Supporting Report XVII Preliminary Design and Cost Estimates

FEASIBILITY STUDY
ON
WATER RESOURCES DEVELOPMENT
IN
RURAL AREA
IN
THE KINGDOM OF MOROCCO

FINAL REPORT

VOLUME V
SUPPORTING REPORT (2.B)
FEASIBILITY STUDY

SUPPORTING REPORT XVII
PRELIMINARY DESIGN AND COST ESTIMATES

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SUPPORTING REPORT XVII

DESIGN AND COST ESTIMATE

XVII1 Introduction

This report deals with the preliminary design of dam, its appurtenant structure and irrigation facility, construction plan of dam and cost estimate carried out for the feasibility study of high priority four (4) project, namely N'Fifikh dam (No.5), Taskourt dam (No.9), Timkit dam (No.10) and Azghar dam (No.17) to define the scale of each project and the cost. The design of dam was based upon the map of topographical survey of scaled 1:500 and 1:5,000, and geological investigation carried out in this feasibility study as sub-letting work to Moroccan company or organization. Existing map scaled 1:2,000 or 1:5,000 and result of geological drilling investigation (for Azghar dam site) conducted by DGH were also utilized for the dam designing.

For the irrigation planning and designing, maps scaled 1:5,000 by the result of the sub-letting work except Timkit project were utilized. Map scaled 1:5,000 for Timkit project was provided by ORMVA at Tafilalet.

Detailed result of the geological investigation and the construction material survey are compiled separately in other annex

XVII2 Preliminary Design

XVII2.1 N'FIFIKH Dam

XVII2.1.1 Dam Facilities

Summary of N'FIFIKH DAM is described in Table XVII2.1.1.

(1) Selection of Dam Site and Dam Type

The dam site is located in the hilly area, 25 km southwest from Benslimene. An access to the dam site is possible by 4-wheel driving vehicle.

The dam site is selected at just upstream side of the narrow valley on the Daliya river where both abutments become closer. Many out-crops of quartzite which is hard rock are observed at both abutments and they run across the site with narrow width. However both upstream and downstream sides of the quartzite are deteriorated by faults. Therefore dam body, especially impervious embankment zone, could not be placed on the quartzite layer. This will cause harmful un-uniform settlement of the embankment due to difference of settlement characteristics of hard foundation and weak foundation. In order to avoid this, dam axis is shifted to somewhat upstream side where impervious embankment may not be placed on the quartzite layer. In this case a foundation of dam body is rather soft rock of weathered sandstone and pelite stone.

The above foundation rock may belong to CL of rock classification, which will not have sufficient bearing capacity for concrete gravity type dam. And the dam site has a wide riverbed of being around 100m with very moderate slope abutments. Accordingly from geological and topographical conditions a fill type dam that can apply to the above soft foundation is selected at this site.

The dam foundation is weathered rock, and is seemingly semi-pervious rock that probably requires grouting against leakage. In the right abutment pervious quartzite may stretch to the foundation of spillway inlet portion and higher parts of dam foundation. Then limb grouting will be also necessary.

As impervious soil materials can be obtained around dam site, a type of the dam is recommendable to be center-cored fill dam that make necessary grouting works shorter than other fill type.

(2) Reservoir and Dam Planning

- Return Period of Design Flood

(a) Medium Scale Dam

A return period of medium scale dam designing was discussed with JICA Team and DGH as counterpart during the study. Agreement of stipulation was done as follows:

1) For spillway discharge

Case of fill type dam; 10,000 years of return period

Case of rigid concrete dam; basically 1,000 years of return period, and checking of safe flow at 10,000 years

As N'Fifikh dam is a fill type, a return period follows former case, namely 10,000 years.

2) For diversion discharge

Case of concrete facility of fill type dam; basically 20 years of return period and checking of safe flow at 50 tears

Case of concrete facility of gravity dam; basically 10 years of return period and checking of safe flow at 20 years

As N'Fifikh dam is a fill type, a return period follows former case.

- Reservoir Storage, Sedimentation and Normal Water Level –

(b) Sedimentation

A sediment volume(Qs) to be counted for planning reservoir is follows:

Qs(m3) = qs x Y

Here qs: unit sediment volume(m3/year)

Y: term of sedimentation (year)

From the result of hydrological study concerning sedimentation of the project, a unit sediment volume for this dam site, which hold a basin area of 323km2, is proposed to be qs=92m3/km2 x 323km2=30,000 m3/year. As term of sedimentation for a medium scale dam is regulated in Morocco to be Y=50years, a sediment volume (Qs) is estimated as follows:

Qs=30,000m3/year x 50year=1,500,000m3

(c) Sediment Prevention Measures

In order to store the sediment volume for reservoir planning, alternative measures are studied. One is to store total sediment volume in the reservoir as dead water storage. Another is to share a part of the sediment on a Sabo dam, which will be located nearby upstream of main dam reservoir to stop only sediment. The scale of Sabo dam varies from 0 to 30 years sediment volume. The last is dredging. The relation between sedimentation period and total cost is shown on Figure XVII2.1.1 for each measure. Study results show that to store the total sediment volume (1,500,00m3) in main dam reservoir is most economical and recommendable for this dam planning.

(d) Storage Volume of Reservoir

On the base of reservoir water level an optimizations study was performed in former chapter. The study concluded that normal water level(NWL) of reservoir at 245.0 m would be recommendable for this dam. Gross storage and effective storage of the reservoir are as follows:

NWL: 245.0 m

Gross storage of reservoir: 19,200,000m3

Effective storage of reservoir: 17,700,000m3

Elevation – area and volume curve of N'Fifikh dam are shown in Figure XVII2.1.2.

- Reservoir Operation of Design Flood –

(a) Design flood Discharge(Qd-in) into Reservoir

Return period of design flood for medium scale dam will be 1/10,000 for fill type and 1/1,000 for concrete type respectively. As this dam is proposed to be center-cored fill type dam, return period of design flood is 1/10,000.

The results of hydrological study on this site concerning flood discharge show as follows;

Peak discharge: Qd-in=1,800m3/s

Total discharge of design flood: Σ Qd-in=58.3Mm3

Duration time of flood: 18hours

(b) Reservoir Operation, Peak out-flow and High Water level of Reservoir

Reservoir operation between inflow and outflow of design flood was performed at the condition that the length of spillway weir is 120m, which may have a maximum overflow depth being about and less than 4m. The calculation of reservoir operation is shown at the item of Design of Spillway.

The peak out-flow discharge (Qd-out) of design flood and maximum overflow depth (Hd) at weir are as follows;

Peak discharge: Qd-out=1,668m3/s

Overflow depth: Hd=3.64m

Accordingly flood water level (FWL) of reservoir is as follows;

NWL=245.0m

FWL=NWL+ Hd=245.0+3.64=248.64 m

- Elevation of Dam Crest -

Crest of impervious zone is required to satisfy following two (2) formula.

1) In case of NWL as basic water level: NWL+Hv1+Hi

2) In case of FWL as basic water level: FWL+Hv2+Hi’

Here, Hv1 and Hv2; Rush-up wave height due to wind at 160km./h(maximum)and

80km/h(minimum), respectively

Hi and Hi'; Allowance according to type of dam,

For fill type: Hi>Hi' equal/more 1.0m

(a) Rush-up Wave Height due to Wind (Hv)

Rush-up wave height due to wind added to reservoir water level will be obtained from Monitor-Stevenson's formula and Gaillad's formula as follows;

$H=0.76+0.032(U \times F)^{0.5}-0.26(F)^{0.25}$

$V=1.5+2H$

$Hv=0.75H+(V)^2/(2g)$

Here, H: Height of wave due to wind (m)

U: Wind velocity (m/s)

F: Fetch of reservoir (km), 2.5km for this dam

g: Acceleration of gravity ($9.8m/s^2$)

Hv1 at maximum velocity of 160km/h and Hv2 at minimum velocity of 80km/h are calculated as follows:

1) $H=0.76+0.032 \times (160 \times 2.5)^{0.5}-0.26 \times (2.5)^{0.25}=1.07m$

$V=1.5+2 \times 1.07=3.65m/s$

$Hv=0.75 \times 1.07+(3.65)^2/(2 \times 9.8)=1.48m$

2) $H=0.76+0.032 \times (80 \times 4)^{0.5}-0.26 \times (4)^{0.25}=0.89m$

$V=1.5+2 \times 0.96=3.27m/s$

$Hv=0.75 \times 0.96+(3.42)^2/(2 \times 9.8)=1.21m$

The crest of impervious zone is estimated as follows;

1) In case of NWL as basic water level

NWL+Hv1+Hi=245.0+1.48+1.22=247.7m

2) In case of FWL as basic water level

FWL+Hv2+Hi'=248.64+1.21+1.35=251.2m

Then it is selected as below:

Crest of impervious: **EL 251.2m**

Dam crest is covered with 30 cm of protection layer. Then dam crest becomes below:

Dam crest; EL 251.5m

(3) Design of Dam Body

- Available Construction Material for Dam

Embankment materials obtained at/around the dam site, their characteristics and available volume are as follows:;

(a) Terrace clayey deposits in the proposed reservoir area and the downstream dam site.

1) They are mostly impervious materials. Some samples are performed laboratory test in this feasibility study.

2) Their natural dry densities are about 1.9 ton/m3. Their plastic indexes are 15 to 18 and their permeability are order of 10^{-7}cm/s at optimum moisture and maximum density, which show good quality for impervious materials.

3) Natural moisture contents of these materials are about 5% dryer than optimum condition.

4) And if density of materials is 90% of optimum density, their permeability becomes large to the order of 10^{-6} cm/s. This implies that dry and low density condition will not satisfy enough impermeability.

5) Accordingly watering to impervious material and density control to be probably more than 95% of maximum density are necessary in actual construction.

6) Their expecting volume is about 460,000m3.

(b) Sand and gravel deposits on the river bed in the downstream dam site and in the proposed reservoir area

1) They are supposed to be semi-pervious material and also useful for filter materials.

2) Maximum size of gravel is about 30cm diameter and most of material can be directly useful without special treatment for semi-pervious embankment.

3) However, for filter embankment selection of proper grading will be necessary.

4) On the right bank of downstream dam site diluvial deposits of sand and gravel with some contents of silt and clay are observed. They are also useful for semi-pervious embankment.

5) Their expecting volume is about 750,000m3.

(c) Excavation rocks from spillway foundation

1) Spillway structure will be placed on the right abutment of dam site. Volume of foundation excavation will be about 430,000m3.

2) Excavation material will be mostly weathered rock of shiest and sandstone. They are supposed to be semi-pervious and pervious materials.

(d) Schist and limestone quarry on the right bank near dam site

1) Hill of quarry has many exposures of hard rocks that are useful for rip-rap materials.

2) To obtain the material blasting is necessary. Besides riprap pervious material can be produced.

3) Existing volume is far beyond the demand.

Materials of a), b) and c) are cheap and material of d) is costly because of blasting work being necessary.

- Dam Designing –

(a) Zoning

Typical cross section of the dam is shown in Figure XVII2.1.3. The impervious core-zone requires above a) material. Zones of filters and drain are b) material. The main embankment of upstream-side and downstream are b) and c) materials. Upstream-side slope of the dam will be protected by rip-rap of d) material. A cofferdam is zoned inside main dam with semi-pervious b) material. These arrangements of materials for each zone will make dam cost economic.

(b) Stability Analysis of Sliding

1) Design Density of Embankment

To evaluate design density of embankment followings are considered:

- For impervious embankment D value, which is ratio of embankment density against maximum density(γ opt) of Proctor compaction test, is recommended to be more than 95% to insure the reliable imperviousness. And their moisture contents are to be around optimum condition(Wopt) or to be the contents that can obtain the saturation ratio of mare than 80%.

  Reliable imperviousness implies that coefficient of permeability is less than $1x10^{-5}$ cm/s at field test and $1x10^{-6}$ cm/s on laboratory test.

- For pervious or semi-pervious embankment D value should be more than 95% if material is applicable to Proctor compaction test. Or relative density, which is degree of embankment dry density between maximum density and minimum density, should be more 80%, if material is coarse gravel or rock material. However, as no mechanical material tests on pervious and semi-pervious materials have been done in this feasibility study, design densities are assumed as they have a void ratio of 0.25 and 0.3, respectively.

Then design density of embankment is estimated as follows:

- Impervious embankment(core zone) –

  Dry density; γ d= γ opt x 95%= 1.82 t/m3 x 95%=1.73

  γ opt; mean value of 4 tests is 1.82t/m3

  Moisture contents; Wopt=15% (mean value)

  Specific gravity of soil; Gs=2.71 (mean value)

  Void ratio; e=(Gs x γ w)/ γ d -1 =(2.71 x 1.0)/1.73 -1= 0.57

  Wet density; γ wet= γ d(1+Wopt/100)=1.71 x 1.15=1.99 t/m3

  Saturated density; γ sat=(Gs+e) γ w/(1+e)=2.09 t/m3

  Submerged density; γ sub= γ sat – γ w=2.09 –1.0=1.09 t/m3

- Semi-pervious embankment –

  Specific gravity of gravel, sarface saturated and inside dry(SSD); Gag=2.65 (assumption based on the result of gravel of Azghar's material)

  Wet density; γ wet=(Gagx γ dw)/(1+e)=2.65x1.0/1.25=2.12 t/m^3

  Saturated density;=(Gsg+e) γ w/(1+e)=(2.65+0.25)x1=2.32 t/m^3

Submerged density; γ sub= γ sat – γ w=2.32 –1.0=1.32 t/m^3

- Pervious embankment –

Specific gravity of gravel(SSD); Gag=2.65 (assumption)

Wet density; γ wet=(Gagxdw)/(1+e)=2.65 x 1.0/1.30=2.04 t/m^3

Saturated density; γ sat=(Gsg+e) γ w/(1+e)

=(2.65+0.3)x1=2.04 t/m^3

Submerged density; γ sub= γ sat – γ w=2.04 –1.0=1.04 t/m^3

1) Design Shear Strength of Embankment

- Impervious Embankment –

Samples mostly taken in the reservoir area as prospecting borrow site are tested in the laboratory. Consolidated and un-drained tri-axial shearing test was performed at the 95% of D value with optimum moisture.

Then design strength of effective stress is here selected as following mean strength of the result on above test.

Internal friction angle; ϕ'=25 degree

Cohesion; c'=10 Kps

- Semi-pervious embankment –

Semi-pervious materials for the dam are well-graded sand and gravel. The shear strength is assumed as follow;

Internal friction angle; ϕ'=37 degree

Cohesion; c'=0 Kps

- Pervious embankment –

Materials obtained from excavation of the spillway foundation are rocks. For the use of pervious embankment hard rock will be purposed. The shear strength is assumed as follow;

Internal friction angle; ϕ'=39 degree

Cohesion; c'=0 Kps

3) Coefficient of Seismic Intensity(Is)

Data collection about earthquake in Morocco was done. Frequency analysis of seismic intensity was performed on the earthquake of magnitude being more than 5 degree as shown the Supporting Report X / Geology and Construction Material . Acceleration at return period of 100 year is small and 42 gal is expected. Considering the dam site is located low frequency zone a seismic intensity of this fill dam is proposed as below:

Is=0.10 g

4) Stability against Sliding

In order to evaluate the stability against sliding of the dam a slip circle method was applied. Cases of study and their result are as follows:

Case	Reservoir level(m)
A. Normal water level with seismic intensity	EL.245.0
B. Normal water level	EL.245.0
C. Immediately after completion of dam	non
D. Rapid draw-down of Reservoir	EL.245.0 to El.225.5

Case	Result of stability		Allowable limit
	Upstream slope	Downstream slope	
A.	Fs=1.28	Fs=1.26	Fs,a=1.2
B.	Fs=1.88	Fs=1.60	Fs,a=1.5
C.	Fs=2.14	Fs=1.60	Fs,a=1.3
D.	Fs=2.03		Fs,a=1.2

Accordingly the dam shows the safety against sliding and satisfies allowable limit. Figure XVII2.1.4 shows the result of stability analysis on case A.

(4) Design of Dam Foundation

- Foundation Excavation –

Beneath whole of dam body weak layer, such as organic soil, clayey soft deposit, alluvium deposit containing silt and clay, etc., should be removed to avoid un-even settlement and sliding of dam.

For this dam site loose soil layer about o.5 to 1 m deep on both abutment and silt and clay alluvium deposits about 1m deep should be removed as dam foundation preparation.

Concerning to core trench under impervious zone it is normally required to excavate somewhat deeper than other foundation of dam body, even if it is already rock foundations. This is for the reason as follows:

1) Top layer of foundation rock is commonly highly weathered or abundant with cracks. If it remain there high leakage is anticipated.

2) Grouting which is common against leakage cannot expect effective result for top layer.

3) Foundation excavation of core trench makes the length of seepage along contact of rock and impervious embankment.

4) Foundation excavation can contribute making smooth topography of core trench. This will avoid un-even settlement of impervious embankment.

Excavation of core trench for this dam will have same object above. The bottom line of the trench is planned to reach the depth where velocity of seismic exploration will attain about 3.0km/s. Then maximum depth of excavation will be 10m at river bed and both abutments. This plan is shown in the attached drawing of longitudinal cross section of the dam.

- Grouting –

On the second stage of this feasibility study geological investigation with five (5) drillings including Lupeon water pressure test were carried out in the dam site. Some of Lugeon values that is an index of perviousness of rock foundation show more than three (3) Lugeon. It is commonly recognized that fill dam rock foundation holding wide area being more than 3 Lugeon requires some treatment. Sub-surface geological survey also pointed out that there exists hard but fissured schist layer in the foundation especially at high portion of right abutment.

In order to avoid excessive leakage through foundation grouting will be proposed for this dam. Grouting holes with two (2) rows are maximum 20m deep at riverbed and minimum 10m deep at both abutments as shown in the drawing attached.

(5) Design of Spillway

- General –

A spillway facility will be placed on the right abutment. Hard foundation rock of quartzite is suitable to the base of concrete structure. Quartzite on the right abutment spreads more widely than on the left abutment. And the total length of spillway channel on the right abutment can be shorter than on the left abutment.

Spillway was designed taking following condition and consideration:

1) The side channel type inlet portion on the right bank is recommended. As the abutment for the inlet of spillway slopes toward rectangular direction against spillway centerline, the side channel type can be applied with less excavation of its foundation

2) A firm foundation is necessary for a spillway, especially at a weir, a inflow channel and a stilling basin. All foundation of the spillway design is be on the weathered rock that is classified into CL – CM or much harder one.

3) The non-gated type of weir will be suitable as it can expect economical construction cost and easy operation and maintenance.

4) A rectangular cross section and straight alignment of the chute way will be selected when considered stability of flow.

5) An energy dissipator after chute way channel selected to be a stilling basin type considering condition of topography and geology of the foundation

- Hydraulic Design –

(a) Hydraulic Analysis

The following formula is used for hydrological analysis on the discharge of flood.

$$S_{j+1} - S_j = ((I_j + I_{j+1})/2)\,\Delta t - ((Q_j + Q_{j+1})/2)\,\Delta t$$

where,

S : storage function

Q : outflow hydrograph

I : inflow hydrograph

Δt : interval of duration

The hydrograph routine analysis result of design flood is summarized in the attached Figure XVII2.1.5 for the 10,000 year flood as the dam is fill type dam.

Maximum depth of flow at weir of 120m, which will be applied as that of the design, will be Hd=3.64m through the above analysis.

(b) Basic Feature

The basic feature and dimension for the spillway are summarized as below:

Spillway type	:	Non-gated weir side channel
Weir crest elevation	:	EL 245.00
Design discharge of flood inflow	:	Q10,000 =1,800.00 m³/s
Design discharge of flood outflow	:	1,668.00 m³/s
Side channel length and width	:	120m,12.5 m at beginning and 25 m at end
Transition channel length and width	:	80 m, 25 m
Chute way length and width	:	120m, 25 m
Chute way sloping	:	1V : 6.0H
Stilling basin type	:	Hydraulic jump
Stilling basin length and width	:	90 m, 25 m

(c) Main Structures

1) Weir as Inlet Structure

The inlet structure to control hydraulic condition is designed to have an enough capacity to admit the discharge of 10,000 year flood. A non-gated weir is proposed to expect easy operation and maintenance. A shape of weir crest is decided based on Harold’s standard, US Corps of Engineering (USBR Type).

Velocity in the approach channel to the spillway weir should be slower than 4.0 m/sec. The height of the weir above the floor of the approach side should be higher than one-fifth of the overflow depth (Hd) to attain smooth inflow into side channel with suitable hydraulic coefficient of weir flow

The tangential slope after the top of weir crest is necessary to avoid cavitations by negative pressure acting on the sidewall of the channel.

2) Side Channel

A hydraulic condition in the side channel is not simple flow, as stream on the weir rapidly changes flow direction in the side channel. Based upon experimental study, a profile of the side channel is proposed as follows:

- Inside slope : 1 V: 0.7 H for weir side slope
  : Vertical for the opposite side
- Gradient of channel bed: $I<1/13$
- Ratio of d/B : $d/B = 0.5$

  where B = channel base width at downstream end (m)

  d = water depth (m)
- Froude Number : $Fr < 0.5$

The water level of the upstream extremity of the side channel should be lower than the elevation of the weir crest.

3) Transition Channel

A transition channel should be provided to connect the side channel to the structure holding control point where the flow changes to a supercritical flow. A gradient of channel base should be gentle enough to satisfy the hydraulic condition at the end of side channel. A control section constructed at the end of transition channel has the function to induce control point from sub-critical flow to supercritical flow.

4) Chute way

A chute way having an enough capacity to convey the design discharge should be straight. The height of sidewall of the chute way is decided on the basis of hydraulic calculation. The chute way is on a sound foundation.

5) Energy Dissipater

An energy dissipater is constructed at end of chute way. Through this structure, the flow is evacuated to the river without serious scour or erosion of the toe of the dam and without damage to adjacent structure.

The stilling basin type is finally adopted as the most suitable type in this spillway taking into account influence of riverbed scouring on dam body, and downstream river and structures along the river.

The hydraulic calculation of spillway are presented in the attached Table XVII2.1.2.

(6) Design of Intake Work

The intake is designed for supplying irrigation water to around 1,000 ha and about 100 l/s for water supply for development area. The total design discharge is about 1.61 m³/s.

The intake has been designed in the light of:;

a) The inclined conduit of left bank is proposed for the inlet structure. Water taken from the inlet will flow in the steel pipe of 1,000 mm diameter installed in the diversion culvert.

b) The outlet structure will be located at the end of diversion culvert. A jet flow gate of 1,000mm diameter to release irrigation water to river will be installed to control discharge. Four pipes of 300mm diameter will be provided for water supply to the downstream villages.

(7) Design of Diversion

- General –

Main structures of temporary diversion for this dam are a cofferdam and a diversion canal.

A cofferdam will be planed to place upstream inside of the main dam to make the dam cost economic. The embankment of the cofferdam mainly consists of gravel materials from borrow pit around dam site. The impervious embankment is set on the upstream surface of the cofferdam.

A river diversion facility by box culvert will be placed in the sound rock foundation of left abutment slope along the riverbed.

A tunnel type of diversion is common for medium to large-scale fill dam but it is much expensive than culvert type. Because this is for avoiding damage of diversion facility and its contact of the dam embankment due to un-uniform deformation by big load from the dam embankment.

As the height above the culvert of this dam is only about 30 m and a designing of the culvert is planning not to be set into dam embankment to disperse the dam embankment load, a culvert type is judged to be possible for the dam site.

Principal points of diversion designing are as follows:

1) Design discharge of diversion facility is basically that of return period of 20 years, as the dam is fill type. To ensure the safe leading of flood flow a discharge of 50 years' return period is checked to pass without overflowing the culvert wall.

2) Discharges of above both return periods are 236m3/s for 20 years and 271m3/s for 50 years after considering the storage of flood in the reservoir. The hydrograph routine analysis result of diversion check flood is shown in the attached Figure XVII2.1.6.

3) Then size of culvert is planned to be 5m high and 5m wide with total a length of 300m.

4) The diversion culvert should be soundly founded on CM of rock classification, which is the left abutment.

- Main feature of Diversion works

The main features is summarized as below:

Design flood inflow (outflow)	:	Q20 =250 m^3/s (236 m^3/s)
		Q50 =380 m^3/s (271 m^3/s)
Crest elevation of cofferdam	:	EL226.50
Culvert section	:	5m wide x 5m high
Culvert length	:	300m

XVII 2.1.2 Irrigation Facilities

(1) Irrigation System

Since there are no systematical irrigation facilities in the project area, the proper irrigation system will be newly established. Based on the result of study on the optimum scale of the development plan, the following irrigation works were proposed:

- Construction of a storage dam and diversion weirs at the downstream of the dam,

- Establishment of irrigation canal network to divide water into the farmlands under gravity irrigation,

The total irrigation area of 1,000 ha in net is divided into three irrigation systems as the respective projects according to the topographic condition and available irrigation water.

The water stored in the reservoir will be released to the river and be taken at the diversion weirs. The irrigation water will be diverted from the intake weir to the field located along the river in due consideration of the traditional water rights.

(2) Layout of Irrigation Facilities

The layout of irrigation facilities such as diversion, canal, and related structure was conducted on the basis of the topography, the existing water rights and the land suitability as well as the expected land consolidation in the near future. The main points considered for the respective projects are summarized as follows:

- Zoning -

The irrigation area of 1,000 ha is divided into three zones in consideration of the farmland location and the land suitability

- Typical Farmland -

A typical farmland layout for the determination of irrigation block size was established, taking into account the efficient water management and farm operation. Considering average size and shape of irrigation block, the typical block will be of rectangular with 400 m x 750 m of 30 ha in gross.

Name of Zone	Irrigation Area in Net (ha)	Number of Irrigation Blocks
Main Feeder Canal (1)	43	3
Main Feeder Canal (2)	157	12
Main Canal	800	29
Total	1,000	44

The total number of irrigation blocks is determined to be 44 blocks of which average area in net was about 23 ha.

