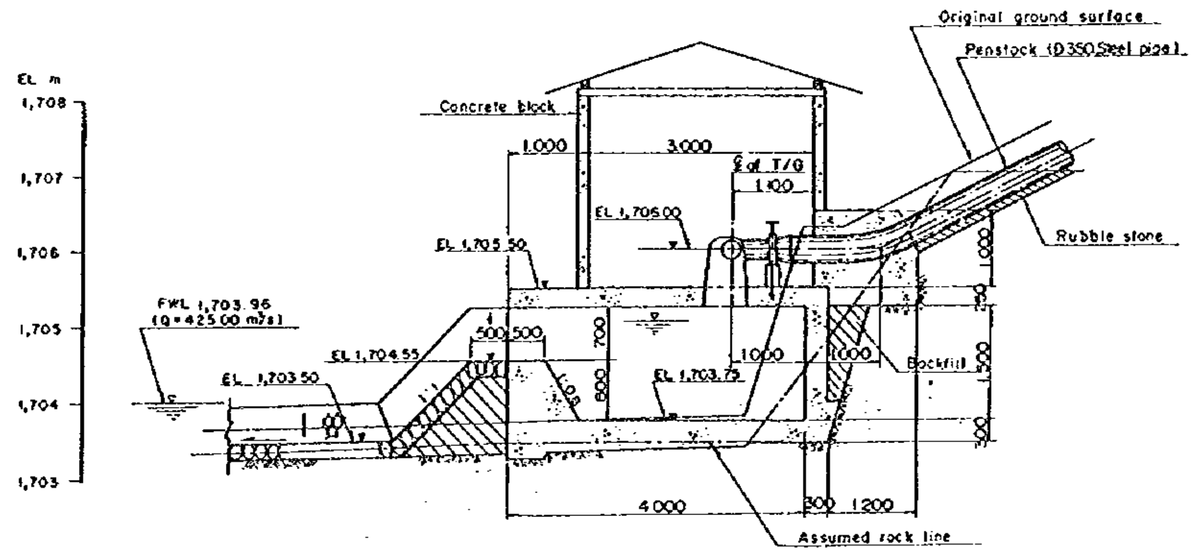


PROFILE

POWERHOUSE



PLAN



SECTION A-A

SCALE 0 — 10 m (PROFILE)

0 — 1 — 2 m (PLAN, SECTION)

MASTER PLAN STUDY ON DECENTRALIZED RURAL ELECTRIFICATION OF HAOUZ REGION IN KINGDOM OF MOROCCO
TIDSI - MICRO HYDRO POWER PLANT
PENSTOCK AND POWER HOUSE PROFIEL AND TYPICAL SECTION
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
DWG No. MHC-09 — DATE SEP. 1997

JICA