The typical farmland layout is shown in Figure XVII2.1.7.

- Diversion Weir -

The diversion weir in each zone is proposed at the site where the irrigation water is available to higher level than the irrigated land. The site of each weir is located at 0.7 km, 4.9 km and 16.0 km downstream from the dam respectively.

The structures of diversion weir are considered to secure the intake of enough irrigation water at all times. The width of diversion is given to more than the double of river so as to release flood and maintain original river function as before.

- Canals-

Main feeder canal routes are laid out along the skirts of gently sloping hills. Both feeder canals mean primarily for conveying water from the diversions to area in which the water of river is at present used for irrigation.

Main canal route is laid out in the left bank along the gentle slope with a gradient of less than 8 degrees available to irrigate lands by gravity. Branch canal is separated from the main canal at 2.2 km downstream of intake weir so as to convey water to farmlands in the right bank.

- Related Structures -

Various related structure would be required in conjunction with irrigation canals for conveyance, regulation and measurement of irrigation water and protection of canal system.

(3) Preliminary Design

- Diversion Weir

(a) Basic Design Condition

Three diversions will be newly constructed. The following design intake discharges are applied to the designs of diversion weir.

Name of Diversion	Command Area (ha)	Design Intake (m^3/s)	Remarks
Diversion (1)	43	0.07	Main Feeder Canal (1)
Diversion (2)	157	0.26	Main Feeder Canal (2)
Diversion (3)	800	1.28	Main Canal

The intake water level will be determined based on the field surface elevation at the project implementation.

(b) Design of Diversion Weir

Item	Diversion		
	(1)	(2)	(3)
Type	Fixed Concrete	Fixed Concrete	Fixed Concrete
Crest elevation (El. m)	211.3	194.0	157.0
Crest length (m)	8.0	8.0	12.0
Crest width (m)	1.0	1.0	1.0
Weir height (m)	3.0	3.0	4.0
Side slope (upstream)	vertical	vertical	vertical
Side slope (downstream)	1V:0.7H	1V:0.7H	1V:0.7H
Width of sluice section(m)	1.0	1.0	1.5
Scouring sluice gate	1.0	1.0	1.5
Slide gate (W m x H m)	0.5 x 0.5	0.5 x 0.5	1.5 x 1.0

(c) Measuring Device

The discharge measurement for intake water would be made with the rectangular weir to be installed at the end of flume section. The overflow depth would be measured under the complete overflow condition.

- Irrigation Canals and Related Structures

(a) Hydraulic Calculation

The criteria for the hydraulic calculation are applied to the design of irrigation canals and related structures as follows:

- Manning Formula

The following “Manning Formula” was adopted for the hydraulic calculations.

$Q = A \times V$

$V = 1/n \times R^{2/3} \times I^{1/2}$

where,
- Q: Design discharge (m^3/sec)
- A: Flow area (m^2)
- V: Mean velocity (m/sec)
- N: Roughness coefficient
- R: Hydraulic radius
- I: Hydraulic gradient

- Roughness Coefficient

The roughness coefficient of irrigation canals is determined as below, considering the texture of canal construction material and the canal inside condition with proper maintenance after the project implementation.

Materials and Condition of Canals	Roughness Coefficient
Concrete lining	0.015
Stone lining, Pitching	0.020

- Velocity

The maximum permissible velocity of canals is determined so as not to cause scouring of canal. The minimum permissible velocity is determined so as not to induce the growth of aquatic plant and moss, and not to cause the sedimentation in canal. Permissible velocity of each canal type is determined as follows:

Type	Min.	Max.
Thick concrete	0.45m/s	3.0m/s
Thin concrete, stone lining	0.45m/s	1.5m/s

- Free Board

The freeboard of the canal is designed based on the following criteria:

$Fb \geqq Fbmin$

$Fbmin = 0.07 \times d + hv + 0.05$

$$hv = \frac{v^2}{2xg}$$

where,		
	Fb:	Freeboard (m)
	Fbmin:	Minimum freeboard (m)
	v:	Mean velocity (m/sec)
	d:	Water depth (m)
	hv:	Velocity head (m)
	v:	Velocity (m/sec)
	g:	Acceleration of gravity (9.8 m/sec^2)

(b) Design of Irrigation Canals

Irrigation canals are, in principle, designed as stone with concrete filled or concrete flume in consideration of water loss and maintenance of canals.

The design of irrigation canals were made in conformity with the basic design criteria mentioned below:

- Design Discharge

Based on the irrigation water requirement and the commanding area, the design discharges for irrigation canals are estimated. Irrigation diagram for the proposed irrigation system is shown in Figure XVII2.1.8.

- Design Water Level

The design water level in the irrigation canal is determined based on the required water level at offtake diverting the water to an irrigation block.

The required water level in the canal at offtake is estimated at the field surface elevation taking into account head losses caused at several structures and in canals through which the irrigation water will be transferred to each field lot.

The design water level in main, branch, main feeder (1) and main feeder (2) canals are given in Table XVII2.1.3.

- Canal Section

The canal section is designed taking into account the effective water flow and the canal slope stability. The relationship between the canal base width and designed water depth is determined on the principle that the ratio of water depth to base width would be more than one under the condition. The canal inside slope is determined at 1V : 1.25H in accordance with the soil mechanical condition.

General features of the irrigation canal are as follows:

Name of Canal	Canal Length (m)	Canal Discharge (m^3/s)	Canal Base Width (m)	Water Depth (m)	Canal Height (m)
Main Feeder Canal (1)	2,500	0.07	0.15	0.10	0.11
Main Feeder Canal (2)	4,450	0.26	0.50	0.46	0.70
Main Canal	9,200	1.28-0.29	0.80-0.62	0.80-0.60	1.00-0.80
Branch Canal	9,250	0.68-0.14	1.35-0.70	0.69-0.37	0.89-0.57
Total	25,400	-	-	-	-

(c) Related Structures

The general characteristics and design criteria of related structures are briefed as follows:

- Turnout and offtake

Turnouts will be provided to divert the required water from main canal to branch canal. Offtakes will be installed to distribute the irrigation water from main, branch or main feeder canal to feeder canal.

Offtakes will be provided double orifice gates. Two staff gauges will be provided upstream and downstream of the first gate to measure the head across the orifice.

- Siphon

Siphons will be constructed across the rivers and farm roads. Single pipe barrel type of siphon will be considered depending on the design discharge. Siphon consists of inlet transition, barrel inlet, barrel section, barrel outlet and downstream transition.

- Cross Drain

Cross drains will be provided under canals to cross the rivers. Cross drain consists of inlet protection and transition, barrel section, outlet transition and protection.

- Check Gate

In order to maintain the required water level at the site of offtaking even during periods of off-peak discharge, check gates will be provided at just or near downstream of turnouts. In consistence with canal longitudinal profile, the ordinary type check gates were considered.

The ordinary type check gate consists of upstream transition, throat section and downstream transition, and will be equipped with one rectangular slide gate and operation deck in the throat.

- Spillway

Spillways will be constructed in the canal system for the purpose of spilling out excess flow or flushing off all water in the canals incase of the emergency and the canal clearing and repairing. The spillway consists of side spillway, slide gate for waste of water, culvert under canal inspection road and outlet transition.

- Aqueduct

Aqueduct, in which the canal is carried over the natural stream, will be constructed in consideration of the effective water flow. The bottom of the canal must be above the high flood level in the river.

The numbers and types of all the related structures for the proposed irrigation system are shown as follows:

Name of Canal	Offtake (nos.)	Spillway (nos.)	Check (nos.)	Cross drain (nos.)	Aqueduct (nos.)	Siphon (nos.)
Main Feeder Canal (1)	1	-	-	6	-	-
Main Feeder Canal (2)	8	-	-	11	-	9
Main Canal	14	2	4	23	-	-
Branch Canal	9	2	4	23	1	-
Total	32	4	8	63	1	9

(4) For the Downstream Area

- Irrigation System

Since there are now no existing irrigation facilities in the project area, the proper irrigation system should be newly established. Based on the result of study on the optimum scale of the development plan, the following irrigation works were proposed:

- Construction of diversion weirs at the near site of irrigated land;
- Establishment of irrigation canal network to divide water into the farmlands under mechanical irrigation i.e. sprinkler, drip, etc;
- Establishment of pump station and pipelines to convey water from the river to the farmlands varying elevation between 30 m and 45 m.

The total irrigation area of 260 ha in net is determined as its own project according to the topographic condition and available irrigation water, which will be collected from the remaining (intermediate) drainage basin of the dam.

The pump station will be established as the weir to lift water to the existing farmland owned by small farmers, which is located between the railroad and the highway.

- Layout of Irrigation Facilities

The layout of irrigation facilities such as diversion, pump station, pipelines and related structures was conducted on the basis of the topography and the land suitability as well as the expected land consolidation in the near future. The main points considered for the own project in no connection with N'Fifikh dam are summarized as follows:

(a) Irrigation Area

The irrigation area situated between the railroad and the highway was selected in consideration of the present farmer's size and the land suitability. The irrigation system covers 260 ha in net and consists of 8 blocks with average area of 33 ha.

(b) Lift Irrigation

The diversion weir and pump station were proposed at the site of 3.2 km upstream from the bridge of railroad. The water will be lifted by pump to a regulating reservoir through pipeline. The pipeline network will be equipped for conveying the water from regulating reservoir to the farmlands under mechanical irrigation. The diversion is located at 58 km downstream of N'Fifikh dam along river stream.

- Preliminary Design

(a) Diversion Weir

Design intake discharge	:	7.5 m^3/min (0.13 m^3/s)
Type	:	Fixed Concrete Type
Crest elevation (El. m)	:	6.0
Crest length (m)	:	70.0
Crest width (m)	:	1.0
Weir height (m)	:	5.0
Side slope (upstream)	:	Vertical
Side slope (downstream)	:	1V:0.7H
Width of sluice section (m)	:	2.0
Scouring sluice gate	:	2.0
Slide gate (W m x H m)	:	0.5 x 0.5

(b) Pump Station

Total pump head (m)	:	68
Type of pump	:	Volute pump
Number of pump	:	2
Shaft power	:	95 kw x 2

(c) Irrigation Facilities

Regulating reservoir	:	35 m x 35 mx2 m (v=2,400 m^3)	
Conveyance pipe	:	800 m	(Ø=400)
Main pipe	:	5,000 m	(Ø =400)
Branch pipe	:	11,000 m	(Ø =150)

XVII2.2 TASKOURT Dam

XVII2.2.1 Dam Facilities

Summary of TASKOURT DAM is described in Table XVII2.2.1.

(1) Selection of Dam Site and Dam type

The dam site is located on the valley of the skirt of the Grate Atlas Mountains, about 70 km southwest from Marrakech. An access to the dam site is possible by 4-wheel vehicle through both routes of the river bed plain of the Asif el Mehl river and local unpaved road running in the middle of steep hill slope.

The Asif el Mehl river has open mouth of valley at the upstream of Taskourt Village. The dam site is selected at its just downstream, where efficient reservoir can be planned. Both the right and left abutments are rather steep slopes and the riverbed is narrow. The foot of left abutment is high upright slope where mass of foundation rock is exposed widely. On the contrary right abutment has less exposure of rocks. It is mostly covered with shallow talus deposits. Depth to reach foundation rock is shallow on both abutments. And the height of planning dam is around 70 m. Judging from above geological condition, topography and scale of dam, it is clearly recommended that type of the dam should be concrete gravity.

According to the exploration of subsurface geology and drilling survey it is recognized that the left abutment is very good condition with massive and hard sandy schist exposures. However it is anticipated that right abutment has possibility to be covered with thickly fractured and weathered rocks beneath the talus deposits because of faults running across the right abutment. Excavation of the right abutment somewhat becomes large. But the dam site is still narrow valley.

There is a possibility that a alternative dam site about 100m upstream from proposed present site is also suitable for gravity if the geology of the site is as good as its appearance of surface rock of hard sandy schist. Further detailed survey is expected for next stage.

(2) Reservoir and Dam Planning

- Reservoir Storage, Sedimentation and Normal Water Level –

(a) Sedimentation

A sediment volume(Qs) to be counted for planning reservoir is follows:

$Qs(m^3) = qs \times Y$

Here qs: unit sediment volume(m^3/year)

Y: term of sedimentation (year)

From the result of hydrological study concerning sedimentation of the project, a unit sediment volume for this dam site, which hold a basin area of $419km^2$, is proposed to be $qs=286m^3/km^2$ x $419km^2$ 120,000 m^3/year. As term of sedimentation for a medium scale dam is regulated in Morocco to be Y=50years, a sediment volume (Qs) is estimated as follows:

$$Qs=120,000m^3/year \times 50year=6,000,000m^3$$

(b) Sediment Prevention Measures

In order to store the sediment volume for reservoir planning, alternative measures are studied. One is to store total sediment volume in the reservoir as dead water storage. Another is to share a part of the sediment on a Sabo dam, which will be located nearby upstream of main dam reservoir to stop only sediment. The scale of Sabo dam varies from 0 to 30 years sediment volume. The last is dredging. The relation between sedimentation period and total cost is shown on Figure XVII2.2.1 for each measure. Study results show that to store the total sediment volume (6,000,00m^3) in main dam reservoir is most economical and recommendable for this dam planning.

(c) Storage Volume of Reservoir

On the base of reservoir water level an optimizations study was performed in former chapter. The study concluded that normal water level(NWL) of reservoir at 995 m would be recommendable for this dam. Gross storage and effective storage of the reservoir are as follows:

NWL: 995 m

Gross storage of reservoir: 25,100,000m^3

Effective storage of reservoir: 19,100,000m^3

Elevation – area and volume curve of Taskourt dam are shown in Figure XVII2.2.2.

- Reservoir Operation of Design Flood –

(a) Design flood Discharge (Qd-in) into Reservoir

Return period of design flood for medium scale dam will be 1/10,000 for fill type and 1/1,000 for concrete type respectively. As this dam is proposed to be concrete gravity type dam, return period of design flood is 1/1,000. But safe flood flow condition should be confirmed even if the discharge is at return period of 1/10,000.

The results of hydrological study on this site concerning flood discharge show as follows;

Peak discharge: Qd-in=1,700m^3/s

Total discharge of design flood: Σ Qd-in= 46.0Mm^3

Duration time of flood: 15hours

(b) Reservoir Operation, Peak out-flow and High Water level of Reservoir

Reservoir operation between inflow and outflow of design flood was performed at the condition that the length of spillway weir is 100m, which may have a maximum overflow depth being about and less than 4m. The calculation of reservoir operation is shown at the item of Design of Spillway.

The peak out-flow discharge (Qd-out) of design flood and maximum overflow depth (Hd) at weir are as follows;

Peak discharge: Qd-out=1,569m^3/s

Overflow depth: Hd=3.95m

Accordingly high water level (HWL) of reservoir is as follows;

NWL=995m

HWL=NWL+ Hd=995+3.95=998.95 m

- Elevation of Dam Crest -

Crest of dam is required to satisfy following two (2) formula.

1) In case of NWL as basic water level: NWL+Hv1+Hi

2) In case of HWL as basic water level: HWL+Hv2+Hi’

Here, Hv1 and Hv2; Rush-up wave height due to wind at
160km./h(maximum)and
80km/h(minimum), respectively

Hi and Hi’; Allowance according to type of dam,
For fill type: Hi>Hi’ equal/more 0m

(a) Rush-up Wave Height due to Wind (Hv)

Rush-up wave height due to wind added to reservoir water level will be obtained from Monitor-Stevenson's formula and Gaillad's formula as follows;

$$H=0.76+0.032(U \times F)^{0.5}-0.26(F)^{0.25}$$

$$V=1.5+2H$$

$$Hv=0.75H+(V)^2/(2g)$$

Here, H: Height of wave due to wind (m)

U: Wind velocity (m/s)

F: Fetch of reservoir (km), 3km for this dam

g: Acceleration of gravity ($9.8m/s^2$)

Hv1 at maximum velocity of 160km/h and Hv2 at minimum velocity of 80km/h are calculated as follows:

1) $H=0.76+0.032 \times (160 \times 3)^{0.5}-0.26 \times (3)^{0.25}=1.12m$

$V=1.5+2 \times 1.12=3.74m/s$

$Hv=0.75 \times 1.12+(3.74)^2/(2 \times 9.8)=1.55m$

2) $H=0.76+0.032 \times (80 \times 3)^{0.5}-0.26 \times (3)^{0.25}=0.91m$

$V=1.5+2 \times 0.91=3.32m/s$

$Hv=0.75 \times 0.91+(3.32)^2/(2 \times 9.8)=1.24m$

The crest of the dam is estimated as follows;

1) In case of NWL as basic water level

NWL+Hv1+Hi=995.0+1.55+0.45=997.0m

2) In case of HWL as basic water level

HWL+Hv2+Hi'=998.95+1.24+0.31=1000.5m

3) In case of exceptionally high flood water level

Water level at return period of 1/10,000; MaxWL=999.85m

Then it is selected as below:

Crest of impervious: **EL 1,000.5m**

(3) Design of Dam Body

- Available aggregate for Dam

Coarse and fine aggregate obtained at/around the dam site. Sand and gravel deposits on the riverbed in the downstream of dam site are selected for the quarry area. When aggregates are collected for the concrete works, the required sizes shall be obtained by using a few different sizes of screens and processing plant. Two or three kinds of screening may be proposed for storage of coarse aggregate, 80-40 mm, 40-5mm and 5- 0mm.

The aggregate volumes of this dam construction are estimated as follows.

1) Coarse aggregate volume is about 248,900m3 (647,000 t).

2) Fine aggregate volume is about 153,500m3 (307,000 t).

- Dam Designing –

(a) Typical cross section

Typical cross section of the dam is shown in **Fig. XVII2.2.3.**

The slope of dam body is decided base on the results of stability analysis.

The concrete of dam consists of two kinds such as outer concrete and inner concrete. Outer concrete of the conventional concrete must produce the required strength, durability and water tightness, while inner concrete of RCC contributes to the stability of dam by its weight and strength. The cement content for RCC concrete must be of the minimum unit as far as strength and workability are required.

In order to prevent cracking of the concrete due to shrinkage and effect of thermal stress, placed concrete will be divided into blocks of 15m interval toward longitudinal direction.

(b) Stability Analysis of Sliding

1) Site Geology

The following geological units underlie Dam site.

General Relation Between Geological Units and Rock

Loose materials	Recent river deposit (Rd),talus deposit
CL class	Highly weathered sandy schist
More than CM class	Weathered or non- weathered schist

The foundations of the dam shall be on the rock classified into CM or much better classes. Following table will gives general properties of rock.

Expectable Physical and Mechanical Properties

Rock class	Modulus Deformation (Kgf/cm²)	Modulus of Elasticity (kgf/cm²)	Shear strength Cohesion (kgf/cm²)	Shear strength Int. friction Angle (°)	Seismic Velocity (km/sec)	Repulsiveness Through rock Hammer test
CH	20,000 –50,000	20,000 -40,000	20-40	40-55	3.0-3.7	27-36
CM	5,000-20,000	15,000-40,000	10-20	30-45	2.0-3.0	15-27
CL	1,000-5,000	3,000-15,000	4-10	15-38	1.2-2.2	10-15
D	-1,000	-3,000	-4	-30	-1.2	-10

2) Design Values of Foundation

Referring the above table, the design values of the foundation are estimated as follows:

Coefficient of friction:

f=0.7 as internal friction angle being 35 degrees

Initial shear strength (cohesion):

τ =15kg/cm^2=150tf/m^2 (150Kps)

3) Coefficient of Seismic Intensity(Is)

Data collection about earthquake in Morocco was done. Frequency analysis of seismic intensity was performed on the earthquake of magnitude being more than 5 degree as shown the Supporting Report X / Geology and Construction Material Acceleration at return period of 100 year is 102 gal is expected. Considering the dam site is located high frequency zone a seismic intensity of this dam is proposed as below:

Is=0.12 g

4) Stability Analysis

For gravity dams, the stability against sliding on the contact plane between dam body and bedrock should be examined by the safety factor required for shear friction resistance as follows;

$$n = \frac{fv + \tau 1}{H}$$

where n : safety factor for shear friction

f : coefficient of internal friction

V : normal force per unit width of shearing plane including uplift

τ : initial shear strength

l : length for shear resistance

H : shearing force per unit width

Cases of stability analysis and their result are as follows:

Case	Reservoir level(m)
A..Empty with 50% seismic intensity	non
B. Normal water level with seismic intensity	EL.995.0
C. Normal water level	EL.995.0
D. Flood water level	EL.998.95

Case	Result of stability	Allowable limit
A.	n=37.5	nsa > 4
B.	n= 3.4	nsa > 2.5
C.	n= 4.5	nsa > 4
D.	n= 4.1	nsa > 2.5

Accordingly the dam shows the safety against sliding and satisfies allowable limit.

(4) Design of Dam Foundation

- Dam Foundation Line

The loose materials such as the recent river deposit are not suitable as foundation of the dam in terms of strength as well as suitability for grouting. The foundation of this dam is consisted of slightly weathered or non- weathered schist, which is classified into the massive and hard rocks such as CM to CH class. Thickness removed from dam foundation will be about 15 m at the left abutment and riverbed, and about 10 m at the left abutment.

- Grouting

(a) Consolidation Grouting

Consolidation grouting into rock will be planned to make the firm and even foundation of dam that might suffer loosening of surface rock by excavation. Plan of grouting holes will be arranged as 5m grids with length of 5m into foundation rock.

(b) Curtain Grouting

Grouting is also planned from the upstream taper filet of the dam to avoid a foundation leakage that will cause as lifting pressure, targeting pervious rock more than about 2 Lugeon. The maximum depth and the minimum depth of the grouting are planned to be 45 m.

The depth of curtain grout will be planned under the following experimental formula proposed by Simonds.

$$D = 1/3\ H + C$$

where, D: Depth of grout

H: Hydrostatic head above foundation

C: Constant , assuming as 20m

Required depth at the river bed portion is,

Dmax = 1/3 (NFW 995.00 – EL.927.00) + 20 ≅ 40 m

Also at the minimum depth is,

Dmin ≅ 20.00 m

The injection holes will be arranged in two (2) rows of 1.5 m apart with spacing 3.0 m each others on the same row.

(5) Design of Spillway

- General –

The spillway has been designed in the light of :

1) The non-gated overflow type spillway is installed in the center of dam body.

2) The rectangular cross section and straight line of chute way is preferable considering the flow stability.

3) Width of chute channel will be 100 m at the top beginning and 80 m at the bottom ending, and a width of stilling basin to dissipate energy form chute flow is selected to be 80 m considering the geometry of riverbed.

- Hydraulic Design –

(a) Hydraulic Analysis

The following formula is used for hydrological analysis for the design of spillway.

Hydrograph routine analysis is prepared on the basis of hydrological study.

$$S_{j+1} - S_j = ((I_j + I_{j+1})/2)\,\Delta t - ((Q_j + Q_{j+1})/2)\,\Delta t$$

where,

S	:	storage function
Q	:	outflow hydrograph
I	:	inflow hydrograph
Δt	:	interval of duration

The hydrograph routine analysis result of design flood is summarized in the attached Figure XVII2.2.4 for the 1,000 year flood as the dam is concrete type.

Maximum depth of flow at weir of 100m, which will be applied as that of the design, is Hd=3.67m through the above analysis.

(b) Basic feature

The basic feature and dimension for the spillway are summarized as below:

Spillway type	:	Non-gated over flow type
Weir crest elevation	:	EL 995.00
Design flood inflow	:	Q1,000 =1,700.00 m³/s
Design flood outflow		1,569.00 m³/s
Chute way length and width	:	48m, 100-80 m
Chute way bed slope	:	1 : 0.84
Stilling basin type	:	Hydraulic jump
Stilling basin length and width	:	54 m, 80 m

(c) Main structures

1) Control Structure

The inlet structure to control hydraulic condition is designed to have an enough capacity to admit the discharge 1,569 m^3/s of 1,000 years flood. A non-gated weir is proposed to expect easy operation and maintenance. A shape of weir crest is decided based on Harold's standard, US Corps of Engineering (USBR Type).

2) Chute Way

A chute way having enough capacity to convey the design discharge should be straight. The height of sidewalls of the chute way is decided on the basis of hydraulic calculation. The chute way is on the downstream of dam body.

3) Energy Dissipater

An energy dissipater is constructed at end of chute way. Through this structure, the flow is evacuated to the river without serious scour or erosion of the toe of the dam and without damage to adjacent structure.

The roller bucket of 30m radius is provided at the beginning point of stilling basin to prevent the flow separating from the bottom.

The hydraulic calculation of spillway are presented in the attached Table XVII2.2.2 .

(6) Design of Intake Work

The intake is designed for supplying irrigation water to around 4,500 ha (Qmax=6.75m3/s) and about 70 l/s for potable water for development area.

The intake has been designed in the light of ;

a) The tower type on right side dam body is proposed for the inlet structure, the water taken from the inlet flows in the steel pipe of 2,000 mm diameter within dam body.

b) The outlet structure is located the right side downstream edge of dam, the jet flow gate of 2,000mm diameter is installed to control discharge.

The intake discharge after regulating is released into the stilling basin of spillway.

c) Four (4) pipes of 300mm in diameter for potable water is provided for the law water conveyance at just upstream of the jet flow gate.

(7) Design of Diversion

- General –

The river flow at the dam site is perennial. Discharge of flood in rainy season is very large. As the construction of the dam could not complete within a single dry season, a diversion facility is necessary. It is recommended to place a box culvert on the rock foundation in the riverbed. The culvert will be constructed by half closing river method during dry season. Other diversion facility such as tunnel in the abutment is conceivable. This is, however, very expensive compared with the culvert type. Namely, the culvert type diversion is selected as it is cheap and is possibly constructed in the site.

Principal points of diversion designing are as follows:

1) Design discharge of diversion facility is basically that of return period of 10 years, as the dam is a rigid concrete gravity type. To ensure the safe leading of flood flow a discharge of 20 years' return period is checked to pass without overflowing the culvert wall.

2) Discharges of above both return periods are 340m3/s for 10 years and 474m3/s for 20 years considering the storage effect of the flood in the reservoir. The hydrograph routine analysis result of diversion check flood is shown in the attached Figure XVII2.2.5.

3) Then size of culvert is planned to be 7.2m high and 7.2m wide with total a length of 270m.

4) The culvert will be used as room for conduit of intake facility for irrigation and others afterward.

- Main feature of Diversion works -

The following features is recommended for this study;

Design flood inflow (outflow) : Q_{10} =400 m^3/s (340 m^3/s)

Q_{20} =600 m^3/s (474 m^3/s)

Crest elevation of cofferdam : EL962.50

Culvert section : width 7.2m x height 7.2m

Culvert length : 270m

XVII2.2.2 Irrigation Facilities

(1) Irrigation System

There are the existing irrigation facilities in the project area. These irrigation facilities will be, therefore, incorporated as much as possible in proposed plan for the whole irrigation system.

Based on the result of study on the optimum scale of the development plan, the following irrigation works were proposed:

- Construction of a storage dam and a diversion weir at the downstream of the dam in Taslimant;
- Establishment of irrigation canal network to divide water into the existing farmlands under gravity irrigation;
- Improvement of existing feeder canals called seguias for using main and branch canals of the project.

The water stored in the reservoir will be released to the river and be taken at the diversion weir. The irrigation water will be diverted from the intake weir to the existing perennial and seasonal irrigated farmlands respecting their traditional water rights.

(2) Layout of Irrigation Facilities

The layout of irrigation facilities such as diversion, canals and related structures was conducted on the basis of the topography, the present water rights and the land suitability. The main points considered for the alignment of irrigation facilities are summarized as follows:

- Zoning

The total irrigation area of 4,500 ha in net is divided into 18 irrigation zones according to the existing irrigation systems as shown in Figure XVII2.2.6.

- Diversion Weir

The diversion weir was proposed at 9.0 km downstream of the dam in the near site of existing diversion of Taslimant to maintain the present water rights.

- Canals

Main canal route was laid out in the left bank along the seguias which currently convey the water of river from existing diversions to its commanded farmlands. Branch canal was separated from the main canal at 5.45 km downstream of intake weir so as to divide water into farmlands in the right bank.

- Related Structures

Various related structure would be required in conjunction with irrigation canals for conveyance, regulation and measurement of irrigation water and protection of canal system

(3) Preliminary Design

- Diversion Weir

(a) Basic design condition

The diversion will be newly constructed with the design intake discharge of 6.75 m^3/s determined based on the irrigation water requirement.

(b) Design of Diversion Weir

Type	:	Fixed Concrete Type
Crest Elevation (El. m)	:	833.0
Crest length (m)	:	70
Crest width (m)	:	2.0
Weir height (m)	:	5.0
Side Slope (upstream)	:	vertical
Side Slope (downstream)	:	1 : 0.7
Width of sluice section (m)	:	2.0
Scouring sluice gate(m)	:	2.0
Slide gate (W m x H m x nos.)	:	2.0 x 2.0 x 2

(c) Measuring Device

The discharge measurement for intake water will be made with the rectangular weir to be installed at the end of flume section. The overflow depth will be measured under the complete overflow condition.

- Irrigation Canals and Related Structures

(a) Hydraulic calculation

The following criteria for the hydraulic calculation were applied to the design of irrigation canals and related structures.

- Manning Formula

The "Manning Formula" was adopted for the hydraulic calculations.

- Roughness Coefficient

The roughness coefficient of irrigation canals was determined as below, considering the texture of canal construction material and the canal inside condition with proper maintenance.

Materials and Condition of Canals	Roughness Coefficient
Concrete lining	0.015
Masonry (rough stone wet masonry)	0.025

- Velocity

The maximum permissible velocity of canals was determined so as not to cause scouring of canal. The minimum permissible velocity was determined so as not to induce the growth of aquatic plant and moss, and not to cause the sedimentation in canal. Permissible velocity of each canal type was determined as follows:

Type	Min.	Max.
Thick concrete	0.45m/s	3.0m/s
Masonry with concrete filled	0.45m/s	2.5m/s

- Free Board

The freeboard of the canal was designed based on the following criteria:

$Fb \geqq Fbmin$

$Fbmin = 0.07 \times d + hv + 0.05$

$hv = \frac{v^2}{2xg}$

where, Fb: Freeboard (m)

Fbmin: Minimum freeboard (m)

v: Mean velocity (m/sec)

d: Water depth (m)

hv: Velocity head (m)

v: Velocity (m/sec)

g: Acceleration of gravity (9.8 m/sec^2)

(b) Design of Irrigation Canals

Irrigation canals were, in principle, designed as masonry with concrete filled and as concrete flume in consideration of water loss and maintenance of canals.

The design of irrigation canals were made in conformity with the basic design criteria mentioned below:

- Design Discharge

Based on the irrigation water requirement and the commanding area, the design discharges for irrigation canals were estimated. Irrigation diagram for the proposed irrigation system is shown in Figure XVII2.2.6.

- Design Water Level

The design water level in the irrigation canal was determined based on the required water level at offtake diverting the water to the seguias.

The design water level in the main and branch canals are given in Table XVII2.2.3.

- Canal Section

The canal section was designed taking into account the effective water flow and the canal slope stability. The relationship between the canal base width and designed water depth was determined so that the ratio of water depth to base width would be more than one under the condition.

General features of the irrigation canals are as follows:

Name of Canal	Canal Length (m)	Canal Discharge (m^3/s)	Canal Base Width (m)	Water Depth (m)	Canal Height (m)
Main Canal	21,600	6.75-1.26	1.60-1.20	1.59-0.62	2.10-0.90
Branch Canal	15,280	1.67-1.02	1.35-1.10	1.30-0.52	1.50-0.80
Total	36,880	-	-	-	-

(c) Related Structures

The general characteristics and design criteria of related structures are briefed as follows:

- Turnout and Offtake

Turnouts will be provided to divert the required water from main canal to branch canal. Offtakes will be installed to distribute the irrigation water from main and branch canals to feeder canal (seguia).

Offtakes will be provided double orifice gates. Two staff gauges will be provided upstream and downstream of the first gate to measure the head across the orifice.

- Drop

The function of drop structure is to convey the water from a higher to a lower elevation and dissipate excess energy resulting due to the drop.

- Siphon

Siphons will be constructed across the existing rivers and farm roads. Single pipe barrel type of siphon will be considered depending on the design discharge. Siphon consists of inlet transition, barrel inlet, barrel section, barrel outlet and downstream transition.

- Cross drain

Cross drains will be provided under canals to cross the rivers. Cross drain consists of inlet protection and transition, barrel section, outlet transition and protection.

- Spillway

Spillways will be constructed in the canal system for the purpose of spilling out excess flow or flushing off all water in the canals incase of the emergency and the canal clearing and repairing. The spillway consists of side spillway, slide gate for waste of water, culvert under canal inspection road and outlet transition.

The numbers and types of all the structures for the proposed irrigation system are shown blow.

Name of Canal	Offtake (nos.)	Spillway (nos.)	Cross Drain (nos.)	Drop (m)
Main Canal	11	5	54	3,610
Branch Canal	7	1	38	1,180
Total	18	6	102	4,790

XVII2.3 TIMKIT Dam

XVII2.3.1 Dam Facilities

Summary of TASKOURT DAM is described in Table XVII2.3.1

(1) Selection of Dam Site and Dam type

The dam site is located on the Ifegh river in the mountain range 25 km northwest from Tinejdad, which is about 70km southwest of Er-Rachidia. It takes about one hour from Tinejdad by 4-wheel vehicle to reach the dam site passing road on the riverbed plain and unpaved rough road, and through close-by Ifegh village. To the upstream-ward from Ifege village, the river forms series of gorge in around one (1) km reach of the river. After passing the gorge there is a confluence of two rivers, where the river has wide riverbed which will create very efficient reservoir.

The dam site is selected in the downstream end of this series of gorge with very steep slope in the left abutment and moderately steep slope in the right abutment.

The geology of this area mainly consists of limestone, which normally possesses so many cavities and open cracks being highly pervious. However, clayey limestone layers that make wide impervious planes exist in the foundation of the dam. Strike of the planes is parallel with the dam axis dipping 20 to 30 degrees being declined to upstream.

The dam axis should be properly selected so that the dam body could be connected with the impervious planes by grouting work.

The base of dam body mostly sits on pervious lime stone layer. As limestone itself is hard rock foundation, it could bear the load from both the concrete gravity dam and the fill dam. However, there remains anxiety that some cavities and open cracks of limestone beneath dam base are left unplugged even if enough contact grouting were carried out. If such phenomenon happens in fill type dam, erosion and piping in the embankment, which may lead to fatal damage of dam, is anticipated. Accordingly a concrete gravity dam that is highly resistible against such erosion is selected for this dam site.

(2) Reservoir and Dam Planning

- Reservoir Storage, Sedimentation and Normal Water Level –

(a) Sedimentation

A sediment volume(Qs) to be counted for planning reservoir is follows:

$$Qs(m^3) = qs \times Y$$

Here qs: unit sediment volume(m^3/year)

Y: term of sedimentation (year)

From the result of hydrological study concerning sedimentation of the project,a unit sediment volume for this dam site, which hold a basin area of 572km^2, is proposed to be qs=349m^3/km^2 x 572km^2=200,000 m^3/year. As term of sedimentation for a medium scale dam is regulated in Morocco to be Y=50years, a sediment volume (Qs) is estimated as follows:

$$Qs=200,000m^3/year \times 50year=10,000,000m^3$$

(b) Sediment Prevention Measures

In order to store the sediment volume for reservoir planning, alternative measures are studied. One is to store total sediment volume in the reservoir as dead water storage. Another is to share a part of the sediment on a Sabo dam, which will be located nearby upstream of main dam reservoir to stop only sediment. The scale of Sabo dam varies from 0 to 30 years sediment volume. The relation between sedimentation period and total cost is shown on Figure XVII2.3.1 for each measure.

Study results show that Sabo dam is slightly less economical. If total sedimentation is planned to rest in the main dam's reservoir, water storage for irrigation should be kept on the storage volume of sedimentation. This implies an area of reservoir surface for irrigation becomes large. On the other hands, as dam site is located semi-arid dry area, loss of storage water by evaporation will be highly anticipated. Accordingly 30 years sediment on Sabo dam, that is maximum sharing, is recommended for storage planning. Then sediment volume in the reservoir of the main dam is 4,000,000m^3 of 20 years sedimentation.

(c) Storage Volume of Reservoir

On the base of reservoir water level an optimizations study was performed in former chapter. The study concluded that normal water level(NWL) at 1,245.5 and surcharge water level(SWL) of reservoir at 1,255.8 m would be recommendable for this dam. Gross storage and effective storage of the reservoir are as follows:

NWL: 1,245.0 m

SWL; 1,255.8 m

Gross storage of reservoir:	27,500,000m^3
Flood control storage of reservoir;	20,000,000m^3
Effective storage of reservoir:	3,500,000m^3
Dead storage of reservoir;	4,000,000m^3

Elevation – area and volume curve of Taskourt dam are shown in Figure XVII2.3.2.

- Reservoir Operation of Design Flood –

(a) Design flood Discharge(Qd-in) into Reservoir

Return period of design flood for medium scale dam will be 10,000 year for fill type and 1,000 year for concrete type respectively. As this dam is proposed to be concrete gravity type dam, return period of design flood is 1,000 year. But capability of passing flood flow at return period of 10,000 years should be confirmed.

The results of hydrological study on this site concerning flood discharge show as follows;

Peak discharge:	Qd-in=2,800m^3/s
Total discharge of design flood:	Σ Qd-in=32.4Mm^3
Duration time of flood:	9 hours

(b) Reservoir Operation, Peak out-flow and High Water level of Reservoir

Reservoir operation between inflow and outflow of design flood was performed at the condition that the length of spillway weir is 60m, which is proper width from the topography of dam site. The calculation of reservoir operation is shown at the item of Design of Spillway.

The peak out-flow discharge (Qd-out) of design flood and maximum overflow depth (Hd) at weir are as follows;

Peak discharge: Qd-out=426m^3/s

Overflow depth: Hd=2.32m

Accordingly high water level (HWL) of reservoir is as follows;

SWL=1,255.8m

HWL=SWL+Hd=1,255.8+2.32=1,258.12m

- Elevation of Dam Crest -

Crest of dam is required to satisfy following two (2) formula.

1) In case of NWL as basic water level: SWL+Hv1+Hi

2) In case of HWL as basic water level: HWL+Hv2+Hi’

Here, Hv1 and Hv2; Rush-up wave height due to wind at 160km./h(maximum)and 80km/h(minimum), respectively

Hi and Hi’; Allowance according to type of dam, For fill type: Hi>Hi’ equal/more 0m

(a) Rush-up Wave Height due to Wind (Hv)

Rush-up wave height due to wind added to reservoir water level will be obtained from Monitor-Stevenson’s formula and Gaillad’s formula as follows;

$H=0.76+0.032(U \times F)^{0.5}-0.26(F)^{0.25}$

$V=1.5+2H$

$Hv=0.75H+(V)^2/(2g)$

Here, H: Height of wave due to wind (m)

U: Wind velocity (m/s)

F: Fetch of reservoir (km), 2km for this dam

g: Acceleration of gravity ($9.8m/s^2$)

Hv1 at maximum velocity of 160km/h and Hv2 at minimum velocity of 80km/h are calculated as follows:

1) $H=0.76+0.032 \times (160 \times 2)^{0.5}-0.26 \times (2)^{0.25}=1.02m$

$V=1.5+2 \times 1.20=3.55m/s$

$Hv=0.75 \times 1.02+(3.55)^2/(2 \times 9.8)=1.41m$

2) $H=0.76+0.032 \times (80 \times 2)^{0.5}-0.26 \times (2)^{0.25}=0.86m$

$V=1.5+2 \times 0.96=3.21m/s$

$Hv=0.75 \times 0.86+(3.21)^2/(2 \times 9.8)=1.17m$

The crest of the dam is estimated as follows;

1) In case of NWL as basic water level

SWL+Hv1+Hi=1,255.8+1.41+0.29=1,257.5m

2) In case of HWL as basic water level

HWL+Hv2+Hi’=1,258.12+1.17+0.21=1,259.5m

3) Incase of exceptional flood water level

MaxWL=SWL+Hd=1,255.8+2.90=1,258.7

Then it is selected as below:

Crest of impervious: **EL 1,259.5m**

(3) Design of Dam Body

- Available aggregate for Dam

Coarse and fine aggregate obtained at/around the dam site. Sand and gravel deposits on the riverbed in the downstream of dam site are selected for the quarry area. When aggregates are collected for the concrete works, the required sizes shall be obtained by using a few different sizes of screens.

Two or three kinds of screening may be proposed for storage of coarse aggregate, such as 80-40mm ,40-5mm and 5- 0mm.

The aggregate volumes of this dam construction are estimated as follows.

1) Coarse aggregate volume is about 38,000m3 (99,000 t).

2) Fine aggregate volume is about 24,000m3 (47,000 t).

- Dam Designing –

(a) Typical cross section

Typical cross section of the dam is shown in Fig XVII2.3.3.

The slope of dam body is decided base on the results of stability analysis.

The concrete of dam consists of two kinds such as outer concrete and inner concrete. Outer concrete of the conventional concrete must produce the required strength, durability and water tightness, while inner concrete of RCC contributes to the stability of dam by its weight and strength. The cement content for RCC concrete must be of the minimum unit as far as strength and workability are required.

In order to prevent cracking of the concrete due to shrinkage and effect of thermal stress, placed concrete will be divided into blocks of 15m interval toward longitudinal direction.

(b) Stability Analysis of Sliding

1) Site Geology

Dam site are underlain by the following geological units.

General Relation Between Geological Units and Rock

Loose materials	Recent river deposit (Rd)
CL class	Highly weathered limestone, clayey limestone layer
More than CM class	Weathered or non- weathered limestone

The direct foundations of the dam will consisted of hard limestone as major basement and clayey limestone layers with thickness about 30m as minor basement. The rock classification is estimated to be more than CM class for hard limestone and CL to CM class for clayey limestone layers.

Following table will gives general properties of rock.

Expectable Physical and Mechanical Properties

Rock class	Modulus Deformation (Kgf/cm^2)	Modulus of Elasticity (kgf/cm^2)	Shear strength		Seismic Velocity (km/sec)	Repulsiveness Through rock Hammer test
			Cohesion (kgf/cm^2)	Int. friction Angle (°)		
CH	20,000 –50,000	20,000 -40,000	20-40	40-55	3.0-3.7	27-36
CM	5,000-20,000	15,000-40,000	10-20	30-45	2.0-3.0	15-27
CL	1,000-5,000	3,000-15,000	4-10	15-38	1.2-2.2	10-15
D	-1,000	-3,000	-4	-30	-1.2	-10

2) Design Values of Foundation

As the foundation partly contains weaker rock than CM class, the design strength will be evaluated from lower boundary of CM class in the above table. Then following is estimated:

Coefficient of friction: f=0.6 as internal friction angle being 30 degrees

Initial shear strength (cohesion): τ =10kg/cm2=100tf/m2 (100Kps)

3) Coefficient of Seismic Intensity(Is)

Data collection about earthquake in Morocco was done. Frequency analysis of seismic intensity was performed on the earthquake of magnitude being more than 5 degree as shown the Supporting Report X / Geology and Construction Material. Acceleration at return period of 100 year is 88 gal is expected. Considering the dam site is located high frequency zone a seismic intensity of this dam is proposed as Is=0.10 g.

4) Stability Analysis

For gravity dams, the stability against on the contact plane between dam body and bed rock should be examined by the safety factor required for shear friction resistance as follows;

$$n = \frac{fv + \tau 1}{H}$$

where n : safety factor for shear friction

f : coefficient of internal friction

V : normal force per unit width of shearing plane including uplift

τ : initial shear strength

l : length for shear resistance

H : shearing force per unit width

Cases of stability analysis and their result are as follows:

Case	Reservoir level(m)
A. Empty	non
B. Normal water level with seismic intensity	EL.1,245.0
C. Normal water level	EL.1,245.0
D. Flood water level	EL.1,258.12

Case	Result of stability	Allowable limit
A.	n=32.5	nsa > 4
B.	n= 3.3	nsa > 2.5
C.	n= 4.4	nsa > 4
D.	n= 3.0	nsa > 2.5

Accordingly the dam shows the safety against sliding and satisfies allowable limit.

(4) Design of Dam Foundation

- Dam Foundation Line

The loose materials such as the recent river deposit and talus deposit are not suitable as foundation of the dam in terms of strength as well as suitability for grouting. The foundation of this dam is mostly consisted of slightly weathered or non- weathered limestone. That will be classified into the massive and hard rocks such as CM to CH class except clayey limestone layer.

Thickness removed from dam foundation will be about 15 m at the left abutment and riverbed, and about 10 m at the left abutment.

- Grouting

(a) Consolidation Grouting

Consolidation grouting into rock will be planned to make the firm and even foundation of dam that might suffer loosening of surface rock by excavation. Plan of grouting holes will be arranged as 5m grids with length of 5m into foundation rock.

(b) Curtain Grouting

Most of dam bottom faces limestone foundation that has open cracks and cavities to be excessively pervious. On the other hand impervious plane of sedimentation rock layer forms under dam foundation. To avoid leakage of foundation grouting that makes continuous water-stop curtain connecting impervious plane and dam body is necessary beside common consolidation grouting.

Grouting at riverbed will be performed from the upstream taper filet of dam. And grouting position will gradually move toward downstream of dam site from middle of both abutment to make grouting depth as shorter as possible.

The depth of the grouting are planned to be about 15 m at riverbed The maximum depth of the grouting at abutments is about 60 m, which is much deeper than that of riverbed because of geometry of impervious rock plane in the limestone.The plan of grouting holes will be arranged as three (3) rows with spacing 1.0 m each other. The space of each grouting holes on the row will be 1.5 m. This is somewhat denser arrangement than common dam because of treatment for high perviouness of limestone foundation.

(5) Design of Spillway

-General –

The spillway has been designed in the light of :

1) The non-gated overflow type spillway is installed in the center of dam body.

2) The rectangular cross section and straight line of chute way is preferable considering the flow stability. The width of chute way is 60 m reflecting the geometry of riverbed.

3) Timkit dam will be designed to make the reservoir hold the storage not only for irrigation water of just downstream Ifegh area but also for occasional flood water to distancing downstream irrigation areas.

The outlet works of flood control to utilize for downstream irrigation is installed at normal water level to evacuate reservoir storage more than normal water level.

- Hydraulic Design –

(a) Hydraulic Analysis

The following formula is used for hydrological analysis for the design of spillway.

$S_{j+1} - S_j = ((I_j + I_{j+1})/2)\,\Delta t - ((Q_j + Q_{j+1})/2)\,\Delta t$

where,

S	:	storage function
Q	:	outflow hydrograph
I	:	inflow hydrograph
Δt	:	interval of duration

The hydrograph routine analysis result of design flood is summarized in the attached Figure XVII2.3.4 for the 1,000 year flood as the dam is concrete type.

Maximum depth of flow at weir of 60m, which will be applied as that of the design, is Hd=2.32m through the above analysis.

(b) Basic Feature

The basic feature and dimension for the spillway are summarized as below:

Spillway type	:	Non-gated over flow type
Weir crest elevation	:	EL 1,255.80

Design flood inflow	:	Q1,000 =2,000.00 m^3/s
Design flood outflow	:	1,258.00 m^3/s
Chute way length and width	:	34m, 60 m
Chute way bed slope	:	1 V: 0.86H
Stilling basin type	:	Hydraulic jump
Stilling basin length and width	:	42 m, 60 m

(c) Main Structures

1) Control Structure

The control structure is designed to have enough capacity to flow the 1,000 year flood of 1,258 m^3/sec. The non-gated weir was proposed. A shape of overflow crest is decided based on Harold's standard overflow weir, US Corps of Engineering (USBR Type).

2) Chute Way

A chute way having an enough capacity to convey the design discharge should be straight. The height of sidewalls of the chute way is decided on the basis of hydraulic calculation. The chute way is on the downstream of dam body.

3) Energy Dissipater

An energy dissipater is constructed at end of chute way. Through this structure, the flow is evacuated to the river without serious scour or erosion of the toe of the dam and without damage to adjacent structure. The roller bucket of 15m radius is provided at the beginning point of stilling basin to prevent the flow separating from the bottom.

The hydraulic calculation of spillway are presented in the attached Table XVII2.3.2 .

(6) Design of Intake Work

The intake is designed for supplying irrigation water to around 200 ha (Q_{max}=0.45m^3/s) and about 240 l/s for potable water for development area.

The intake has been designed in the light of ;

a) The tower type on right side dam body is proposed for the inlet structure, the water taken from the inlet flows is the steel pipe of 600 mm in diameter within dam body.

b) The outlet structure is located on the right side of downstream edge of dam. The jet flow gate of 300mm diameter is installed to control discharge. The intake discharge after regulating is released into the stilling basin of spillway.

c) Three pipes of 400mm in diameter for potable water is provided at just upstream of the jet flow gate.

(7) Design of Diversion

- General –

The river of the dam site is non-perennial, but it has subsurface flow in the riverbed through whole year. Floods of which the likely occurring season is not always predicted also occur two or three times changeably in a year. Then the diversion is necessary during the dam construction. A box culvert for diversion will be placed on the foundation of the riverbed. The culvert should be constructed by half closing river method for some months, when flood is not likely to occur statistically.

Principal points of diversion designing are as follows:

1) Design discharge of diversion facility is basically that of return period of 10 years, as the dam is a concrete gravity type. To ensure the safe leading of flood flow a discharge of 20 years' return period is checked to pass without overflowing the culvert wall.

2) Discharges of above both return periods are 300m3/s for 10 years and 348m3/s for 20 years considering the storage effect of the flood in the reservoir. . The hydrograph routine analysis result of diversion check flood is shown in the attached Figure XVII2.3.5.

3) Then the size of culvert is planned to be 6m high and 6m wide with total a length of 200m.

4) The box culvert will be used as room for conduit of intake facility for irrigation and others afterward.

- Main feature of Diversion works -

The following features is recommended for this study;

Design flood inflow (outflow) :	Q10 =300 m³/s (300 m³/s)
	Q20 =500 m³/s (348 m³/s)
Crest elevation of cofferdam :	EL1,230.5
Culvert section :	width 6m x height 6m
Culvert length :	200m

XVII2.3.2 Irrigation Facilities

(1) Irrigation System

There are the existing irrigation facilities in the project area. These irrigation facilities will be, therefore, incorporated as much as possible in proposed plan for the whole irrigation system.

Based on the result of study on the optimum scale of the development plan, the following irrigation works were proposed:

- Construction of a storage dam and rehabilitation of existing diversion weirs in the rivers of Tanguerfa, Todrha, Satt and so on;
- Rehabilitation of existing irrigation canals called seguias to divide water into farmlands in oases of Tinjidad and Chtam areas under flood irrigation;
- Improvement of existing feeder canal to extend farmlands in Ifegh area under gravity irrigation.

The water stored in the reservoir will be released to the river and be taken at the diversion weirs. The irrigation water will be conveyed from the intake weir to the existing farmlands according to the prevailing traditional water rights.

In the Tinejdad and Chtam areas, the principal diversion weirs and main canals are already constructed on the basis of their design concept.

(2) Rehabilitation of Irrigation Facilities

The main points considered for the rehabilitation of irrigation facilities are summarized as follows:

- The total irrigation area of 3,850 ha in gross is divided into three areas i.e. Ifegh, Tinjidad and Chtam areas as shown in Figure XVII2.3.6.

- All the traditional diversion weirs located along the rivers and those related seguias are necessary to be required the rehabilitation works.
- The canal bases, which are shallow owing to erosion of inside slopes and sedimentation, will be necessary to be excavated and the destroyed inside slopes will be required to be re-embanked by masonry.

(3) Preliminary Design

- Diversion Weir

The diversion of 12 weirs as shown in Figure XVII2.3.6 will be rehabilitated with the design intake discharges of 15 liters/sec/ha to convey flood water to entire fields.

- Irrigation Canals and Related Structures

(a) Hydraulic Calculation

The following criteria for the hydraulic calculation were applied to the design of irrigation canals and related structures.

- Manning Formula

The "Manning Formula" was adopted for the hydraulic calculations.

- Roughness Coefficient

The roughness coefficient of irrigation canals was determined as below, considering the texture of canal construction material and the canal inside condition with proper maintenance.

Materials and Condition of Canals	Roughness Coefficient
Concrete lining	0.015
Masonry (rough stone wet masonry)	0.025

- Velocity

The maximum permissible velocity of canals was determined so as not to cause scouring of canal. The minimum permissible velocity was determined so as not to induce the growth of aquatic plant and moss, and not to cause the sedimentation in canal. Permissible velocity of each canal type was determined as follows:

Type	Min.	Max.
Thick concrete	0.45m/s	3.0m/s
Masonry with concrete filled	0.45m/s	2.5m/s

- Free Board

The freeboard of the canal was designed based on the following criteria:

$Fb \geqq Fbmin$

$Fbmin = 0.07 \times d + hv + 0.05$

$$hv = \frac{v^2 2}{2xg}$$

where, Fb: Freeboard (m)

Fbmin: Minimum freeboard (m)

v: Mean velocity (m/sec)

d: Water depth (m)

hv: Velocity head (m)

v: Velocity (m/sec)

g: Acceleration of gravity (9.8 m/sec^2)

(b) Design of Irrigation Canals

Irrigation canals were, in principle, designed as masonry with concrete filled and as concrete flume in consideration of water loss and maintenance of canals.

The design of irrigation canals were made in conformity with the basic design criteria mentioned below:

- Design Discharge

Based on the irrigation water requirement and the commanding area, the design discharges for irrigation canals were estimated. Irrigation diagram for the proposed irrigation system is shown in Figure XVII2.3.6.

- Canal Section

The canal section was designed in attached Table XVII2.3.3 taking into account the effective water flow and the canal slope stability. The relationship between the canal base width and designed water depth was determined so that the ratio of water depth to base width would be more than one under condition.

General features of the irrigation canals are as follows:

Type of Canal	Canal Length (m)	Canal Discharge (m^3/s)	Canal Base Width (m)	Water Depth (m)	Canal Height (m)
Concrete flume	3,600	0.45	0.50	0.61	0.85
Masonry	34,900	3.50-1.00	1.23-0.71	1.23-0.71	1.53-0.91
Total	38,500	-	-	-	-

XVII2.4 AZGHAR Dam

XVII2.4.1 Dam Facilities

Summary of AZGHAR DAM is described in Table XVII2.4.1.

(1) Selection of Dam Site and Dam type

The dam site is located on the Zloul river in the hilly area,7 km east from Ribat Al Khayre that is around 50 km eastward from Sefrou.

An access through paved road is possible up to around one(1) km downstream from the dam site. Further access to the dam site is possible by 4 wheel driving vehicle.

From hilly point in Ribat el Kheir future irrigation service area could be nicely observed. The Zloul river is running along south edge of the irrigation service area. A mountain range closes to the upstream end of the irrigation service area. The valley in the mountain range caved by the Zloul river is the dam site.

Geology of the dam site is blackish marl. Hard foundation rocks of the marl expose on the riverbed and on the slopes of both abutments. Lots of bedding stratification are observed in the marl, but their contacts are firm. Accordingly the foundation plan possibly both type of gravity dam and fill dam. Construction materials for the both dams could be obtained near the dam site. In order to select the dam type, fill type dam with center-core and concrete gravity type dam, to be constructed by RCC (BCR in French) are compared. Their principal features and construction cost for the both dams are summarized in Table XVII2.4.2**.** From the result of the comparative study the construction cost of the center-cored fill dam is cheaper by about 30 % than RCC, then a fill type dam for this site is recommendable.

(2) Reservoir and Dam Planning

- Reservoir Storage, Sedimentation and Normal Water Level –

(a) Sedimentation

A sediment volume(Qs) to be counted for planning reservoir is follows:

Qs(m3) = qs x Y

Here qs: unit sediment volume(m^3/year)

Y: term of sedimentation (year)

From the result of hydrological study concerning sedimentation of the project, a unit sediment volume for this dam site, which hold a basin area of 263km^2, is proposed to be qs=494/km^2 x 263km^2=130,000 m^3/year. As term of sedimentation for a medium scale dam is regulated in Morocco to be Y=50years, a sediment volume (Qs) is estimated as follows:

Qs=130,000m^3/year x 50year=6,500,000m^3

(b) Sediment Prevention Measures

In order to store the sediment volume for reservoir planning, alternative measures are studied. One is to store total sediment volume in the reservoir as dead water storage. Another is to share a part of the sediment on a Sabo dam, which will be located nearby upstream of main dam reservoir to stop only sediment. The last is dredging. The scale of Sabo dam varies from 0 to 30 years sediment volume. The relation between sedimentation period and total cost is shown on Figure XVII2.4.1 for each measures. Study results show that to store the total sediment volume (6,500,00m^3) in main dam reservoir is most economical and recommendable for this dam planning.

(c) Storage Volume of Reservoir

On the base of reservoir water level an optimizations study was performed in former chapter. The study concluded that normal water level(NWL) of reservoir at 865.0 m would be recommendable for this dam. Gross storage and effective storage of the reservoir are as follows:

NWL: 865.0 m

Gross storage of reservoir: 11,700,000m^3

Effective storage of reservoir: 5,200,000m^3

Elevation – area and volume curve of the reservoir is shown in Figure XVII2.4.2.

- Reservoir Operation of Design Flood –

(a) Design flood Discharge(Qd-in) into Reservoir

Return period of design flood for medium scale dam will be 1/10,000 for fill type and 1/1,000 for concrete type respectively. As this dam is proposed to be center-cored fill type dam, return period of design flood is 1/10,000.

The results of hydrological study on this site concerning flood discharge show as follows:

Peak discharge: Qd-in=700m3/s

Total discharge of design flood: ΣQd-in=18.9Mm3

Duration time of flood: 15hours

(b) Reservoir Operation, Peak out-flow and High Water level of Reservoir

Reservoir operation between inflow and outflow of design flood was performed at the condition that the length of spillway weir is 40m, which may have a maximum overflow depth being about and less than 4m. The calculation of reservoir operation is shown at the item of Design of Spillway.

The peak out-flow discharge (Qd-out) of design flood and maximum overflow depth (Hd) at weir are as follows;

Peak discharge: Qd-out=592m^3/s

Overflow depth: Hd=2.89m

Accordingly flood water level (FWL) of reservoir is as follows;

NWL=854.0m

FWL=NWL+Hd=854.0+2.89=856.89 m

- Elevation of Dam Crest -

Crest of impervious zone is required to satisfy following two (2) formula.

1) In case of NWL as basic water level: NWL+Hv1+Hi

2) In case of FWL as basic water level: FWL+Hv2+Hi’

Here, Hv1 and Hv2; Rush-up wave height due to wind at

160km./h(maximum)and

80km/h(minimum), respectively

Hi and Hi’; Allowance according to type of dam,

For fill type: Hi>Hi’ equal/more 1.0m

(a) Rush-up Wave Height due to Wind (Hv)

Rush-up wave height due to wind added to reservoir water level will be obtained from Monitor-Stevenson’s formula and Gaillad’s formula as follows;

$H=0.76+0.032(U \times F)^{0.5} -0.26(F)^{0.25}$

$V=1.5+2H$

$Hv=0.75H+(V)^2/(2g)$

Here, H: Height of wave due to wind (m)

U: Wind velocity (m/s)

F: Fetch of reservoir (km), 1.9m for this dam

g: Acceleration of gravity (9.8m/s^2)

Hv1 at maximum velocity of 160km/h and Hv2 at minimum velocity of 80km/h are calculated as follows:

1) $H=0.76+0.032 \times (160 \times 1.9)^{0.5} -0.26 \times (1.9)^{0.25} =1.01$m

$V=1.5+2 \times 1.01=3.52$m/s

$Hv=0.75 \times 1.01+(3.52)^2 /(2 \times 9.8)=1.39$m

2) $H=0.76+0.032 \times (80 \times 1.9)^{0.5} -0.26 \times (1.9)^{0.25} =0.85$m

$V=1.5+2 \times 0.85=3.20$m/s

$Hv=0.75 \times 0.85+(3.20)^2 /(2 \times 9.8)=1.16$m

The crest of impervious zone is estimated as follows;

1) In case of NWL as basic water level

NWL+Hv1+Hi=854.0+1.39+1.31=856.70m

2) In case of FWL as basic water level

FWL+Hv2+Hi'=856.89+1.16+1.15=859.20m

Then it is selected as below:

Crest of impervious zone: **EL 859.20m**

Dam crest is covered with 30 cm of protection layer. Then dam crest becomes below:

Dam crest; EL 859.50m

(3) Design of Dam Body

- Available Construction Material for Dam

Embankment materials obtained at/around the dam site, their characteristics and available volume are as follows:;

a) Residual deposit or colluvial clayey deposits in the proposed reservoir area

1) Natural moisture contents of the soils are 15 to 19 %, their plastic index are 7 to 17, mostly about 9, and natural density is 1.6 to 1.9 t/m3.These properties indicate that they are not even quality and somewhat low plasticity materials.

2) Laboratory permeability test shows imperviousness to be order of 10-7 cm/s at the condition of optimum moisture content and maximum compaction density. However, low compaction density at 90 % of maximum density with optimum moisture content does not hold enough imperviousness such as order of 10-5 to 10-6 cm/s. Sufficient compaction to attain high density and saturation ratio will be required for actual embankment.

3) Their expecting volume is about 1,000,000m3.

b) Sand and gravel deposits from Oued Oarya

1) Sand and gravel from river bed of Oued Oarya are recommendable for filter and one of pervious materials.

2) Materials beside perennial river flow look clean without silt and clay. However, some of deposits are covered or consisted with fine sediment. Clean materials should be selected for filter material.

3) Gravel has excellent quality such as 0.4 % of water absorption, 2.65 of specific gravity, 23 % loss of abrasion test and non-reaction of alkali reaction. Then this material is judged to be suitable for concrete aggregate.

4) Their expecting volume is about 1,200,000m^3.

(c) Excavation rocks from spillway foundation

1) Spillway structure will be placed on the right abutment of dam site. Volume of foundation excavation will be about 200,000m3 .

2) Excavation material will be mostly hard rock of marl They are supposed to be pervious materials.

3) Some rocks from spillway foundation are also expected as riprap. But the volume will be small to satisfy the demand of total volume of riprap.

(d) Limestone quarry in the reservoir area

1) There expects blackish marl strata, which is hard and rather massive rock, in and around proposed reservoir area.

2) Boulder size rocks will be suitable for riprap material.

Materials of a), b) and c) are cheap and material of d) is costly because of blasting work being necessary.

- Dam Designing –

(a) Zoning

Typical cross section of the dam is shown in Figure XVII2.4.3. The impervious core-zone requires above a) material. Zones of filters and drain are b) material. The main embankment of upstream-side and downstream are b) materials. Upstream-side of pervious embankment will be c) material. Upstream-side slope of the dam will be protected by riprap of d) material. A cofferdam is zoned inside main dam with pervious b) material. These arrangements of materials for each zone will make dam cost economic.

(b) Stability Analysis of Sliding

1) Design Density of Embankment

To evaluate design density of embankment followings are considered:

- For impervious embankment D value, which is ratio of embankment density against maximum density(γ opt) of Proctor compaction test, is recommended to be more than 95% to insure the reliable imperviousness. And their moisture contents are to be around optimum condition(Wopt) or to be the contents that can obtain the saturation ratio of mare than 80%.

Reliable imperviousness implies that coefficient of permeability is less than $1x10^{-5}$ cm/s at field test and $1x10^{-6}$ cm/s on laboratory test.

- For pervious or semi-pervious embankment D value should be more than 95% if material is applicable to Proctor compaction test. Or relative density, which is degree of embankment dry density between maximum density and minimum density, should be more 80%, if material is coarse gravel or rock material. However, as no mechanical material tests on pervious materials have been done in this feasibility study, design densities are assumed as they have a void ratio of 0.25 for sand and gravel and 0.4, respectively. Void ratio of rock is taken larger than case of N'Ffikh dam, as shape of rock here will be flat reflecting its original geology, which is abundant with fissures along its sedimentation plane

Then design density of embankment is estimated as follows:

- Impervious embankment(core zone) –

Dry density; γ d= γ opt x 95%= 1.76 t/m^3 x 95%=1.67

γ opt; mean value of 5 tests is 1.76t/$m3^3$

Moisture contents; Wopt=16% (mean value)

Specific gravity of soil; Gs=2.71 (mean value)

Void ratio; e=(Gs x γ w)/ γ d -1 =(2.71 x 1.0)/1.67 -1= 0.62

Wet density; γ wet= γ d(1+Wopt/100)=1.67 x 1.16=1.94 t/m^3

Saturated density; γ sat=(Gs+e) γ w/(1+e)=2.06 t/m^3

Submerged density; γ sub= γ sat – γ w=2.06 –1.0=1.06 t/m^3

- Pervious sand and gravel embankment –

Specific gravity of gravel, saturated surface-dry (SSD) Gag=2.65 (mean value)

Wet density; γ wet=(Gag x γ dw)/(1+e)=2.65 x 1.0/1.25=2.12 t/m^3

Saturated density; =(Gsg+e) γ w/(1+e)=(2.65+0.25)x1=2.32 t/m^3

Submerged density; γ sub= γ sat – γ w=2.32 –1.0=1.32 t/m^3

- Pervious rock embankment –

Specific gravity of gravel(SSD); Gag=2.65 (assumption)

Wet density; γ wet=(Gag x γ dw)/(1+e)=2.65x1.0/1.40=1.89 t/m^3

Saturated density; γ sat=(Gsg+e) γ w /(1+e)=2.19 t/m^3

Submerged density; γ sub= γ sat – γ w=2.19–1.0=1.19 t/m^3

2) Design Shear Strength of Embankment

- Impervious Embankment –

Samples mostly taken in the reservoir area as prospecting borrow site are tested in the laboratory. Consolidated and un-drained tri-axial shearing test was performed at the 95% of D value with optimum moisture.

Then design strength of effective stress is here selected as following mean strength of the result on above test.

Internal friction angle; ϕ'=30 degree

Cohesion; c'=10 kps(=10kN/m^2)

- Pervious sand and gravel embankment –

The materials for the dam are well-graded sand and gravel. The shear strength is assumed as follow;

Internal friction angle; ϕ'=37 degree

Cohesion; c'=0 Kps

- Pervious rock embankment –

Materials obtained from excavation of the spillway foundation are rocks. For the use of pervious embankment hard rock will be proposed. The shear strength is assumed as follow considering that it will be somewhat lower density because of shape of rock;

Internal friction angle; ϕ'=38 degree

Cohesion; c'=0 Kps

3) Coefficient of Seismic Intensity(Is)

Data collection about earthquake in Morocco was done. Frequency analysis of seismic intensity was performed on the earthquake of magnitude being more than 5 degree as shown the Supporting Report X / Geology and Construction Material.

Acceleration at return period of 100 year is small and 66 gal is expected. Considering the dam site is located high frequency zone a seismic intensity of this fill dam is proposed as below:

Is=0.12 g

4) Stability against Sliding

In order to evaluate the stability against sliding of the dam a slip circle method was applied. Cases of study and their result are as follows:

Case	Reservoir level(m)
A. Normal water level with seismic intensity	EL.854.0
B. Normal water level	EL.854.0
C. Immediately after completion of dam	non
D. Rapid draw-down of Reservoir	EL.854.0 to El.848.5

Case	Result of stability		Allowable limit
	Upstream slope	Downstream slope	
A.	Fs=1.29	Fs=1.34	Fs,a=1.2
B.	Fs=2.14	Fs=1.82	Fs,a=1.5
C.	Fs=1.92		Fs,a=1.3
D.	Fs=2.11		Fs,a=1.2

Accordingly the dam shows the safety against sliding and satisfies allowable limit.

Figure XVII2.4.4 shows the result of stability analysis on case A

(4) Design of Dam Foundation

- Foundation Excavation –

Beneath whole of dam body weak layer, such as organic soil, clayey soft deposit ,alluvium deposit containing silt and clay, etc., should be removed to avoid un-even settlement and sliding of dam.

Thickness removed will be o.5m at the left abutment where many rock exposures are observed. And it is about 1.0m at the right abutment and riverbed as dam foundation preparation.

Concerning to core trench under impervious zone it is normally required to excavate somewhat deeper than other foundation of dam body, even if it is already rock foundations. This is for the reason as follows:

1) Top layer of foundation rock is commonly highly weathered or abundant with cracks. If it remain there high leakage is anticipated.

2) Grouting which is common against leakage cannot expect effective result for top layer.

3) Foundation excavation of core trench makes the length of seepage along contact of rock and impervious embankment.

4) Foundation excavation can contribute making smooth topography of core trench. This will avoid un-even settlement of impervious embankment.

Excavation of core trench for this dam will have same object above. The core trench for the dam will be excavated up to depth of about 10m in the foundation of the both abutment and the riverbed to expect the sound rock where grouting could effectively improve perviousness of shallow foundation.

- Grouting –

It is commonly recognized that fill dam rock foundation holding wide area being more than 3 – 5 Lugeon requires some treatment. Existing geological survey also shows that the foundation rock, especially shallow rocks, have pervious ones. Grouting is planned to avoid a leakage through the dam foundation and its limb foundation targeting pervious rock more than 3 to 5 Lugeon. The maximum depth and the minimum depth of the grouting are planned to be 25 m at left abutment and 20 m at river bed.

(5) Design of Spillway

- General –

The spillway facility will be placed on the right abutment. This considers the dam site topography that the right abutment is moderate slope while the left abutment is very steep slope of 45 degrees.

Spillway was designed taking following condition and consideration:

1) As the right abutment slopes toward rectangular direction against spillway centerline, the side channel type can be applied with less excavation of its foundation.

2) A firm foundation is necessary for a spillway, especially the discharge inflow channel and stilling basin. Proposed foundation of the design is located on the marl that is classified into CM – CH.

3) The non-gated type of weir will be suitable as it can expect economical construction cost and easy operation and maintenance.

4) The rectangular cross section and straight alignment of the chute way will be considered with the flow stability.

5) The energy dissipator after chute way will be installed to be erosion-resistant the river bed from the high kinetic energy.

- Hydraulic Design –

(a) Hydraulic Analysis

The following formula is used for hydrological analysis on the design discharge of flood.

$$\mathbf{S_{j+1} - S_j = ((I_j + I_{j+1})/2)\,\Delta t - ((Q_j + Q_{j+1})/2)\,\Delta t}$$

where,

S	:	storage function
Q	:	outflow hydrograph
I	:	inflow hydrograph
Δt	:	interval of duration

The hydrograph routine analysis data and the result of design flood is summarized in the attached Figure XVII2.4.5 for the 10,000 year flood as the dam id fill type dam.

The comparative study in relation to the weir length of side channel to the dam height made based on the cost estimation is shown in Table

XVII2.4.3. As the results of study ,the 40 m length of the weir is proposed to the design which have a maximum overflow depth being 3.17m.

(b) Basic Feature

The basic feature and dimension for the spillway are summarized as follows:;

Spillway type	:	Non-gated weir side channel
Weir crest elevation	:	EL 854.00
Design flood inflow	:	Q10,000 =700.00 m³/s
Design flood outflow		592.00 m³/s
Side channel length and width	:	60m,7.5 m and 15 m
Transition channel length and width	:	120 m, 15 m
Chute way length and width	:	160m, 15 m
Chute way bed slope	:	1V : 4.32H
Stilling basin type	:	Ski jump

(c) Main structures

1) Control Structure

The inlet structure to control hydraulic condition is designed to have an enough capacity to admit the discharge of 10,000 year flood. The non-gated weir is proposed to expect easy operation and maintenance. A shape of crest is decided based on Harold's standard, US Corps of Engineering (USBR Type).

Velocity in the approach channel to the spillway weir should be lower than 4.0 m/sec. The height of the weir above the floor of the approach side should be higher than one-fifth of the overflow depth(Hd) to attain smooth inflow into side channel with suitable hydraulic coefficient of weir flow.

The tangential slope after the top of weir crest is necessary to avoid cavitations by negative pressure acting on the sidewall of the channel.

2) Side Channel

A hydraulic condition in the side channel is not simple flow, as stream on the weir rapidly change flow direction in the side channel. Based upon experimental study, a profile of the side channel is proposed as follows:

- Inside slope : 1: 0.7 for weir side
  : Vertical for opposite side
- Gradient of channel bed : I<1/13
- Ratio of d/B : d/B = 0.5

  where; B = channel base width at downstream end (m)

  d = water depth (m)
- Froude number : Fr < 0.5

The water level of the upstream extremity of the side channel should be lower than the elevation of the weir crest

3) Transition Channel

A transition channel should be provided to connect the side channel to the structure holding control point where the flow changes to a supercritical flow. A gradient of channel base should be gentle enough to satisfy the hydraulic condition at the end of side channel. A control section constructed at the end of transition channel has function to induce control point from sub-critical flow to supercritical flow

4) Chute way

A chute way having an enough capacity to convey the design discharge should be straight. The height of sidewall of the chute way is decided on the basis of hydraulic calculation. The chute way is on a sound foundation.

5) Energy Dissipater

An energy dissipater is constructed at end of chute way. Through this structure, the flow is evacuated to the river without serious scour or erosion of the toe of the dam and without damage to adjacent structure.

The stilling basin type is finally adopted as the most suitable type in this spillway taking into account influence of riverbed scouring on dam body, and downstream river and structures along the river.

The hydraulic calculation of spillway are presented in the attached Table XVII2.4.4.

(6) Design of Intake Work

The intake is designed for supplying irrigation water to around 2,000 ha. and about 100 l/s for water supply for development area. The total design discharge is about 2.60 m^3/s.

The intake has been designed in the light of ;

1) The inclined composite type of left bank is proposed for the inlet structure. Water taken from the inlet flows in the steel pipe of 1,000 mm diameter inserted in the diversion tunnel.

2) The two type outlet structures will be located at the end of diversion tunnel and left downstream sloop of EL.847.00 height. One of jet flow gate of 300mm diameter at the end of diversion tunnel is installed to control the downstream maintenance. Other of sleeve valve of 1,000mm diameter at left downstream slope is installed to control the irrigation discharge. Three (3) pipes of water supply will be provided for downstream village.

(7) Design of Diversion

- General –

Main features of temporary diversion for this dam are a cofferdam and a diversion canal.

A cofferdam will be planed to place upstream inside of the main dam to make the dam cost economic. The embankment of the cofferdam mainly consists of gravel materials from borrow pit around dam site. The impervious embankment is set on the upstream surface of the cofferdam.

The diversion canal is classified into tow types such as culvert and tunnel. The culvert type diversion is not rare to be selected for the medium-scale dam. Comparison study for a tunnel type and culvert type was done, the comparative study is summarized in Table XVII2.4.5. The cost of culvert type is cheaper than that of tunnel type. Then a culvert type diversion will be selected for this dam site.

The diversion culvert will be placed in the right abutment, as a length of culvert is shorter than that in the left abutment.

Principal points of diversion designing are as follows:

1) Design discharge of diversion culvert is basically that of return period of 20 years, as the dam is fill type. To ensure the safe leading of flood flow a discharge of 50 years return period is checked to pass without overtopping the crest of cofferdam.

2) Discharge of above both return periods are 219m^3/s for 20 years and 222m^3/s for 50 years after considering the storage of flood in the reservoir. The hydrograph routine analysis result of diversion check flood is shown in the attached Figure XVII2.4.6.

3) Then culvert is planned to be 5m x 5m section with total a length of 240m.

4) The diversion culvert should be soundly founded on CM-CH of rock classification

.

- Main feature of Diversion works -

The main features is summarized as follows:

Design flood inflow (outflow)	:	Q20 =250 m^3/s (210 m^3/s)
		Q50 =300 m^3/s (219 m^3/s)
Crest elevation of cofferdam	:	EL835.00
Tunnel section	:	5m wide (2 x 2.5m) x 5m high
Culvert length	:	240m

XVII2.4.2 Irrigation Facilities

(1) Irrigation System

Since there are no existing irrigation facilities except for the farmlands irrigated by pump of about 20 ha in the project area, the proper irrigation system will be newly established. Based on the result of study on the optimum scale of the development plan, the following irrigation works were proposed:

- Construction of the storage dam and the stilling basin to divert the water into canals at just downstream of the dam,
- Establishment of irrigation canal network such as main, branch, feeder canals, and related structures to divide water into the farmlands under gravity irrigation,

The total irrigation area of 2,000 ha in net will be obtained so as to maintain the water level of canal as high as possible for maximizing the irrigation area. The water stored in the reservoir will be released to the stilling basin and be divided into main and branch canals.

(2) Layout of Irrigation Facilities

The layout of irrigation facilities such as main canal, branch canals and related structures was conducted on the basis of the topography, the existing water rights and the land suitability as well as the expected land consolidation in the near future. The main points considered for the alignment of irrigation facilities are summarized as follows:

- Typical Farmland -

A typical farmland layout for the determination of irrigation block size was established, taking into account the efficient water management and farm operation. Considering average size and shape of irrigation block, the typical block will be of rectangular with 400 m x 750 m of 30 ha in gross.

The total number of irrigation blocks is determined to be 44 blocks of which average area in net was about 26 ha as shown blow.

Name of Canal	Irrigation Area in Net (ha)	Number of Irrigation Blocks
Main Canal	967	37
Branch Canal (1)	319	15
Branch Canal (2)	541	17
Branch Canal (3)	173	8
Total	2,000	77

The typical farmland layout is shown in Figure XVII2.1.7.

- Canals -

Main canal route was laid out in the right bank along the gentle slope with a grade of less than 8 degrees available to irrigate lands by gravity. Branch canal (1) was directly connected to the end of main canal and branch canal (2) was separated from the main canal at 3.72 km downstream of the stilling basin so as to convey water to farmlands nearly located along the river.

Branch canal (3) route was laid out along the skirts of gently sloping hills in the left bank

- Related Structures -

Various related structure would be required in conjunction with irrigation canals for conveyance, regulation and measurement of irrigation water and protection of canal system.

(3) Preliminary Design

- Hydraulic Calculation

The following criteria for the hydraulic calculation were applied to the design of irrigation canals and related structures.

(a) Manning Formula

The "Manning Formula" was adopted for the hydraulic calculations.

(b) Roughness Coefficient

The roughness coefficient of irrigation canals was determined as below, considering the texture of canal construction material and the canal inside condition with proper maintenance after the project implementation.

Materials and Condition of Canals	Roughness Coefficient
Concrete lining	0.015
Stone lining, Pitching	0.020

(c) Velocity

The maximum permissible velocity of canals was determined so as not to cause scouring of canal. The minimum permissible velocity was determined so as not to induce the growth of aquatic plant and moss, and not to cause the sedimentation in canal. Permissible velocity of each canal was determined as follows:

Type	Min.	Max.
Thick concrete	0.45m/s	3.0m/s
Thin concrete, stone lining	0.45m/s	1.5m/s

(d) Free Board

The freeboard of the canal was designed based on the following criteria:

$Fb \geqq Fbmin$

$Fbmin = 0.07 \times d + hv + 0.05$

$hv = V^2 / 2 \times g$

where, Fb: Freeboard (m)

Fbmin: Minimum freeboard (m)

v: Mean velocity (m/sec)

d: Water depth (m)

hv: Velocity head (m)

v: Velocity (m/sec)

g: Acceleration of gravity (9.8 m/sec^2)

- Design of Irrigation Canals-

Irrigation canals were, in principle, designed as stone with concrete filled or concrete flume in consideration of water loss and maintenance of canals.

The design of irrigation canals were made in conformity with the basic design criteria mentioned below:

(a) Design discharge

Based on the irrigation water requirement and the commanding area, the design discharges for irrigation canals were estimated. Irrigation diagram for the proposed irrigation system is shown in Figure XVII2.4.7.

(b) Design Water Level

The design water level in the irrigation canal was determined based upon the required water level at offtake diverting the water to an irrigation block.

The required water level in the canal at offtake was estimated at the field surface elevation taking into account head losses caused at several structures and in canals through which the irrigation water would be transferred to each field lot.

The design water level in each canal is given in Table XVII2.4.6.

(c) Canal Section

The canal section was designed taking into account the effective water flow and the canal slope stability. The relationship between the canal base width and designed water depth was determined on the principle that the ratio of water depth to base width would be more than one under the condition. The canal inside slope was determined at 1V : 1.25 H in accordance with the soil mechanical condition.

General features of the irrigation canal are as follows:

Name of Canal	Canal Length (m)	Canal Discharge (m^3/s)	Canal Base Width (m)	Water Depth (m)	Canal Height (m)
Main Canal	13,545	2.38-0.63	1.60-0.60	1.01-0.58	1.25-0.80
Branch Canal (1)	2,580	0.25-0.14	0.50-0.40	0.45-0.40	0.60-0.50
Branch Canal (2)	5,515	0.71-0.29	1.00-0.60	0.49-0.40	1.00-0.70
Branch Canal (3)	2,670	0.23	0.80	0.40	0.60
Total	24,310	-	-	-	-

- Related Structures -

The general characteristics and design criteria of related structures are briefed as follows:

(a) Turnout and Offtake

Turnouts will be provided to divert the required water from main canal to branch canal. Offtakes will be installed to distribute the irrigation water from main or branch canal to feeder canal.

Offtakes will be provided double orifice gates. Two staff gauges will be provided upstream and downstream of the first gate to measure the head across the orifice.

(b) Drop

The function of drop structure is to convey the water from a higher to a lower elevation and dissipate excess energy resulting due to the drop.

(c) Siphon

Siphons will be constructed across the existing rivers. Single pipe barrel type of siphon will be considered depending on the design discharge. Siphon consists of inlet transition, barrel inlet, barrel section, barrel outlet and downstream transition.

(d) Culvert

Culvert will be constructed where a road crosses over the canal. These culverts will be strong enough for the increase of heavy traffic after the project implementation. The culvert consists of upstream transition, box or pipe culvert and downstream transition.

(e) Cross Drain

Cross drains will be provided under canals to cross the rivers. Cross drain consists of inlet protection and transition, barrel section, outlet transition and protection.

(f) Check Gate

In order to maintain the required water level at the site of offtaking even during periods of off-peak discharge, check gates will be provided at just or near downstream of turnouts. In consistence with canal longitudinal profile, the ordinary type check gates were considered.

The ordinary type check gate consists of upstream transition, throat section and downstream transition, and will be equipped with one rectangular slide gate and operation deck in the throat.

(g) Spillway

Spillways will be constructed in the canal system for the purpose of spilling out excess flow or flushing off all water in the canals incase of the emergency and the canal clearing and repairing. The spillway consists of side spillway, slide gate for waste of water, culvert under canal inspection road and outlet transition.

The numbers and types of all the structures for the proposed irrigation system are shown below.

Name of Canal	Offtake (nos.)	Spillway (nos.)	Check (nos.)	Cross drain (nos.)	Bridge (nos.)	Siphon (nos.)
Main Canal	29	4	10	33	14	11
Branch Canal (1)	5	1	1	6	3	2
Branch Canal (2)	12	2	2	14	6	7
Branch Canal (3)	4	-	-	7	3	-
Total	50	7	13	60	26	20

XVII3 Construction Plan and Cost Estimate

XVII3.1 N'FIFIKH Dam

XVII3.1.1 Construction Plan

(1) Monthly workable days

The number of monthly workable days for construction works of excavation, embankment and concrete are estimated based on the rainfall data at each project area from 1991 to 2000. The above common works will be suspended by the classification of daily rainfall depth as below.

Daily Rainfall Depth (mm/day)	Suspension of Work (day)		
	Excavation	Embankment	Concrete
X=0	0	0	0
$0 < X \leqq 5$	0	0	0
$5 < X \leqq 10$	0	0	0
$10 < X \leqq 30$	0.5	1.0	0
$30 < X \leqq 50$	1.0	1.5	1.0
$50 < X$	1.5	2.0	1.5

The monthly workable days are obtained by multiplication of suspension period and certain rainfall days. The results are shown on Table XVII3.1.1 below and details on XVII3.1.2 for all four sites. And the rainfall data of N'Fifikh is shown on Table XVII3.1.3.

Table XVII3.1.1 Monthly Workable Days

Work	N'Fifikh	Taskourt	Timkit	Azghar
Excavation	25	25	27	23
Embankment	25	26	28	24
Concrete	25	26	28	24

(2) Daily workable hours

The daily workable hours of dam construction are follows:

- Earth works and concrete works – 8 hours/day, 1shift
- Grouting works – 9 hours/day, 2 shifts, 2 hours overtime

(3) Equipment Used for Earth Works

Earth works consist of excavating, loading, hauling, spreading and compacting. Since there are various methods for these earth works, due consideration must be made on the choice of the suitable method. Earth works of the big volumes would be depended on a heavy duty equipments and their combinations. Table XVII3.1.4 shows major equipments for each work.

Table XVII3.1.4 Earth Works and Equipments

Works	Materials	Proposed Equipment
Excavation	Common Soil	Bulldozer (21-44t), Backhoe (0.6-1.2m3)
	Weathered Rock	Ripperdozer (32t)
	Rock	Blasting and Bulldozer (32t)
Loading	All materials	Tractor Shovel (5.4m3)
		Backhoe (0.4-1.2m3)
Hauling	All materials	Dump Truck (4-32t)
Spreading	All materials	Bulldozer (21-32t)
Compacting	Dam Core	Tamping Roller (30t)
	Other materials	Vibrating Roller (15-18t), Tamper (60kg)

(4) Construction Volume and Schedule

Construction volumes of each work in four sites are shown on Table XVII3.1.5. The construction period of each work is calculated based on production rate as shown on Table XVII3.1.6, and the results are summarized on Figure XVII3.1.1. The same equipments and production rates are assumed for the specific work in all four sites. The hauling distance of dump trucks is standardized in 0.5km because it is assumed that in-situ materials are basically used for all construction works after processed by screens and aggregate plants.

(5) Dam Construction

- Earth moving plan

It is planned that most of the earth and rock materials produced at site are used for construction works such as the coffer dam and the main dam embankment, backfill around the spillway, aggregate, etc. Lacking volume is obtained from borrow area and quarry site at upstream side of the riverbed. The plans of all for sites are shown on Table XVII3.1.7.

- Major works

Major works are listed as below.

- Preparatory works such as access roads, office yard, meter pools, etc.
- River diversion work
- Foundation excavation
- Dam embankment
- Spillway
- Outlet

1) River diversion

A cofferdam shall be constructed for a fill type dam, which is very fragile against overflowing during construction, to divert mainstream of a river. 300 meters long diversion channel would be constructed on the left side bedrock with reinforced concrete.

2) Foundation excavation

Beneath the whole of dam body, weak layers, such as organic soil, clayey soft deposit, alluvium deposit containing silt and clay, etc., should be removed to avoid un-even settlement and sliding of dam.

Loose soil layer about 0.5 to 1 m deep on both abutment and silt and clay alluvium deposits about 1m deep should be removed as dam foundation preparation. The core trench under impervious zone should be excavated deeper than other foundation of dam body, even if it is already rock foundation. The bottom line of the trench is planned to reach the maximum depth of 10m at riverbed and both abutments.

3) Foundation treatment

After foundation excavation work, grouting work shall be carried out in order to avoid excessive leakage through foundation. The depth of curtain grouting is maximum 15m at riverbed and minimum 10m at both abutments. Rotary boring shall be applied for curtain grouting.

4) Dam embankment

A center-cored fill type is chosen for N'fifikh site due to low bearing capacity of foundation. In-situ materials are used as much as possible by screening or mixing for proper gradation. The core zone is compacted by tamping roller and, filter and transition zones are compacted by vibrating roller.

5) Spillway

A fill type dam requires an independent spillway constructed on the stable foundation. The spillway made of reinforced concrete is constructed on the right bank and its size is quite big due to the big design flood.

6) Outlet

An inclined type outlet facility is constructed to control discharge, connecting the intake facility to outlet structure. Its pipeline is constructed in the diversion channel. Besides slide gates, jet flow gates and flow meters are installed.

(6) Irrigation Facility Construction Work

1) Main Canal

The structures of main canals, named Main, Branch and Main Feeder canal (1 and 2), are masonry lining, masonry flume and reinforced concrete flume, depending on the discharge and geological condition. Backhoes are used for excavation work and masonry work would be implemented manually.

2) Structures

Structures of irrigation facility are head works, siphons, offtakes, spillways, checks, aqueducts, cross drains, bridges, and on-farm facilities.

XVII3.1.2 Cost Estimate

(1) Basic Assumptions and Conditions

Both dam and irrigation facility construction costs in all four sites are estimated based on the following conditions.

1) The project costs are estimated at the price level of April 2000.

2) The exchange rate used in the estimate is shown as below;

US$1.00 = DH10.68, ¥100 = DH9.90 DH; Dirhams

3) Both local and foreign currency portions are estimated in Dirhams.

4) Physical contingency is fixed at 10%.

5) Price escalation rate is estimated at 3% per annum for both local and foreign currency portions.

6) The estimation includes 14% of value added tax.

7) Land acquisition, resettlement, and administration cost are not included.

8) International competitive bidding (ICB) is applied for the construction of dams and local competitive bidding (LCB) is applied for the construction of such facilities as irrigation and potable water supply.

9) The rate of local and foreign currency portion is 0.35 : 0.65 for the dam construction cost and 0.50 : 0.50 for the irrigation facility construction cost. The construction of a dam has higher dependence to foreign resources. Those values are referred from statistic data.

10) Earth materials shall be obtained in and around the construction sites, and aggregates shall be produced from those materials.

(2) Unit Cost

The construction costs are estimated on the unit cost basis. They are calculated based on basic prices collected through survey. The price of each unit cost is cautiously fixed considering the prices used in actual bidding. Japanese standard is referred for working rate and production rate.

Table XVII3.1.8 to XVII3.1.10 show basic prices of laborers, materials and equipments, collected from MOE, MOA, both foreign and local manufacturers, suppliers and agents. On the other hand, the production rate of each equipment is calculated as shown on Table XVII3.1.11 (refer Table XVII3.1.11 Attachment for the production rate of boring) and based on them, the equipment cost is estimated as shown on Table XVII3.1.12. Some unit cost are not used for calculation of implementation costs.

The unit costs shown on Table XVII3.1.13 are estimated based on the above basic prices and equipment costs. Considering the difference of bidding type, volume of work and the implementation method, the rate of local and foreign currency portion is distinguished to 0.35 : 0.65 for the dam construction cost and 0.50 : 0.50 for the irrigation facility construction cost. Table XVII3.1.14 and XVII3.1.15 show unit costs of each construction work.

Finally the implementation costs are estimated based on the above values, as shown on Table XVII3.1.16 for dam construction and XVII3.1.XVII for irrigation facility construction, and the results are summarized on Table XVII3.1.18.

(3) Constitution of Construction Cost

The construction cost consists of the following items.

1) Direct Construction Cost comprises the cost for actual civil works, and overhead and profit of contractor. The percentages of overhead and profit of contractor are about 15% for dam and 7% for irrigation works.

2) Physical Contingency is fixed at 10% of 1) for all construction works.

3) Price Contingency is estimated at 3% per annum for both local and foreign currency portions, based on the price escalation rate, and calculated at compound interest on the sum of 1) and 2). Based on the project implementation schedule, the construction cost is assumed to occur in the middle of the construction period, 7 years later in N'fifikh. Therefore the total percentage of price contingency is 23 % ($1.03^{7} - 1 = 0.23$).

4) Value Added Tax is fixed at 14% for all construction works, the standard percentage for a civil work contract, and multiplied by the sum of 1) to 3).

The costs of construction are 220.7 Million Dirham for dam and 56.3 MDH for irrigation facility and the total is 277.0 MDH. Table XVII.3.1.19 shows the cost of each work item of all four sites.

The breakdown is shown on Table XVII3.1.20. Detail cost estimate and work volume for irrigation facilities are shown on Table XVII3.1.21 and XVII3.1.22.

(4) Annual Operation and Maintenance Cost

Annual operation and maintenance cost is estimated 0.5% for a dam project cost and 2.0% for an irrigation project cost, based on the data obtained from the Ministry of Equipment and Ministry of Agriculture respectively.

XVII3.2 TASKOURT Dam

XVII3.2.1 Construction Plan

(1) Monthly workable days

The monthly workable days are calculated by the same method with N'fifikh.

The results are shown on Table XVII3.1.1 and XVII3.1.2. And the rainfall data of Taskourt is shown on Table XVII3.2.1.

(2) Daily workable hours

The daily workable hours of dam construction are follows:

- Earth works and concrete works – 8 hours/day, 1shift
- Grouting works – 9 hours/day, 2 shifts, 2 hours overtime

(3) Equipment Used for Earth Works

The equipments and their combinations used for the various earth works are same as N'fifikh and they are shown on Table XVII3.1.4.

(4) Construction Volume and Schedule

Construction volume of each work is shown on Table XVII3.1.5. The construction period of each work is calculated based on production rate as shown on Table XVII3.1.6, and the results are summarized on Figure XVII3.1.1.

(5) Dam Construction

- Earth moving plan

It is planned that most of sand and gravel materials produced at site are used for aggregate as much as possible. Main volume is obtained from quarry site at upstream side of the riverbed. The plan is shown on Table XVII3.1.7.

- Major works

Major works are listed as below.

- Preparatory works such as access roads, office yard, meter pools, etc.
- River diversion work
- Foundation excavation
- Dam embankment
- Spillway
- Outlet

1) River diversion

270 meters long diversion channel would be constructed prior to dam construction work. The construction procedure is roughly planned as below.

- Construct a temporary cutoff by mixing impermeable material and riverbed sandy soil across the river
- Divert the mainstream along the left bank
- Construct the main cutoff on the right side and divert the stream to corrugate pipe
- Finish the excavation on the left side and construct the dam body
- Construct the diversion channel

2) Foundation excavation

The riverbed deposit is estimated in the thickness of about 10 meters. Its whole layer should be removed as well as a layer of weathered rock.

3) Foundation treatment

The depth of curtain grouting is maximum 45m at riverbed and minimum 20m at both abutments. Besides it, consolidation grouting shall be done with 5m deep to make dam body stick well to foundation. Percussion boring shall be applied for consolidation grouting.

4) Dam embankment

A concrete gravity type is chosen for Taskourt. Outer conventional concrete is rich concrete and inner concrete is roller compacted concrete (RCC).

The features of RCC are the zero slump, minimum cement volume, compacted by vibrating rollers, and hauled by dump trucks in order to minimize the heat of hydration and to maximize efficiency. Coarse aggregate’s size is 80mm maximum and classified into 2 or 3 to ensure the gradation. Concrete mixing plant produces RCC to control the quality.

Aggregate plants produce aggregate from in-situ materials. Inner concrete is spread by swamp bulldozers and compacted by vibrating roller. Outer concrete is placed by concrete pumps and chutes between fixed precast concrete plate and inner concrete.

5) Spillway

As a flood overflows the dam crest, an independent spillway is not needed. 4 meters high guide wall and downstream slab are constructed with the dam body. The width is 100 meters at crest and 80 meters at riverbed.

6) Outlet

The outlet facility is constructed to control discharge. The diversion channel is used for it. An intake structure is also constructed with the installation of slide gates, jet flow gates and flow meters.

(6) Irrigation Facility Construction Work

1) Main Canal

The structures of main canals, named Main and Branch canal, are masonry flume and reinforced concrete flume, depending on the discharge and geological condition. Backhoes are used for excavation work and masonry work would be implemented manually.

2) Structures

Structures of irrigation facility are a head work, siphon, drops, offtakes, spillways, cross drains, bridges, and on-farm facilities.

XVII3.2.2 Cost Estimate

(1) Basic Assumptions and Conditions

Both dam and irrigation facility construction costs in all four sites are estimated based on the same conditions as N'fifikh.

(2) Unit Cost

The way of calculation and the amount of unit costs are same as N'fifikh. The results are shown on Table XVII3.1.8 to XVII3.1.18.

(3) Constitution of Construction Cost

The construction cost consists of the direct construction cost, physical contingency, price contingency and value added tax, same as N'fifikh except for the followings.

- Percentage of overhead and profit of contractor in dam construction; 22%

The costs of construction are 424.6 Million Dirham for dam and 203.1 MDH for irrigation facility and the total is 627.7 MDH. Table XVII3.1.19 shows the cost of each work item of all four sites.

The breakdown is shown on Table XVII3.2.2. Table XVII3.2.2 Attachment shows cost calculation of access road enlargement. Detail cost estimate and work volume for irrigation facilities are shown on Table XVII3.1.21 and XVII3.1.22

(4) Annual Operation and Maintenance Cost

Annual operation and maintenance cost is estimated 0.5% for a dam project cost and 2.0% for an irrigation project cost, based on the data obtained from the Ministry of Equipment and Ministry of Agriculture respectively.

XVII3.3 TIMKIT Dam

XVII3.3.1 Construction Plan

(1) Monthly workable days

The monthly workable days are calculated by the same method with N'fifikh.

The results are shown on Table XVII3.1.1 and XVII3.1.2. And the rainfall data of Timkit is shown on Table XVII3.3.1.

(2) Daily workable hours

The daily workable hours of dam construction are follows:

- Earth works and concrete works – 8 hours/day, 1shift
- Grouting works – 9 hours/day, 2 shifts, 2 hours overtime

(3) Equipment Used for Earth Works

The equipments and its combination used for the various earth works are same as N'fifikh and they are shown on Table XVII3.1.4.

(4) Construction Volume and Schedule

Construction volume of each work is shown on Table XVII3.1.5. The construction period of each work is calculated based on production rate as shown on Table XVII3.1.6, and the results are summarized on Figure XVII3.1.1.

(5) Dam Construction

- Earth moving plan

It is planned that most of the sand and gravel materials produced at site are used for aggregate as much as possible. Main volume is obtained from the riverbed around dam site. The plan is shown on Table XVII3.1.7.

- Major works

Major works are listed as below.

- Preparatory works such as access roads, office yard, meter pools, etc.
- River diversion work
- Foundation excavation
- Dam embankment
- Spillway
- Outlet
- Sabo dam

1) River diversion

200 meters long diversion channel would be constructed prior to dam construction work. The construction procedure is same as Taskourt.

2) Foundation excavation

The riverbed deposit is estimated in the thickness of about 10 meters. Its whole layer should be removed as well as a layer of weathered rock.

3) Foundation treatment

The depth of curtain grouting is maximum 60m at abutment and minimum 15m at riverbed. Consolidation grouting shall be done with 5m deep to make dam body stick well to foundation. The dam site has limestone foundation, so that grout curtain should be appropriately connected to the impermeable clayey limestone layer. Quantity of cement for curtain grouting is 10 times more than other three sites.

4) Dam embankment

A concrete gravity type is chosen for Timkit. Outer conventional concrete is rich concrete and inner concrete is roller compacted concrete (RCC).

The features of RCC and implementation methods are same as Taskourt.

5) Spillway

4 meters high guide wall and downstream slab are constructed with the dam body. The width is 60 meters at both crest and riverbed.

6) Outlet

The role and structure of the outlet is same as Taskourt.

7) Sabo dam

A sabo dam is constructed in Timkit to store 6.0 million m3 of sediment, equivalent to 30 years sediment volume at the main dam site. The site of sabo dam is located approximately 20km upstream from the main dam and it has 60% of basin area of the main one. Rubble masonry is applied for sabo dam body.

(6) Irrigation Facility Construction Work

1) Main Canal

There is an existing irrigation system in Timkit. Its main canals are rehabilitated with concrete flume and masonry flume, depending on the discharge and geological condition. Backhoes are used for excavation work and masonry work would be implemented manually.

2) Structures

Rehabilitated structures of irrigation facility are head works and on-farm facilities.

XVII3.3.2 Cost Estimate

(1) Basic Assumptions and Conditions

Both dam and irrigation facility construction costs in all four sites are estimated based on the same conditions as N’fifikh.

(2) Unit Cost

The way of calculation and the amount of unit costs are same as N'fifikh. The results are shown on Table XVII3.1.8 to XVII3.1.18.

(3) Constitution of Construction Cost

The construction cost consists of the direct construction cost, physical contingency, price contingency and value added tax, same as Taskourt except for the following.

- Percentage of overhead and profit of contractor in dam construction; 15%

The costs of construction are 250.3 Million Dirham for dam and 173.2 MDH for irrigation facility and the total is 423.5 MDH. Table XVII3.1.19 shows the cost of each work item of all four sites.

The breakdown is shown on Table XVII3.3.2. Table XVII3.3.2 Attachment shows the cost calculation of road relocation and, the features and volume of sabo dam. Detail cost estimate and work volume for irrigation facilities are shown on XVII3.1.22.

(4) Annual Operation and Maintenance Cost

Annual operation and maintenance cost is estimated 0.5% for a dam project cost and 2.0% for an irrigation project cost, based on the data obtained from the Ministry of Equipment and Ministry of Agriculture respectively.

XVII3.4 AZGHAR Dam

XVII3.4.1 Construction Plan

(1) Monthly workable days

The monthly workable days are calculated by the same method with N'fifikh.

The results are shown on Table XVII3.1.1 and XVII3.1.2. And the rainfall data of Azghar is shown on Table XVII3.4.1.

(2) Daily workable hours

The daily workable hours of dam construction are follows:

- Earth works and concrete works – 8 hours/day, 1shift

- Grouting works – 9 hours/day, 2 shifts, 2 hours overtime

(3) Equipment Used for Earth Works

The equipments and its combination used for the various earth works are same as N'fifikh and they are shown on Table XVII3.1.4.

(4) Construction Volume and Schedule

Construction volume of each work is shown on Table XVII3.1.5. The construction period of each work is calculated based on production rate as shown on Table XVII3.1.6, and the results are summarized on Figure XVII3.1.1.

(5) Dam Construction

- Earth moving plan

It is planned that most of the earth and rock materials produced at site are used for aggregate as much as possible. Lacking volume is obtained from quarry site. The plan is shown on Table XVII3.1.7.

- Major works

Major works are listed as below.

- Preparatory works such as access roads, office yard, meter pools, etc.
- River diversion work
- Foundation excavation
- Dam embankment
- Spillway
- Outlet

1) River diversion

A cofferdam shall be constructed to divert mainstream of a river. 240 meters long diversion culvert would be constructed prior to dam construction work. It locates on the right side to shorten the length.

2) Foundation excavation

Beneath the whole of dam body, weak layers, such as organic soil, clayey soft deposit, alluvium deposit containing silt and clay, etc., should be removed to avoid un-even settlement and sliding of dam in the same manner with N'fifikh.

3) Foundation treatment

After foundation excavation work, grouting work shall be carried out in order to avoid excessive leakage through foundation. The depth of curtain grouting is maximum 25m at abutments and minimum 20m at riverbed. Rotary boring shall be applied for curtain grouting.

4) Dam embankment

A center-cored fill type is economically chosen for Azghar site through the comparison study with concrete type. In-situ materials are used as much as possible by screening or mixing for proper gradation. The core zone is compacted by tamping roller and, filter and transition zones are compacted by vibrating roller.

5) Spillway

A fill type dam requires an independent spillway constructed on the stable foundation. The spillway made of reinforced concrete is constructed on the right bank.

6) Outlet

The role and structure of the outlet is same as N'fifikh.

(6) Irrigation Facility Construction Work

1) Main Canal

The structures of main canals, named Main and Branch canal (1 to 3), are masonry lining and reinforced concrete flume, depending on the discharge and geological condition. Backhoes are used for excavation work and masonry work would be implemented manually.

2) Structures

Structures of irrigation facility are siphons, drops, offtakes, spillways, checks, cross drains, bridges, box culverts and on-farm facilities.

XVII3.4.2 Cost Estimate

(1) Basic Assumptions and Conditions

Both dam and irrigation facility construction costs in all four sites are estimated based on the same conditions as N'fifikh.

(2) Unit Cost

The way of calculation and the amount of unit costs are same as N'fifikh. The results are shown on Table XVII3.1.8 to XVII3.1.18.

(3) Constitution of Construction Cost

The construction cost consists of the direct construction cost, physical contingency, price contingency and value added tax, same as N'fifikh except for the following.

- Percentage of overhead and profit of contractor in dam construction; 13%

The costs of construction are 173.4 Million Dirham for dam and 113.1 MDH for irrigation facility and the total is 286.5 MDH. Table XVII3.1.19 shows the cost of each work item of all four sites.

The breakdown is shown on Table XVII3.4.2. Detail cost estimate and work volume for irrigation facilities are shown on XVII3.1.21 and XVII3.1.22. Table XVII3.4.2 Attachment shows the cost calculation of the diversion tunnel.

(4) Annual Operation and Maintenance Cost

Annual operation and maintenance cost is estimated 0.5% for a dam project cost and 2.0% for an irrigation project cost, based on the data obtained from the Ministry of Equipment and Ministry of Agriculture respectively.

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Tables

Table XVII2.1.1: Principal Features of No.5 N'Fifikh

Description			Remark
A. Dam			
1 General			
Province		Ben Slimane	
River		Oued Daliya	
Coordinate of dam site	Xl1	345,640	Location: direct distance 25km from Ben Sliman
	Yl1	311,800	
	Xr2	345,700	
	Yr2	312,200	
2 Hydrology			
Catchment area	km2	323.00	
Annual mean rainfall	mm	323.00	
Annual mean run-off	Mm3	13.32	
3 Reservoir			
Gross storage	m3	19,200,000.00	
Effective storage	m3	17,700,000.00	
Dead storage	m3	1,500,000.00	30,000m3/yr. x 50yrs
Reservoir surface area	ha	173.60	
Elevation of flood water level (FWL)	m	248.64	Hd=3.64m
Elevation of normal water level (NWL)	m	245.00	
Elevation of low water level (LWL)	m	225.50	
4 Dam Body			
Geology of foundation		Alternation of sandstone & Pelitic stone (Devonian to Carboniferous)	
Type of dam		Center-cored rock fill	
Elevation of dam crest	EL	251.50	Freeboard above FWL 2.86
Elevation of dam foundation	EL	204.00	above NWL 6.50
Height from proposed foundation	m	47.50	
Length of dam crest	m	325.00	
Upstream slope		1:2.50	
Downstream slope		1:2.00	
Width of dam crest	m	6.00	
Seismic intensity		0.10	(100yr.acceleration=42gal)
Embankment quantity (total)	m3	678,400.00	
Core	m3	142,500.00	
Filter & drain + Gravel, rock	m3	515,600.00	
Rip rap	m3	20,300.00	
5 Spillway			
Location		Right bank	
Geology of foundation		Sandstone & Pelitic stone of CL-CM	
Design inflow discharge (10,000yr)	m3/s	1,800.00	
Design outflow discharge(10,000yr)	m3/s	1,668.00	
Type of weir		Non gated side channal	
Weir length /width		120m x 25m	
Design overflow depth	m	3.64	
Type of stilling basin		Hydraulic jump type	
6 Intake/Outlet			
Type		Inclined conduit	
		D600mm slide gate x 2	
Intake location		Left bank	
Capacity	m3/s	1.61	
Outlet pipe		D1000mm x 270m	
Discharge control valve		D1000mmJFG	
Raw water facilities		D300mm pipe and D300 sluice valve	
7 Diversion			
Type		Cofferdam/Culvert	
Design inflow discharge(20yr/50yr)	m3/s	250.0/380.0	
Design outflow discharge(20yr/50yr)	m3/s	236.1/271.0	
Cofferdam crest elevation	m	226.50	
Upstream water level(20yr/50yr)	m	221.1/226.2	
Culvert location		Left abutment	
Culvert section/length		5m x 5m / 300m	
8 Dam Construction Cost			
1.Direct cost			
1.1 Diversion works	MDH	18.07	
1.2 Foundation excavation	MDH	7.65	
1.3 Foundation treatment	MDH	3.56	
1.4 Dam embankment	MDH	11.56	
1.5 Spill way	MDH	70.49	
1.6 Intake works	MDH	3.66	
1.7 Gate and pipe	MDH	8.56	
1.8Overhed and profit of contractor	MDH	19.60	
Sub-total	MDH	143.15	
2.Physical contingency	MDH	14.32	
3.Price contingency	MDH	36.20	
Total	MDH	193.67	
4.Value added tax(14%)	MDH	27.11	
Ground total	MDH	220.70	325 DH/m3
B. Irrigation			
9 Service Area			
Service area	ha	1,000.00	
10 Irrigation Construction Cost			
1.Direct cost			
1.1 Main canal	MDH	12.82	
1.2 Structures	MDH	21.29	
1.3Overhed and profit of contractor	MDH	2.39	
Sub-total	MDH	36.50	
2.Physical contingency	MDH	3.65	
3.Price contingency	MDH	9.23	
Total	MDH	49.38	
4.Value added tax(14%)	MDH	6.91	
Ground total	MDH	56.30	56,300 DH/m3

Table XVII2.1.2: Hydraulic Calculation of Spillway (N'FIFIKH DAM) (1/2)

Q10,000yr.(out) = 1668.00 (M^3/S)

(1)Side Channel

NO.	DIS. (M)	EL. (M)	WL. (M)	DEPTH (M)	WIDTH (M)	AREA (M2)	WET PER. (M)	HYD.DEPTH (M)	Q (M^3/S)	V (M/S)
1	120.000	230.080	239.821	9.741	25.000	276.723	46.631	5.934	1668.000	6.028
2	110.000	230.413	240.391	9.978	23.958	273.902	46.116	5.939	1529.000	5.582
3	100.000	230.747	240.905	10.158	22.917	268.912	45.475	5.913	1390.000	5.169
4	90.000	231.080	241.380	10.300	21.875	262.432	44.747	5.865	1251.000	4.767
5	80.000	231.413	241.821	10.408	20.833	254.738	43.945	5.797	1112.000	4.365
6	70.000	231.747	242.235	10.488	19.792	246.085	43.083	5.712	973.000	3.954
7	60.000	232.080	242.622	10.542	18.750	236.554	42.160	5.611	834.000	3.526
8	50.000	232.413	242.979	10.566	17.708	226.177	41.171	5.494	695.000	3.073
9	40.000	232.747	243.303	10.557	16.667	214.952	40.110	5.359	556.000	2.587
10	30.000	233.080	243.589	10.509	15.625	202.847	38.961	5.206	417.000	2.056
11	20.000	233.413	243.823	10.410	14.583	189.733	37.700	5.033	278.000	1.465
12	10.000	233.747	243.987	10.240	13.542	175.374	36.282	4.834	139.000	0.793
13	0.000	234.080	244.051	9.971	12.500	159.444	34.643	4.602	0.000	0.000

(2)Transition Channel

NO.	DISTANCE (M)	(M)	EL. (M)	WL. (M)	DEPTH (M)	WIDTH (M)	AREA (M^2)	V (M/S)	WET PER. (M)	HYD.DEPTH (M)	HV (M)	FR
1	0.000	0.000	230.000	237.682	7.682	25.000	192.050	8.685	40.364	4.758	3.849	1.00
2	10.000	10.000	230.010	237.942	7.932	25.000	198.300	8.411	40.864	4.853	3.610	0.95
3	20.000	10.000	230.020	238.046	8.026	25.000	200.644	8.313	41.051	4.888	3.526	0.94
4	30.000	10.000	230.030	238.118	8.088	25.000	202.206	8.249	41.176	4.911	3.472	0.93
5	40.000	10.000	230.040	238.183	8.143	25.000	203.573	8.194	41.286	4.931	3.425	0.92
6	50.000	10.000	230.050	238.240	8.190	25.000	204.745	8.147	41.380	4.948	3.386	0.91
7	60.000	10.000	230.060	238.297	8.237	25.000	205.917	8.100	41.473	4.965	3.348	0.90

Table XVII2.1.2: Hydraulic Calculation of Spillway (N'FIFIKH DAM) (2/2)

8	70.000	10.000	230.070	238.346	8.276	25.000	206.894	8.062	41.551	4.979	3.316	0.90
9	72.500	2.500	230.073	238.965	8.893	25.000	229.243	7.276	42.921	5.341	2.701	0.79
10	75.000	2.500	230.075	239.331	9.256	25.000	246.399	6.770	44.063	5.592	2.338	0.73
11	77.500	2.500	230.078	239.603	9.526	25.000	261.963	6.367	45.284	5.785	2.069	0.69
12	80.000	2.500	230.080	239.821	9.741	25.000	276.723	6.028	46.631	5.934	1.854	0.65

(3)Chute way

NO.	DISTANCE		EL.	WL.	DEPTH1	DEPTH2	WIDTH	AREA	V	WET PER.	HYD.DEPTH	HV
	(M)	(M)	(M)	(M)	(M)	(M)	(M)	(M^2)	(M/S)	(M)	(M)	(M)
1	0.000	0.000	230.000	237.682	7.682	7.682	25.000	192.050	8.685	40.364	4.758	3.849
2	10.000	10.000	228.333	233.840	5.507	5.432	25.000	135.802	12.283	35.864	3.787	7.697
3	20.000	10.000	226.667	231.514	4.847	4.781	25.000	119.537	13.954	34.563	3.459	9.934
4	30.000	10.000	225.000	229.427	4.427	4.366	25.000	109.161	15.280	33.733	3.236	11.912
5	40.000	10.000	223.333	227.453	4.119	4.063	25.000	101.579	16.421	33.126	3.066	13.757
6	50.000	10.000	221.667	225.547	3.880	3.828	25.000	95.690	17.431	32.655	2.930	15.503
7	60.000	10.000	220.000	223.686	3.686	3.636	25.000	90.902	18.349	32.272	2.817	17.179
8	70.000	10.000	218.333	221.857	3.524	3.476	25.000	86.898	19.195	31.952	2.720	18.798
9	80.000	10.000	216.667	220.053	3.386	3.340	25.000	83.495	19.977	31.680	2.636	20.362
10	90.000	10.000	215.000	218.266	3.266	3.222	25.000	80.542	20.710	31.443	2.562	21.882
11	100.000	10.000	213.333	216.495	3.161	3.118	25.000	77.960	21.396	31.237	2.496	23.356
12	110.000	10.000	211.667	214.735	3.069	3.027	25.000	75.670	22.043	31.054	2.437	24.791
13	120.000	10.000	210.000	212.986	2.986	2.945	25.000	73.623	22.656	30.890	2.383	26.189

(4)Stilling Basin

Depth before jump : D1 = 2.945 M

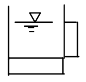
Velocity before jump : V1 = 22.656 M/S

Froude number before jump : FR = 4.217

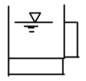
Jump depth : D2 = 16.153 M

Table XVII2.1.3 Water Head Allotment of Canal in N'Fifikh (1/2)

Main Feeder Canal (1)

Station	Dischage (Q m^3/s)	Length (L m)	Canal Structures	Energy	Loss (m)	Height of Energy Line (EL m)	Velocity (m/s)	Velocity Head (m)	Water Surface Elevation (EL m)	Water Depth (d m)	Bottom Elevation (EL m)	Cross Section	Dimension of Cross Section Coefficient of Head Loss
0+000	0.07					211.31	0.47	0.01	211.30	0.10	211.20		d=0.10 m m=0.00 b=0.15 m Fb=0.10 m n=0.015 i =1/300
		1000	Open Canal	$n^2*V^2*L/R^{4/3}$	3.33								
1+000						207.98	0.47	0.01	207.97	0.10	207.87		
		1000	ditto	ditto	3.33								
2+000						204.64	0.47	0.01	204.63	0.10	204.53		
		500	ditto	ditto	1.67								
2+500						202.98	0.47	0.01	202.97	0.10	202.87		

Main Feeder Canal (2)

Station	Dischage (Q m^3/s)	Length (L m)	Canal Structures	Energy	Loss (m)	Height of Energy Line (EL m)	Velocity (m/s)	Velocity Head (m)	Water Surface Elevation (EL m)	Water Depth (d m)	Bottom Elevation (EL m)	Cross Section	Dimension of Cross Section Coefficient of Head Loss
0+000	0.26					194.07	1.14	0.07	194.00	0.46	193.54		d=0.46 m m=0.00 b=0.50 m Fb=0.24 m n=0.015 i =1/300
		1000	Open Canal	$n^2*V^2*L/R^{4/3}$	3.33								
1+000						190.73	1.14	0.07	190.67	0.46	190.21		
		1000	ditto	ditto	3.33								
2+000						187.40	1.14	0.07	187.33	0.46	186.87		
		1000	ditto	ditto	3.33								
3+000						184.06	1.14	0.07	184.00	0.46	183.54		
		1000	ditto	ditto	3.33								
4+000						180.73	1.14	0.07	180.66	0.46	180.20		
		450	ditto	ditto	1.50								
4+450						179.23	1.14	0.07	179.16	0.46	178.70		

Main Canal

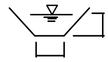
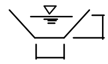
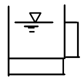
Station	Dischage (Q m^3/s)	Length (L m)	Canal Structures	Energy	Loss (m)	Height of Energy Line (EL m)	Velocity (m/s)	Velocity Head (m)	Water Surface Elevation (EL m)	Water Depth (d m)	Bottom Elevation (EL m)	Cross Section	Dimension of Cross Section Coefficient of Head Loss
0+000	1.28					157.24	0.90	0.04	157.20	0.80	156.40		d=0.80 m m=1.25 b=0.80 m Fb=0.20 m n=0.020 i =1/1000
		1,000	Open Canal	$n^2*V^2*L/R^{4/3}$	1.00								
1+000	1.28					156.24	0.90	0.04	156.20	0.80	155.40		
		1,000	ditto	ditto	1.00								
2+000	1.28					155.24	0.90	0.04	155.20	0.80	154.40		
		200	ditto	ditto	0.20				155.00	0.80	154.20		
2+200	0.61					155.04	0.74	0.03	155.01	0.60	154.41		d=0.60 m m=1.25 b=0.62 m Fb=0.20 m n=0.020 i =1/1000
		800	ditto	ditto	0.80								
3+000	0.61					154.24	0.74	0.03	154.21	0.60	153.61		
		1,000	ditto	ditto	1.00								
4+000	0.61					153.24	0.74	0.03	153.21	0.60	152.61		
		1,000	ditto	ditto	1.00								
5+000	0.61					152.24	0.74	0.03	152.21	0.60	151.61		
		1,000	ditto	ditto	1.00								
6+000	0.61					151.24	0.74	0.03	151.21	0.60	150.61		
		900	ditto	ditto	0.90				150.31	0.60	149.71		
6+900	0.29					150.34	0.75	0.03	150.31	0.60	149.71		d=0.60 m m=0.00 b=0.65 m Fb=0.20 m n=0.015 i =1/1000
		100	ditto	ditto	0.10								
7+000	0.29					150.24	0.75	0.03	150.21	0.60	149.61		
		1,000	ditto	ditto	1.00								
8+000	0.29					149.24	0.75	0.03	149.21	0.60	148.61		
		1,000	ditto	ditto	1.00								
9+000	0.29					148.24	0.75	0.03	148.21	0.60	147.61		
		200	ditto	ditto	0.20								
9+200	0.29					148.04	0.75	0.03	148.01	0.60	147.41		

Table XVII2.1.3 Water Head Allotment of Canal in N'Fifikh (2/2)

Branch Canal

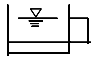
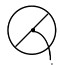
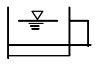
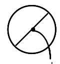
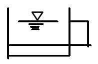
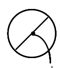
Station	Dischage (Q m³/s)	Length (L m)	Canal Structures	Energy	Loss (m)	Height of Energy Line (EL m)	Velocity (m/s)	Velocity Head (m)	Water Surface Elevation (EL m)	Water Depth (d m)	Bottom Elevation (EL m)	Cross Section	Dimension of Cross Section Coefficient of Head Loss
0+000	0.68					154.83	0.73	0.03	154.80	0.69	154.11	O.T. : Open Ttransition	
		59	Open Canal	$n^{2}*V^{2}*L/R^{4/3}$	0.83								
0+059	0.68					154.00	0.73	0.03	153.97	0.69	153.28		
		8	Aqueduct	ditto	0.00								d=0.69 m m=0.00
0+067	0.68					154.00	0.73	0.03	153.97	0.69	153.28	d	b=1.35 m Fb=0.20 m
		108	Open Canal	ditto	0.05								n=0.015 i =1/2,000
0+175	0.68					153.94	0.73	0.03	153.91	0.69	153.22	b	
			O.T.	$0.5*\Delta hv$	0.03								
			Trashrack	f_r*h_{v1}	0.00								φ=800mm
		26	Syphon	$n^{2}*V^{2}*L/R^{4/3}$	0.09		1.35	0.09					n=0.015
			O.T.	$0.7*\Delta hv$	0.05								
0+195	0.68					153.77	0.73	0.03	153.74	0.69	153.05	φ	
		805	Open Canal	$n^{2}*V^{2}*L/R^{4/3}$	0.40								
1+000	0.68					153.37	0.73	0.03	153.34	0.69	152.65		
		1,000	ditto	ditto	0.50								
2+000	0.68					152.87	0.73	0.03	152.84	0.69	152.15		
		1,000	ditto	ditto	0.50								
3+000	0.68					152.37	0.73	0.03	152.34	0.69	151.65		
		800	ditto	ditto	0.40								
3+800	0.68					151.97	0.73	0.03	151.94	0.69	151.25		
			O.T.	$0.5*\Delta hv$	0.03								
			Trashrack	f_r*h_{v1}	0.00								
		66	Syphon	$n^{2}*V^{2}*L/R^{4/3}$	0.23		1.35	0.09					
			O.T.	$0.7*\Delta hv$	0.05								
3+860	0.68					151.65	0.73	0.03	151.62	0.69	150.93		
		140	Open Canal	$n^{2}*V^{2}*L/R^{4/3}$	0.07								
4+000	0.68					151.58	0.73	0.03	151.55	0.69	150.86		
		150	ditto	ditto	0.07				151.48	0.69	150.79		
4+150	0.45					151.51	0.73	0.03	151.48	0.56	150.92		
		750	ditto	ditto	0.50								
4+900	0.45					151.01	0.73	0.03	150.98	0.56	150.42		
			O.T.	$0.5*\Delta hv$	0.02								
			Trashrack	f_r*h_{v1}	0.00								
		170	Syphon	$n^{2}*V^{2}*L/R^{4/3}$	0.53		1.17	0.07					d=0.56 m m=0.00
			O.T.	$0.7*\Delta hv$	0.03							d	b=1.10 m Fb=0.20 m
5+060	0.45					150.42	0.73	0.03	150.39	0.56	149.83		n=0.015 i =1/1,500
		20	Open Canal	$n^{2}*V^{2}*L/R^{4/3}$	0.01							b	
5+080	0.45					150.40	0.73	0.03	150.38	0.56	149.82		
			O.T.	$0.5*\Delta hv$	0.02								φ=700mm
			Trashrack	f_r*h_{v1}	0.00								n=0.015
		190	Syphon	$n^{2}*V^{2}*L/R^{4/3}$	0.60		1.17	0.07					
			O.T.	$0.7*\Delta hv$	0.03							φ	
5+260	0.45					149.75	0.73	0.03	149.73	0.56	149.17		
		740	Open Canal	$n^{2}*V^{2}*L/R^{4/3}$	0.49						148.67		
6+000	0.45					149.26	0.73	0.03	149.23	0.56	148.67		
		50	ditto	$n^{2}*V^{2}*L/R^{4/3}$	0.03								
6+050	0.45					149.23	0.73	0.03	149.20	0.56	148.64		
			O.T.	$0.5*\Delta hv$	0.02								
			Trashrack	f_r*h_{v1}	0.00								
		33	Syphon	$n^{2}*V^{2}*L/R^{4/3}$	0.10		1.17	0.07					
			O.T.	$0.7*\Delta hv$	0.03								
6+080	0.45					149.07	0.73	0.03	149.04	0.56	148.48		
		920	Open Canal	$n^{2}*V^{2}*L/R^{4/3}$	0.61								
7+000	0.45					148.46	0.73	0.03	148.43	0.56	147.87		
		150	ditto	ditto	0.10				148.33	0.56	147.77		
7+150	0.14					148.36	0.55	0.02	148.34	0.37	147.97		
		680	ditto	ditto	0.45								
7+830	0.14					147.91	0.55	0.02	147.89	0.37	147.52		
			O.T.	$0.5*\Delta hv$	0.02								
			Trashrack	f_r*h_{v1}	0.00								
		44	Syphon	$n^{2}*V^{2}*L/R^{4/3}$	0.26		1.11	0.06					d=0.37 m m=0.00
			O.T.	$0.7*\Delta hv$	0.03							b	b=0.70 m Fb=0.20 m
7+870	0.14					147.58	0.55	0.02	147.57	0.37	147.20		n=0.015 i =1/1,500
		130	Open Canal	$n^{2}*V^{2}*L/R^{4/3}$	0.09							d	
8+000						147.50	0.55	0.02	147.48	0.37	147.11		
		640	ditto	ditto	0.42								φ=400mm
8+640	0.14					147.07	0.55	0.02	147.06	0.37	146.69		n=0.015
		22	Syphon	$n^{2}*V^{2}*L/R^{4/3}$	0.13		1.11	0.06					
			Others(O.T. , Trashrack)		0.06							φ	
8+660	0.14					146.88	0.55	0.02	146.87	0.37	146.50		
		40	Open Canal	$n^{2}*V^{2}*L/R^{4/3}$	0.03								
8+700	0.14					146.85	0.55	0.02	146.84	0.37	146.47		
		22	Syphon	$n^{2}*V^{2}*L/R^{4/3}$	0.13		1.11	0.06					
			Others(O.T. , Trashrack)		0.06								
8+720	0.14					146.66	0.55	0.02	146.65	0.37	146.28		
		280	Open Canal	$n^{2}*V^{2}*L/R^{4/3}$	0.19								
9+000	0.14					146.48	0.55	0.02	146.46	0.37	146.09		
		150	ditto	ditto	0.10								
9+150	0.14					146.38	0.55	0.02	146.36	0.37	145.99		
		105	Syphon	$n^{2}*V^{2}*L/R^{4/3}$	0.63		1.11	0.06					
			Others(O.T. , Trashrack)		0.06								
9+250	0.14					145.69	0.55	0.02	145.67	0.37	145.30		

Table XV2.2.1: Principal Features of No.9 Taskourt

Description			Remark
A. Dam			
1 General			
Province		Marrakech	
River		Oued Al Mal	
Coordinate of dam site	Xl1	206,800.00	Location: sidi Bou Othmane
	Yl1	69,900.00	
	Xr2	206,900.00	
	Yr2	69,600.00	
2 Hydrology			
Catchment area	km2	419.00	
Annual mean rainfall	mm	366.00	
Annual mean run-off	Mm3	44.65	
3 Reservoir			
Gross storage	m3	25,100,000.00	
Effective storage	m3	19,100,000.00	
Dead storage	m3	6,000,000.00	120,000m3/yr. x 50yrs
Reservoir surface area	ha	124.73	
Elevation of flood water level (FWL)	m	998.95	Hd=3.95m
Elevation of normal water level (NWL)	m	995.00	
Elevation of low water level (LWL)	m	973.00	
4 Dam Body			
Geology of foundation		Schist	(Ordovician)
Type of dam		Concrete gravity by RCC	
Elevation of dam crest	EL	1,000.50	Freeboard above FWL 1.55
Elevation of dam foundation	EL	927.00	above NWL 5.50
Height from proposed foundation	m	73.50	
Length of dam crest	m	225.00	
Upstream slope		1:0.20	
Downstream slope		1:0.84	
Width of dam crest	m	5.00	
Seismic intensity		0.12	(100yr.acceleration=102gal)
Dam concrete quantity (total)	m3	415,000.00	
Conventional concrete	m3	100,300.00	
RCC concrete	m3	314,700.00	
5 Spillway			
Location		Center of dam body	
Geology of foundation		Schist	
Design inflow discharge(1,000yr/10,000yr)	m3/s	1,700/2,300	
Design outflow discharge(1,000yr/10,000yr)	m3/s	1,569/2,138	
Type of weir		Non gate straight crest	
Weir length and width		100m x 80m	
Design overflow depth(1,000yr/10,000yr)	m	3.95/4.85	
Type of stilling basin		Hydraulic jump type	
6 Intake/Outlet			
Type		Intake tower	
		W2.5XH3.0m slide gate x 2	
Intake location		Right side of dam body	
Capacity	m3/s	6.76	
Outlet pipe		D2000mm x 125 m	
Discharge control valve		D2000mm JFG	
Raw water facilities		D300mm pipe and D300 sluice valve	
7 Diversion			
Type		Cofferdam/Buried culvert	
Design inflow discharge(10yr/20yr)	m3/s	400.0/600.0	
Design outflow discharge(10yr/20yr)	m3/s	339.7/474.2	
Cofferdam crest elevation	m	962.50	
Upstream water level(10yr/20yr)	m	955.4/962.3	
Culvert location		Right side of river	
Culvert section/length		7.2m x 7.2m/270m	
8 Dam Construction Cost			
1.Direct cost			
1.1 Diversion works	MDH	5.21	
1.2 Foundation excavation	MDH	17.22	
1.3 Foundation treatment	MDH	9.69	
1.4 Dam embankment	MDH	175.85	
1.5 Spill way	MDH	2.05	
1.6 Intake works	MDH	2.41	
1.7 Gate and pipe	MDH	12.40	
1.8Overhed and profit of contractor	MDH	50.55	
Sub-total	MDH	275.38	
2.Physical contingency	MDH	27.54	
3.Price contingency	MDH	69.63	
Total	MDH	372.55	
4.Value added tax(14%)	MDH	52.16	
Ground total	MDH	424.60	1023 DH/m3
B. Irrigation			
9 Service Area			
Service area	ha	4,500	
10 Irrigation Construction Cost			
1.Direct cost			
1.1 Main canal	MDH	38.55	
1.2 Structures	MDH	84.54	
1.3Overhed and profit of contractor	MDH	8.62	
Sub-total	MDH	131.71	
2.Physical contingency	MDH	13.17	
3.Price contingency	MDH	33.32	
Total	MDH	178.20	
4.Value added tax(14%)	MDH	24.94	
Ground total	MDH	203.10	45,100 DH/m3

TableXVII 2.2.2 Hydraulic Calculation of Spillway (TASKOURT DAM)

Q1,000yr.(out) = 1408.000 (M^3/S)

(1)Chute way

NO.	DISTANCE		EL.	WL.	DEPTH1	DEPTH2	WIDTH	AREA	V	WET PER.	HYD.DEPTH	HV
	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m^2)	(m/S)	(m)	(m)	(m)
1	0.000	0.000	991.581	994.508	2.927	2.927	100.000	292.700	5.360	105.854	2.765	1.466
2	10.000	10.000	979.676	981.125	1.449	0.932	100.000	93.196	16.835	101.864	0.915	14.461
3	20.000	10.000	967.771	968.879	1.107	0.712	100.000	71.233	22.026	101.425	0.702	24.753
4	30.000	10.000	955.867	956.822	0.956	0.615	100.000	61.469	25.525	101.229	0.607	33.242
5	40.000	10.000	943.962	944.833	0.871	0.560	100.000	56.031	28.003	101.121	0.554	40.007
6	40.808	0.808	943.000	943.866	0.866	0.557	100.000	55.705	28.166	101.114	0.551	40.477

(2)Stilling Basin

Depth before jump : D1 = 0.557 m

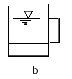
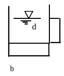
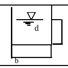
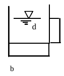
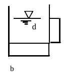
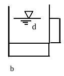
Velocity before jump : V1 = 28.166 m/s

Froude number before jump : FR = 12.055

Jump depth : D2 = 9.222 m

Table XVII2.2.3 Water Head Allotment of Canal in Taskourt

Main Canal

Station	Dischage (Q m3/s)	Length (L m)	Canal Structures	Energy	Loss (m)	Height of Energy Line (EL m)	Velocity (m/s)	Velocity Head (m)	Water Surface Elevation (EL m)	Water Depth (d m)	Bottom Elevation (EL m)	Cross Section	Dimension of Cross Section Coefficient of Head Loss
0+000	6.75					833.12	2.85	0.42	832.70	1.53	831.17		
		1,000	Open Canal	$n^2*V^2*L/R^{4/3}$	4.44								
1+000	6.75					828.67	2.85	0.42	828.26	1.53	826.73		
		1,000	ditto	ditto	4.44								d =1.53 m m=0.00 b=1.55 m Fb=0.57 m n =0.015 i =1/225
2+000	6.75					824.23	2.85	0.42	823.81	1.53	822.28		
		1,000	ditto	ditto	4.44								
3+000	6.75					819.78	2.85	0.42	819.37	1.53	817.84		
		1,000	ditto	ditto	4.44								
4+000	6.75					815.34	2.85	0.42	814.92	1.53	813.39		
		1,000	ditto	ditto	4.44				810.48	1.53	808.95		d =1.80 m b=1.85 m Fb=0.40 m i=1/200 n =0.025
5+000	6.75		Drop Structure			810.89	2.04	0.21	810.68	1.80	808.88		
		450	Open Canal	ditto	12.22								
5+450	4.72		Drop Structure			798.68	1.86	0.18	798.50	1.59	796.91		
		550	Open Canal	ditto	9.58								
6+000	4.72		Drop Structure			789.09	1.86	0.18	788.92	1.59	787.33		d =1.59 m m=0.00 b=1.60 m Fb=0.36 m n =0.025 i =1/200
		1,000	Open Canal	ditto	17.42								
7+000	4.72		Drop Structure			771.67	1.86	0.18	771.50	1.59	769.91		
		1,000	Open Canal	ditto	13.59								
8+000	4.72		Drop Structure			758.08	1.86	0.18	757.90	1.59	756.31		
		1,000	Open Canal	ditto	13.59								
9+000	4.72		Drop Structure			744.49	1.86	0.18	744.31	1.59	742.72		
		60	Open Canal	ditto	0.82				743.50	1.59	741.91		
9+060	3.55					743.67	2.43	0.30	743.37	1.17	742.20		d =1.17 m m=0.00 b=1.25 m Fb=0.43 m n =0.025 i =1/82
		940	Open Canal	ditto	11.46								
10+000	3.55					732.21	2.43	0.30	731.91	1.17	730.74		
		800	ditto	ditto	9.76				722.15	1.17	720.98		
10+800	2.13					722.45	2.24	0.26	722.20	0.71	721.49		
		200	ditto	ditto	2.59								
11+000	2.13					719.87	2.24	0.26	719.61	0.71	718.90		d =0.71 m m=0.00 b=1.35 m Fb=0.34 m n =0.025 i =1/77.3
		800	ditto	ditto	10.35								
11+800	2.13					709.52	2.24	0.26	709.26	0.71	708.55		
		200	ditto	ditto	2.59								
12+000	2.13					706.93	2.24	0.26	706.67	0.71	705.96		
		1,000	ditto	ditto	12.94								
13+000	2.13					693.99	2.24	0.26	693.74	0.71	693.03		
		730	ditto	ditto	9.44				684.30	0.71	683.59		
13+730	1.78					684.55	1.91	0.19	684.37	0.69	683.68		d =0.69 m m=0.00 b=1.35 m Fb=0.31 m n =0.025 i =1/105
		270	ditto	ditto	2.57								
14+000	1.78					681.98	1.91	0.19	681.79	0.69	681.10		
		700	ditto	ditto	6.67				675.13	0.69	674.44		
14+700	1.78					675.31	2.08	0.22	675.09	0.66	674.43		d =0.66 m m=0.00 b=1.30 m Fb=0.34 m n =0.025 i =1/83
		300	ditto	ditto	3.61								
15+000	1.78					671.70	2.09	0.22	671.48	0.66	670.82		
		1,000	ditto	ditto	12.16								
16+000	1.78					659.54	2.09	0.22	659.32	0.66	658.66		
		100	ditto	ditto	1.22				658.10	0.66	657.44		d =0.50 m b=1.20 m Fb=0.30 m i=1/65 n =0.025
16+100	1.26					658.33	2.09	0.22	658.10	0.50	657.60		
		610	ditto	ditto	9.39				648.72	0.50	648.22		
16+710	1.26					648.94	1.69	0.15	648.79	0.62	648.17		
		290	ditto	ditto	2.52								d =0.62 m m=0.00 b=1.20 m Fb=0.28 m n =0.025 i =1/115
17+000	1.26					646.42	1.69	0.15	646.27	0.62	645.65		
		1,000	ditto	ditto	8.70								
18+000	1.26					637.72	1.69	0.15	637.58	0.62	636.96		
		1,000	ditto	ditto	8.70								
19+000	1.26					629.03	1.69	0.15	628.88	0.62	628.26		
		1,000	ditto	ditto	8.70								
20+000	1.26					620.33	1.69	0.15	620.18	0.62	619.56		
		1,000	ditto	ditto	8.70								
21+000	1.26					611.63	1.69	0.15	611.49	0.62	610.87		
		600	ditto	ditto	5.22								
21+600	1.26					606.42	1.69	0.15	606.27	0.62	605.65		

Branch Canal

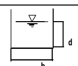
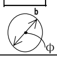
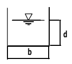
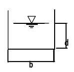
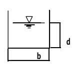
Station	Dischage (Q m3/s)	Length (L m)	Canal Structures	Energy	Loss (m)	Height of Energy Line (EL m)	Velocity (m/s)	Velocity Head (m)	Water Surface Elevation (EL m)	Water Depth (d m)	Bottom Elevation (EL m)	Cross Section	Dimension of Cross Section Coefficient of Head Loss
0+000	1.67		Drop Structure			798.55	0.95	0.05	798.50	1.30	797.20		d =1.30m m=0.00 b=1.35m Fb=0.20m n =0.025 i =1/600
		320	Open Canal	$n^2*V^2*L/R^{4/3}$	23.00								
0+320	1.67					775.55	0.95	0.05	775.50	1.30	774.20		
			O.T.	0.5*⊿hv	0.03								ϕ=1200mm n =0.015
			Trashrack	$fr*h_{v1}$	0.00								
		190	Syphon	$n^2*V^2*L/R^{4/3}$	0.46		1.48	0.11					
			O.T.	0.7*⊿hv	0.05								
0+500	1.67					775.00	0.79	0.03	774.97	1.42	773.55		
		500	Open Canal	$n^2*V^2*L/R^{4/3}$	0.50								
1+000	1.67					774.50	0.79	0.03	774.47	1.42	773.05		d =1.42 m m=0.00 b=1.50 m Fb=0.18 m n =0.025 i =1/1000
		1,000	ditto	ditto	1.00								
2+000	1.67					773.50	0.79	0.03	773.47	1.42	772.05		
		650	ditto	ditto	0.65				772.82	1.42	771.40		
2+650	1.62		Drop Structure			772.85	1.11	0.06	772.79	1.17	771.62		
		160	Open Canal	ditto	10.19								
2+810	1.62					762.66	1.11	0.06	762.60	1.17	761.43		
		190	Open Canal	ditto	0.48								
3+000	1.62					762.18	1.11	0.06	762.12	1.17	760.95		d =1.17 m m=0.00 b=1.25 m Fb=0.18 m n =0.025 i =1/395
		1,000	ditto	ditto	2.53								
4+000	1.62					759.65	1.11	0.06	759.59	1.17	758.42		
		1,000	ditto	ditto	2.53								
5+000	1.62					757.12	1.11	0.06	757.05	1.17	755.88		
		1,000	ditto	ditto	2.53				754.52	1.17	753.35		
6+000	1.02		Drop Structure			754.59	1.77	0.16	754.42	0.52	753.90		
		700	Open Canal	ditto	39.62								
6+700	1.02					714.96	1.77	0.16	714.80	0.52	714.28		
		300	Open Canal	ditto	3.41								
7+000	1.02					711.55	1.77	0.16	711.39	0.52	710.87		
		1,000	ditto	ditto	11.37								
8+000	1.02					700.18	1.77	0.16	700.02	0.52	699.50		d =0.52 m m=0.00 b=1.10 m Fb=0.28 m n =0.025 i =1/88
		1,000	ditto	ditto	11.37								
9+000	1.02					688.82	1.77	0.16	688.66	0.52	688.14		
		1,000	ditto	ditto	11.37								
10+000	1.02					677.45	1.77	0.16	677.29	0.52	676.77		
		1,000	ditto	ditto	11.37								
11+000	1.02					666.08	1.77	0.16	665.92	0.52	665.40		
		1,000	ditto	ditto	11.37								
12+000	1.02					654.72	1.77	0.16	654.56	0.52	654.04		
		1,000	ditto	ditto	11.37								
13+000	1.02					643.35	1.77	0.16	643.19	0.52	642.67		
		1,000	ditto	ditto	11.37								
14+000	1.02					631.99	1.77	0.16	631.82	0.52	631.30		
		1,000	ditto	ditto	11.37								
15+000	1.02					620.62	1.77	0.16	620.46	0.52	619.94		
		280	ditto	ditto	3.18								
15+280	1.02					617.44	1.77	0.16	617.28	0.52	616.76		

Table XVII2.3.1: Principal Features of No.10 Timkit

Description			Remark
A. Dam			
1 General			
Province		Errachidia	
River		Assif N'ifer	
Coordinate of dam site	Xr1	507,335.00	Location: Tinjdid
	Yr1	515,200.00	
	Xl2	507,550.00	
	Yl2	515,500.00	
2 Hydrology			
Catchment area	km2	572.00	
Annual mean rainfall	mm	186.00	
Annual mean run-off	Mm3	10.11	
3 Reservoir			
Gross storage	m3	27,500,000.00	
Flood storage	m3	20,000,000.00	
Effective storage	m3	3,500,000.00	
Dead storage	m3	4,000,000.00	200,000m3/yr. x 20yrs
Reservoir surface area	ha	172.50	
Elevation of flood water level (FWL)	m	1,258.12	Hd=2.32m
Elevation of surcharge water level (SWL)	m	1,255.80	
Elevation of normal water level (NWL)	m	1,245.00	
Elevation of low water level (LWL)	m	1,240.30	
4 Dam Body			
Geology of foundation		Limestone	(Lower Jurassic)
Type of dam		Concrete gravity by RCC	
Elevation of dam crest	EL	1,259.50	Freeboard above FWL 1.38
Elevation of dam foundation	EL	1,195.00	above NWL 14.50
Height from proposed foundation	m	64.50	
Length of dam crest	m	210.00	
Upstream slope		1:0.20	
Downstream slope		1:0.86	
Width of dam crest	m	5.00	
Seismic intensity		0.10	(100yr.acceleration=88gal)
Dam concrete quantity (total)	m3	227,600.00	
Conventional concrete	m3	44,900.00	
RCC concrete	m3	182,700.00	
5 Spillway			
Location		Center of dam body	
Geology of foundation		Limestone	
Design inflow discharge(1,000yr/10,000yr)	m3/s	2,000/2,800	
Design outflow discharge(1,000yr/10,000yr)	m3/s	426/826	
Type of weir		Non gate straight crest	
Weir length	m	60.00	
Design overflow depth(1,000yr/10,000yr)	m	2.32/3.61	
Type of stilling basin		Hydraulic jump type	
6 Intake/Outlet			
Type		Intake tower	
		D400mm slide gate x 1	
Intake location		Right side of dam body	
Capacity	m3/s	0.45	
Outlet pipe		D600 mm x 60 m	
Discharge control valve		D300mmJFG	
Flood control gate		4m x 4m slide gate and pressure conduit	
Raw water facilities		D400mm pipe and D400 sluice valve	
Sediment flush pipe		D800mm	
7 Diversion			
Type		Cofferdam/Buried culvert	
Design inflow discharge(10yr/20yr)	m3/s	300.0/500.0	
Design outflow discharge	m3/s	300.0/348.4	
Cofferdam crest elevation	m	1,230.50	
Upstream water level	m	1,217.8/1,230.2	
Culvert location		Left side of river	
Culvert section/length		6.0mm x 6.00mm/200m	
8 Dam Construction Cost			
1.Direct cost			
1.1 Diversion works	MDH	3.32	
1.2 Foundation excavation	MDH	10.50	
1.3 Foundation treatment	MDH	17.67	
1.4 Dam embankment	MDH	85.70	
1.5 Spill way	MDH	0.99	
1.6 Intake works	MDH	0.59	
1.7 Gate and pipe	MDH	3.44	
1.8 Sabo dam works	MDH	18.86	
1.9 Overhead and profit of contractor	MDH	21.31	
Sub-total	MDH	162.38	
2.Physical contingency	MDH	16.24	
3.Price contingency	MDH	41.06	
Total	MDH	219.68	
4.Value added tax(14%)	MDH	30.75	
Ground total	MDH	250.30	1,100 DH/m3
B. Irrigation			
9 Service Area			
Service area	ha	3,060	
10 Irrigation Construction Cost			
1.Direct cost			
1.1 Main canal	MDH	15.89	
1.2 Structures	MDH	89.07	
1.3Overhed and profit of contractor	MDH	7.35	
Sub-total	MDH	112.31	
2.Physical contingency	MDH	11.23	
3.Price contingency	MDH	28.41	
Total	MDH	151.95	
4.Value added tax(14%)	MDH	21.27	
Ground total	MDH	173.20	56,600 DH/m3

Table 2.3.2 Hydraulic Calculation of Spillway (TIMKIT DAM)

Q1,000(out) = 426.00 (M^3/S)

(1)Chute way

NO.	DISTANCE (M)	(M)	EL. (M)	WL. (M)	DEPTH1 (M)	DEPTH2 (M)	WIDTH (M)	AREA (M^2)	V (M/S)	WET PER. (M)	HYD.DEPTH (M)	HV (M)
1	0.000	0.000	1253.892	1255.617	1.725	1.725	60.000	103.500	4.116	63.450	1.631	0.864
2	9.000	9.000	1243.427	1244.141	0.714	0.465	60.000	27.923	15.256	60.931	0.458	11.875
3	18.000	9.000	1232.962	1233.521	0.560	0.365	60.000	21.889	19.462	60.730	0.360	19.325
4	27.000	9.000	1222.497	1222.996	0.499	0.326	60.000	19.532	21.810	60.651	0.322	24.270
5	36.000	9.000	1212.032	1212.502	0.470	0.307	60.000	18.398	23.155	60.613	0.304	27.354
6	36.027	0.027	1212.000	1212.470	0.470	0.307	60.000	18.397	23.156	60.613	0.304	27.358

(2)Stilling Basin

Depth before jump : D1 = 0.307 M

Velocity before jump : V1 = 23.156 M/S

Froude number before jump : FR = 13.359

Jump depth : D2 = 5.641 M

Table XVII2.3.3 Hydraulic Design of Canals in Timkit

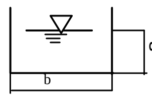
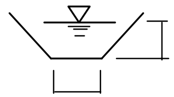
Name of River	Name of Area	Irrigation Area in Gross (ha)	Desgin Discharge ($Q\ m^3/s$)	Length (L m)	Canal Bed Slope (i)	Canal Bed Width (b m)	Water Depth (d m)	Cross-section Area (m^2)	Mean Velocity (V m/s)	Freeboard (m)	Canal Height (m)	Cross-section
Ifegh	Ifegh	300	0.45	3,600	1/200	0.50	0.60	0.30	1.49	0.25	0.75	n=0.015 
	Sub total	300		3,600								
Tributary of Tanguerfa	Ait Ferah	45	1.00	2,400	1/320	0.71	0.71	0.76	1.36	0.20	0.91	
	Ait Labzem	75	1.50	2,000	1/800	0.98	0.98	1.44	1.07	0.25	1.23	
	Tairza	55	1.50	2,000	1/300	0.81	0.81	0.98	1.54	0.25	1.06	m=0.5
Tanguerfa	Talalt	40	1.50	1,400	1/450	0.88	0.88	1.16	1.33	0.25	1.13	 n=0.025
	Tighert	175	2.50	2,700	1/750	1.17	1.17	2.05	1.24	0.25	1.42	
Todrha	Kharbat AM	300	4.50	-	-	-	-	-	-	-	-	
	Ras-Sdat	545	8.50	(4,400)	1/1350	-	-	-	-	-	-	
	Tamazirt	120	1.50	3,500	1/350	0.84	0.84	1.06	1.46	0.25	1.09	
Todrha	Asrir	120	1.50	2,500	1/500	0.89	0.89	1.19	1.27	0.25	1.14	
	Ait Hammou	130	2.00	2,500	1/620	1.04	1.04	1.62	1.26	0.25	1.29	
	Ait Assem	220	3.00	5,500	1/350	1.08	1.08	1.75	1.73	0.30	1.38	
	Lahini	250	3.50	3,700	1/410	1.18	1.18	2.09	1.69	0.30	1.48	
	Chtam	690	11.00	(2,470)	-	-	-	-	-	-	-	
Satt	Satt	90	1.50	3,500	1/470	0.88	0.88	1.16	1.30	0.25	1.13	
	Gardmit	270	3.50	3,200	1/500	1.23	1.23	2.27	1.57	0.30	1.53	( ) : Newly constructed canal
Izilf	Frifra	400	4.00	-	-	-	-	-	-	-	-	
	Sub total	3,525		34,900								
	Total	3,825		38,500								

Table XVII2.4.1: Principal Features of No.17 Azghar

Description			Remark
A. Dam			
1 General			
Province		Sefrou	
River		Oued Zloul	
Coordinate of dam site	Xr1	598,750.00	Location: Sefrou
	Yr1	3,573,500.00	
	Xl2	599,103.00	
	Yl2	3,570,500.00	
2 Hydrology			
Catchment area	km2	263.00	
Annual mean rainfall	mm	447.00	
Annual mean run-off	Mm3	53.21	
3 Reservoir			
Gross storage	m3	11,700,000.00	
Effective storage	m3	5,200,000.00	
Dead storage	m3	6,500,000.00	130,000m3/yr. x 50yrs
Reservoir surface area	ha	118.27	
Elevation of flood water level (FWL)	m	856.89	Hd=2.89m
Elevation of normal water level (NWL)	m	854.00	
Elevation of low water level (LWL)	m	848.50	
4 Dam Body			
Geology of foundation		Marl	(Lower Liassic)
Type of dam		Center-cored rock fill	
Elevation of dam crest	EL	859.50	Freeboard above FWL 2.61
Elevation of dam foundation	EL	817.00	above NWL 5.50
Height from proposed foundation	m	42.50	
Length of dam crest	m	325.00	
Upstream slope		1:2.80	
Downstream slope		1:2.40	
Width of dam crest	m	6.00	
Seismic intensity		0.12	(100yr.acceleration=66gal)
Embankment quantity (total)	m3	769,800.00	
Core	m3	130,900.00	
Filter & drain + Gravel, rock	m3	615,800.00	
Rip rap	m3	23,100.00	
5 Spillway			
Location		Right bank	
Geology of foundation		Marl of CM-CH	
Design inflow discharge(10,000yr)	m3/s	700.00	
Design outflow discharge(10,000yr)	m3/s	592.00	
Type of weir		Non gated side channel	
Weir length and width		60m x 15m	
Design overflow depth(10,000yr)	m	2.89	
Type of stilling basin		Hydraulic jump with roller bucket	
6 Intake/Outlet			
Type		Composite type inclined tower	
		D1000mmslide gate x 1	
Intake location		Left bank	
Capacity	m3/s	2.60	
Outlet pipe		D1000 mm x 480 m	
Discharge control valve		D1000mm Sleeve valve	
Raw water facilities		D300mm pipe and D300 sluice valve	
Sediment flush pipe		D800mm	
7 Diversion			
Type		Cofferdam/Culvert	
Design inflow discharge(20yr/50yr)	m3/s	250.0/300.0	
Design outflow discharge(20yr/50yr)	m3/s	212.6/221.6	
Cofferdam crest elevation	m	835.00	
Upstream water level(20yr/50yr)	m	831.5/834.7	
Culvert location		Right side of Riverbed	
Culvert section/length		5m x 5m / 240m	
8 Dam Construction Cost			
1.Direct cost			
1.1 Diversion works	MDH	19.36	
1.2 Foundation excavation	MDH	9.59	
1.3 Foundation treatment	MDH	5.42	
1.4 Dam embankment	MDH	16.03	
1.5 Spill way	MDH	35.29	
1.6 Intake works	MDH	1.21	
1.7 Gate and pipe	MDH	12.42	
1.8Overhed and profit of contractor	MDH	13.18	
Sub-total	MDH	112.50	
2.Physical contingency	MDH	11.25	
3.Price contingency	MDH	28.45	
Total	MDH	152.20	
4.Value added tax(14%)	MDH	21.30	
Ground total	MDH	173.40	225 DH/m3
B. Irrigation			
9 Service Area			
Service area	ha	2,000	
10 Irrigation Construction Cost			
1.Direct cost			
1.1 Main canal	MDH	12.22	
1.2 Structures	MDH	56.32	
1.3Overhed and profit of contractor	MDH	4.80	
Sub-total	MDH	73.34	
2.Physical contingency	MDH	7.33	
3.Price contingency	MDH	18.55	
Total	MDH	99.22	
4.Value added tax(14%)	MDH	13.89	
Ground total	MDH	113.10	56,600 DH/m3

Table XVII2.4.2 Comparative Study of Dam Type for AZGHAR DAM

The comparative study in dam type between fill and concrete type made based on the estimation of the costs

No.	Work Item	Unit	Unit Cost (DH)	Fill Type Quantity	Fill Type Amount (1,000DH)	Concrete Type Quantity	Concrete Type Amount (1,000DH)	Remarks
1	River Diversion Works							
1-1	Inlet/Outlet Channel							
	Excavation / hauling, soil & gravel	m^3	24.54	53,400	1,311	0	0	
	- ditto -, rock	m^3	94.02	0	0	0	0	
	Reinforced concrete	m^3	882.2	437	386	0	0	
	Form work	m^2	40.65	180	8	0	0	
	Sub-total				1,705		0	
1-2	Culvert Channel							
	Excavation / rock	m^3	94.02	22,900	2,153	0	0	
	Reinforced concrete	m^3	882.2	13,320	11,751	1,530	1,350	
	Plain concrete (Plugging)	m3	546.81	6,000	3,281	930	509	
	Form work	m^2	40.65	6,000	244	1,250	51	
	Sub-total				17,429		1,910	
1-3	Coffer Dam							
	Embankment, soil	m^3	6.76	34,100	230	21,000	142	
	Sub-total				230		142	
	Total				19,364		2,052	
2	Foundation Excavation							
	Excavation / hauling, soil & gravel	m^3	24.54	211,100	5,180	94,570	2,321	
	- ditto -, rock	m^3	94.02	46,900	4,410	72,030	6,772	
	Sub-total				9,590		9,093	
3	Foundation Treatment Works							
	Curtain grouting work	m	1130.99	4,791	5,419	4,760	5,384	
	Consolidation grouting work	m	750.33	0	0	1,760	1,321	
	Sub-total				5,419		6,705	
4	Dam Embankment							
	Impervious zone	m^3	15.54	130,900	2,034	0	0	in-situ material
	Filter and Transition zone	m^3	6.76	314,600	2,126	0	0	in-situ material
	Filter and Transition zone	m^3	35.83	301,200	10,792	0	0	quarry
	Rip-rap	m^3	46.7	23,100	1,079	0	0	
	Inner concrete		331.24	0	0	157,310	52,107	
	Outer concrete		546.81	0	0	84,680	46,304	
	Reinforced concrete		546.81	0	0	1,100	601	
	Tie rod		10,200	0	0	40	408	
	Sub-total				16,031		99,420	
	Total				31,040		115,218	
5	Spillway							
	Excavation / hauling, soil & gravel	m^3	24.54	156,000	3,828	0	0	
	- ditto -, rock	m^3	94.02	39,000	3,667	0	0	
	Backfill, soil	m^3	35.83	26,600	953	0	0	
	Reinforced concrete	m^3	882.2	29,390	25,928	600	529	
	Form work	m^2	40.65	22,565	917	870	35	
	Sub-total				35,293		564	
6	Outlet Works							
6-1	Inlet Structure							
	Reinforced concrete	m^3	882.2	849	749	850	750	
	Form work	m^2	40.65	680	28	52	2	
	Sub-total				777		752	
6-2	Plug Works							
	Plain concrete	m^3	546.81	324	177	0	0	
	Sub-total				177		0	
6-3	Outlet Structure							
	Reinforced concrete	m^3	882.2	250	220	180	220	
	Form work	m^2	40.65	750	31	530	31	
	Sub-total				251		251	
	Total				36,498		1,567	
7	Gate and Pipe							
7-1	Inlet works							
	D100mm Slide gate	pcs	200,000	2	400	2	400	2,000 DH/mm, incl. installation
	W3.5 X H10m Roller gate	pcs	2,000,000	1	2,000	1	2,000	2,000,000 DH/pcs, -do-
	Sub-total				2,400		2,400	
7-2	Outlet works							
	D1000mm Steel pipe	m	6,800	480	1,768	200	1,360	6,800 DH/m, incl. installation
	D1000mm Jet flow gate with hoist	pcs	4,000,000	1	4,000	1	4,000	4,000 DH/mm, -do-
	D1000mm Sleeve valve with hoist	pcs	4,000,000	1	4,000	1	4,000	4,000 DH/mm, -do-
	Flow meter	pcs	250,000	1	251	1	251	250,000 DH/pcs, -do-
	Sub-total				10,019		9,611	
	Total				12,419		12,011	
					99,321		**130,848**	**Total (1-7)**
8	Overhead and Profit of Contractor							
	Overhead	L.S		9%	7,822	9%	10,696	total of 1-6
	Profit of Contractor	L.S		5%	5,357	5%	7,077	above
	Total				13,179		17,773	
					112,500		**148,621**	**Total (1-8)**
9	Physical Contingency	L.S		1	11,250	1	14,863	10% total of 1-8
					123,750		**163,484**	**Total (1-9)**
10	Price Contingency (3% / year)	L.S		1	26,214	1	34,631	21% total of 1-9, 6.5years
					149,964		**198,115**	**Total (1-10)**
	Grand Total				**149,964**		**198,115**	
					100%		132%	

*Cost estimate is based on unit costs of the JICA study (2000 April price).

Table XVII2.4.3 Comparative Study of Spillway Weir Length for AZGHAR DAM

The comparative study in relation to the weir length of side channel to the dam height made based on the estimation of the costs.

Case						Case 1 40m of weir length		Case 2 60m of weir length	
Main feature						Weir length	40m	Weir length	60m
						Overflow depth	3.61m	Overflow depth	2.89m
						EL.of dam crest	EL.860.50	EL.of dam crest	EL.859.50
						Dam height	43.50m	Dam height	42..50m
Direct construction cost				Unit	Unit cost (DH)	Quantity	Amount (1,000DH)	Quantity	Amount (1,000DH)
	Spillway	Excavation	Soil & gravel	m3	24.54	152,900	3,752	156,000	3,828
			Rock	m3	94.02	38,200	3,592	39,000	3,667
		Backfill		m3	35.83	26,000	932	26,600	953
		Reinforced con.		m3	882.20	28,300	24,966	29,390	25,928
		form work		m2	40.65	22,100	898	22,565	917
		Sub-total					34,140		35,293
	Dam	Excavation	Soil & gravel	m3	24.54	253,300	6,216	211,100	5,180
			Rock	m3	94.02	56,200	5,284	46,900	4,410
		Curtain grouting		m	1,130.99	5,760	6,515	4,800	5,429
		Embankment	Impervious	m3	15.54	157,000	2,440	130,900	2,034
			Filter & transition	m3	6.76	377,500	2,552	314,600	2,127
			Filter & Transition	m3	35.83	361,400	12,949	301,200	10,792
			Rip-rap	m3	46.70	27,700	1,294	23,100	1,079
		Sub-total					25,749		21,460
		Total					59,889		56,754
		Cost ratio					106%		100%

TableXVII2.4.4 Hydraulic Calculation of Spillway (AZGHAR DAM) (1/2)

Q10,000 (out) = 452.00 (M^3/S)

(1)Side Channel

NO.	DIS. (M)	EL. (M)	WL. (M)	DEPTH (M)	WIDTH (M)	AREA (M2)	WET PER. (M)	HYD.DEPTH (M)	Q (M^3/S)	V (M/S)
1	60.000	844.090	851.122	7.032	15.000	122.790	30.616	4.011	592.000	4.821
2	50.000	844.423	851.837	7.414	13.750	121.172	30.213	4.011	493.333	4.071
3	40.000	844.757	852.417	7.660	12.500	116.291	29.511	3.941	394.667	3.394
4	30.000	845.090	852.905	7.815	11.250	109.298	28.605	3.821	296.000	2.708
5	20.000	845.423	853.308	7.884	10.000	100.599	27.508	3.657	197.333	1.962
6	10.000	845.757	853.602	7.846	8.750	90.196	26.173	3.446	98.667	1.094
7	0.000	846.090	853.726	7.636	7.500	77.672	24.456	3.176	0.000	0.000

(2)Transition Channel

NO.	DISTANCE (M)	(M)	EL. (M)	WL. (M)	DEPTH (M)	WIDTH (M)	AREA (M^2)	V (M/S)	WET PER. (M)	HYD.DEPTH (M)	HV (M)	FR
1	0.000	0.000	844.000	849.413	5.413	15.000	81.195	7.291	25.826	3.144	2.712	1.00
2	10.000	10.000	844.010	849.657	5.647	15.000	84.711	6.988	26.295	3.222	2.492	0.94
3	20.000	10.000	844.020	849.761	5.741	15.000	86.117	6.874	26.482	3.252	2.411	0.92
4	30.000	10.000	844.030	849.834	5.804	15.000	87.054	6.800	26.607	3.272	2.359	0.90
5	40.000	10.000	844.040	849.898	5.858	15.000	87.875	6.737	26.717	3.289	2.316	0.89
6	50.000	10.000	844.050	849.955	5.905	15.000	88.578	6.683	26.810	3.304	2.279	0.88
7	60.000	10.000	844.060	850.012	5.952	15.000	89.281	6.631	26.904	3.318	2.243	0.87
8	70.000	10.000	844.070	850.061	5.991	15.000	89.867	6.588	26.982	3.331	2.214	0.86
9	80.000	10.000	844.080	850.106	6.026	15.000	90.394	6.549	27.053	3.341	2.188	0.85
10	85.000	5.000	844.085	850.775	6.690	15.000	108.188	5.472	28.779	3.759	1.528	0.70
11	90.000	5.000	844.090	851.122	7.032	15.000	122.790	4.821	30.616	4.011	1.186	0.62

TableXVII2.4.4 Hydraulic Calculation of Spillway (AZGHAR DAM) (2/2)

(3)Chute way

NO.	DISTANCE (M)	(M)	EL. (M)	WL. (M)	DEPTH1 (M)	DEPTH2 (M)	WIDTH (M)	AREA (M^2)	V (M/S)	WET PER. (M)	HYD.DEPTH (M)	HV (M)
1	0.000	0.000	844.000	849.413	5.413	5.413	15.000	81.195	7.291	25.826	3.144	2.712
2	10.000	10.000	842.286	845.925	3.640	3.587	15.000	53.810	11.002	22.175	2.427	6.175
3	20.000	10.000	840.571	843.718	3.146	3.101	15.000	46.514	12.727	21.202	2.194	8.265
4	30.000	10.000	838.857	841.700	2.843	2.802	15.000	42.025	14.087	20.603	2.040	10.124
5	40.000	10.000	837.143	839.770	2.627	2.589	15.000	38.842	15.241	20.179	1.925	11.852
6	50.000	10.000	835.429	837.892	2.464	2.428	15.000	36.423	16.254	19.856	1.834	13.479
7	60.000	10.000	833.714	836.047	2.333	2.299	15.000	34.492	17.163	19.599	1.760	15.030
8	70.000	10.000	832.000	834.226	2.226	2.194	15.000	32.908	17.989	19.388	1.697	16.511
9	80.000	10.000	830.286	832.422	2.136	2.105	15.000	31.583	18.745	19.211	1.644	17.926
10	90.000	10.000	828.571	830.632	2.060	2.030	15.000	30.457	19.437	19.061	1.598	19.276
11	100.000	10.000	826.857	828.851	1.994	1.966	15.000	29.483	20.079	18.931	1.557	20.570
12	110.000	10.000	825.143	827.080	1.937	1.909	15.000	28.634	20.675	18.818	1.522	21.808
13	120.000	10.000	823.429	825.315	1.886	1.859	15.000	27.887	21.229	18.718	1.490	22.993
14	130.000	10.000	821.714	823.556	1.842	1.815	15.000	27.227	21.743	18.630	1.461	24.120
15	140.000	10.000	820.000	821.802	1.802	1.776	15.000	26.637	22.225	18.552	1.436	25.201

(4)Stilling Basin

Depth before jump	:	D1 = 1.773 m
Velocity before jump	:	V1 = 22.225 m/s
Froude number before jump	:	FR = 5.328
Jump depth	:	D2 = 12.521 m

Table XVII2.4.5 Comparative Study of Diversion Mothed for AZGHAR DAM

The comparative study in diversion mothed to the tunnel diversion to the culvert diversion made based on the estimation of the costs.

Case						Case 1 Tunnel type		Case 2 Culvert type	
Main feature						Section / Length	2r=5.0m / 350m	Section / Length	5.0m x 5.0m / 240m
Direct construction cost				Unit	Unit cost (DH)	Quantity	Amount (1,000DH)	Quantity	Amount (1,000DH)
	In/out channel	Excavation	soil & gravel	m3	24.54	30,000	736	53,400	1,310
			rock	m3	94.02	2,000	188	0	0
		Backfill		m3	35.83	0	0	0	0
		Reinforced concrete		m3	882.20	437	386	437	386
		Form work		m2	40.65	180	7	180	7
		Sub-total					1,317		1,703
	Tunnel	Tunnel works		m	80,912.00	350	28,319	-	
		Plugging		m3	546.81	7,230	3,953	-	
		Sub-total					32,273	-	
	Culvert	Excavation	soil & gravel	m3	24.54	-		0	0
			rock	m3	94.02	-		22,900	2,153
		Reinforced concrete		m3	882.20	-		13,320	11,751
		form work		m2	40.65	-		6,000	13,904
		Plugging		m3	546.81	-		6,000	3,281
		Consolidation grouting		m	750.33	-		0	0
		Sub-total				-			31,089
		Total					33,590		32,792
		Cost ratio					102%		100%

Table XVII2.4.6　　Water Head Allotment of Canal in Azgahar (1/2)

Main Canal

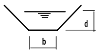
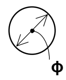
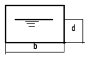
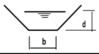
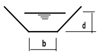
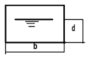
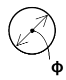
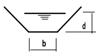
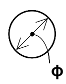
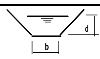
Station	Dischage (Q m³/s)	Length (L m)	Canal Structures	Energy	Loss (m)	Height of Energy Line (EL m)	Velocity (m/s)	Velocity Head (m)	Water Surface Elevation (EL m)	Water Depth (d m)	Bottom Elevation (EL m)	Cross Section	Dimension of Cross Section Coefficient of Head Loss
0+000	2.38					845.06	1.05	0.06	845.00	1.01	843.99		
			O.T.	$0.5*\Delta hv$	0.04							O.T. : Open Ttransition	
			Trashrack	$fr*h_{v1}$	0.01								
		230	Syphon	$n^2*V^2*L/R^{4/3}$	0.61		1.66	0.14					
			O.T.	$0.7*\Delta hv$	0.06								d=1.01 m　m=1.25
0+220	2.38					844.34	1.05	0.06	844.28	1.01	843.27		b=1.00 m　Fb=0.24 m
		450	Open Canal	$n^2*V^2*L/R^{4/3}$	0.45								n=0.020　i=1/1,000
0+670	2.38					843.89	1.05	0.06	843.83	1.01	842.82		
			O.T.	$0.5*\Delta hv$	0.04								
			Trashrack	$fr*h_{v1}$	0.01								Φ=1,350mm
		105	Syphon	$n^2*V^2*L/R^{4/3}$	0.28		1.66	0.14					n=0.015
			O.T.	$0.7*\Delta hv$	0.06								
0+765	2.38					843.50	1.05	0.06	843.45	1.01	842.44		
		1,265	Open Canal	$n^2*V^2*L/R^{4/3}$	1.26								
2+030	2.38					842.24	1.05	0.06	842.18	1.01	841.17		
			O.T.	$0.5*\Delta hv$	0.04								
			Trashrack	$fr*h_{v1}$	0.01								
		33	Syphon	$n^2*V^2*L/R^{4/3}$	0.09		1.66	0.14					
			O.T.	$0.7*\Delta hv$	0.06								
2+060	2.38					842.05	1.05	0.06	841.99	1.01	840.98		
		1,660	Open Canal	$n^2*V^2*L/R^{4/3}$	1.66						839.32		
3+720	1.37					840.39	0.95	0.05	840.34	0.81	839.53		
		840	Open Canal	$n^2*V^2*L/R^{4/3}$	0.93								d=0.69 m　m=0.00
4+560	1.37					839.45	0.95	0.05	839.41	0.81	838.60		b=1.60 m　Fb=0.30 m
			O.T.	$0.5*\Delta hv$	0.02								n=0.015　i=1/750
		20	Box Culvert	$n^2*V^2*L/R^{4/3}$	0.03		1.26	0.08					
			O.T.	$0.7*\Delta hv$	0.02								d=0.81 m　m=1.25
4+580	1.37					839.39	0.95	0.05	839.34	0.81	838.53		b=0.80 m　Fb=0.24 m
		1,210	Open Canal	$n^2*V^2*L/R^{4/3}$	1.34						837.18		n=0.020　i=1/900
5+790	1.15					838.04	0.95	0.05	838.00	0.73	837.27		
			O.T.	$0.5*\Delta hv$	0.02								
		15	Box Culvert	$n^2*V^2*L/R^{4/3}$	0.02		1.23	0.08					
			O.T.	$0.7*\Delta hv$	0.02								
5+805	1.15					837.98	0.95	0.05	837.94	0.73	837.21		
		220	Open Canal	$n^2*V^2*L/R^{4/3}$	0.28								
6+025	1.15					837.71	0.95	0.05	837.66	0.73	836.93		
			O.T.	$0.5*\Delta hv$	0.03								
			Trashrack	$fr*h_{v1}$	0.00								
		44	Syphon	$n^2*V^2*L/R^{4/3}$	0.13		1.46	0.11					d=0.73 m　m=1.25
			O.T.	$0.7*\Delta hv$	0.08								b=0.75 m　Fb=0.22 m
6+065	1.15					837.46	0.95	0.05	837.41	0.73	836.68		n=0.020　i=1/800
		50	Open Canal	$n^2*V^2*L/R^{4/3}$	0.06								
6+115	1.15					837.40	0.95	0.05	837.35	0.73	836.62		
		33	Syphon	$n^2*V^2*L/R^{4/3}$	0.10		1.46	0.11					
			Others(O.T. , Trashrack)		0.11								d=0.63 m　m=0.00
6+145	1.15					837.18	0.95	0.05	837.14	0.73	836.41		b=1.50 m　Fb=0.30 m
		600	Open Canal	$n^2*V^2*L/R^{4/3}$	0.75								n=0.015　i=1/700
6+745	1.15					836.43	0.95	0.05	836.39	0.73	835.66		
		33	Syphon	$n^2*V^2*L/R^{4/3}$	0.10		1.46	0.11					
			Others(O.T. , Trashrack)		0.11								
6+775	1.15					836.22	0.95	0.05	836.17	0.73	835.44		Φ=1,000mm
		110	Open Canal	$n^2*V^2*L/R^{4/3}$	0.14								n=0.015
6+885	1.15					836.08	0.95	0.05	836.03	0.73	835.30		
		33	Syphon	$n^2*V^2*L/R^{4/3}$	0.10		1.46	0.11					
			Others(O.T. , Trashrack)		0.11								
6+915	1.15					835.87	0.95	0.05	835.82	0.73	835.09		
		1,600	Open Canal	$n^2*V^2*L/R^{4/3}$	2.00								
8+515	1.15					833.86	0.95	0.05	833.82	0.73	833.09		
		110	Syphon	$n^2*V^2*L/R^{4/3}$	0.34		1.46	0.11					
			Others(O.T. , Trashrack)		0.11								
8+615	1.15					833.41	0.95	0.05	833.37	0.73	832.64		
		130	Open Canal	$n^2*V^2*L/R^{4/3}$	0.16								
8+745	1.15					833.25	0.95	0.05	833.21	0.73	832.48		
		55	Syphon	$n^2*V^2*L/R^{4/3}$	0.17		1.46	0.11					
			Others(O.T. , Trashrack)		0.11						832.19		
8+795	1.01					832.97	0.94	0.05	832.92	0.69	832.23		
		260	Open Canal	$n^2*V^2*L/R^{4/3}$	0.35								d=0.69 m　m=1.25
9+055	1.01					832.62	0.94	0.05	832.58	0.69	831.89		b=0.75 m　Fb=0.21 m
			O.T.	$0.5*\Delta hv$	0.04								n=0.020　i=1/750
			Trashrack	$fr*h_{v1}$	0.00								
		44	Syphon	$n^2*V^2*L/R^{4/3}$	0.18		1.59	0.13					Φ=900mm
			O.T.	$0.7*\Delta hv$	0.06								n=0.015
9+095	1.01					832.34	0.94	0.05	832.29	0.69	831.60		
		650	Open Canal	$n^2*V^2*L/R^{4/3}$	0.87								
9+745	1.01					831.47	0.94	0.05	831.43	0.69	830.74		
		55	Syphon	$n^2*V^2*L/R^{4/3}$	0.23		1.59	0.13					
			Others(O.T. , Trashrack)		0.10								
9+795	1.01					831.14	0.94	0.05	831.09	0.69	830.40		
		1,950	Open Canal	$n^2*V^2*L/R^{4/3}$	2.60						827.81		
11+745	0.63					828.54	0.93	0.04	828.50	0.58	827.92		d=0.58 m　m=1.00
		1,800	Open Canal	$n^2*V^2*L/R^{4/3}$	3.01								b=0.60 m　Fb=0.22 m
13+545						825.54	0.93	0.04	825.49	0.58	824.91		n=0.020　i=1/600

Table XVII2.4.6 Water Head Allotment of Canal in Azgahar (2/2)

Branch Canal (1)

Station	Dischage (Q m³/s)	Length (L m)	Canal Structures	Energy	Loss (m)	Height of Energy Line (EL m)	Velocity (m/s)	Velocity Head (m)	Water Surface Elevation (EL m)	Water Depth (d m)	Bottom Elevation (EL m)	Cross Section	Dimension of Cross Section Coefficient of Head Loss
0+000	0.25												Φ=400mm
		325	Open Canal	$n^2*V^2*L/R^{4/3}$		803.56	1.14	0.07	803.50	0.45	803.05		n=0.015
0+325	0.25					803.56	1.14	0.07	803.50	0.45	803.05		
			O.T.	$0.2*\Delta hv$	0.07							Φ	
			Trashrack	$fr*h_{v1}$	0.01								d=0.45 m m=0.00
		17	Syphon	$n^2*V^2*L/R^{4/3}$	0.33		1.99	0.20					b=0.50 m Fb=0.15 m
			O.T.	$0.3*\Delta hv$	0.10								n=0.015 i=1/300
0+340	0.25					803.07	1.14	0.07	803.00	0.45	802.55		
		2,150	Open Canal	$n^2*V^2*L/R^{4/3}$	7.15						795.40		
2+490	0.14					795.91	1.07	0.06	795.86	0.35	795.51		
		50	Open Canal	$n^2*V^2*L/R^{4/3}$	0.20								d=0.0.35 m m=0.00
2+540	0.14					795.71	1.07	0.06	795.66	0.35	795.31		b=0.40 m Fb=0.15 m
			O.T.	$0.5*\Delta hv$	0.03								n=0.015 i=1/250
			Trashrack	$fr*h_{v1}$	0.01								
		44	Syphon	$n^2*V^2*L/R^{4/3}$	1.23		1.98	0.20					Φ=300mm
			O.T.	$0.7*\Delta hv$	0.04								n=0.015
2+580	0.14					794.41	1.07	0.06	794.35	0.35	794.00	Φ	

Branch Canal (2)

Station	Dischage (Q m³/s)	Length (L m)	Canal Structures	Energy	Loss (m)	Height of Energy Line (EL m)	Velocity (m/s)	Velocity Head (m)	Water Surface Elevation (EL m)	Water Depth (d m)	Bottom Elevation (EL m)	Cross Section	Dimension of Cross Section Coefficient of Head Loss
0+000	0.71					840.17	1.83	0.17	840.00	0.40	839.60		
		580	Open Canal	$n^2*V^2*L/R^{4/3}$									d=0.40 m m=0.00
			Drop Structure										b=1.00 m Fb=0.60 m
						821.09	1.83	0.17	820.92	0.40	820.52		n=0.020 i=1/100
0+580	0.64					821.09	1.31	0.09	821.00	0.49	820.51		
		720	Open Canal	$n^2*V^2*L/R^{4/3}$	3.21								
1+300	0.64					817.88	1.31	0.09	817.79	0.49	817.30		
			O.T.	$0.5*\Delta hv$	0.09								
			Trashrack	$fr*h_{v1}$	0.01								
		22	Syphon	$n^2*V^2*L/R^{4/3}$	0.32		2.26	0.26					d=0.49 m m=0.00
			O.T.	$0.7*\Delta hv$	0.12								b=1.00 m Fb=0.21 m
1+320	0.64					817.34	1.31	0.09	817.26	0.49	816.77		n=0.020 i=1/225
		1230	Open Canal	$n^2*V^2*L/R^{4/3}$	5.48								
2+550	0.64					811.86	1.31	0.09	811.77	0.49	811.28		
			O.T.	$0.5*\Delta hv$	0.09								Φ=600mm
			Trashrack	$fr*h_{v1}$	0.01								n=0.015
		22	Syphon	$n^2*V^2*L/R^{4/3}$	0.32		2.26	0.26					
			O.T.	$0.7*\Delta hv$	0.12							Φ	
2+570	0.64					811.33	1.31	0.09	811.24	0.49	810.75		
		120	Open Canal	$n^2*V^2*L/R^{4/3}$	0.53								
2+690	0.64					810.79	1.31	0.09	810.70	0.49	810.21		
			O.T.	$0.5*\Delta hv$	0.09								
			Trashrack	$fr*h_{v1}$	0.01								
		22	Syphon	$n^2*V^2*L/R^{4/3}$	0.32		2.26	0.26					
			O.T.	$0.7*\Delta hv$	0.12								
2+710	0.64					810.26	1.31	0.09	810.17	0.49	809.68		
		660	Open Canal	$n^2*V^2*L/R^{4/3}$	2.94								
3+370	0.64					807.32	1.31	0.09	807.23	0.49	806.74		
			O.T.	$0.5*\Delta hv$	0.09								
			Trashrack	$fr*h_{v1}$	0.01								
		22	Syphon	$n^2*V^2*L/R^{4/3}$	0.32		2.26	0.26					
			O.T.	$0.7*\Delta hv$	0.12								
3+390	0.64					806.78	1.31	0.09	806.69	0.49	806.20		
		385	Open Canal	$n^2*V^2*L/R^{4/3}$	1.72				804.98	0.49	804.49		
3+775	0.29					805.07	0.85	0.04	805.03	0.57	804.46		
		320	Open Canal	$n^2*V^2*L/R^{4/3}$	0.46								
4+095	0.29					804.61	0.85	0.04	804.57	0.57	804.00		
			O.T.	$0.5*\Delta hv$	0.04								d=0.57 m m=0.00
			Trashrack	$fr*h_{v1}$	0.00								b=0.60 m Fb=0.13 m
		22	Syphon	$n^2*V^2*L/R^{4/3}$	0.23		1.48	0.11					n=0.015 i=1/700
			O.T.	$0.7*\Delta hv$	0.05								
4+115	0.29					804.28	0.85	0.04	804.25	0.57	803.68		
		440	Open Canal	$n^2*V^2*L/R^{4/3}$	0.63								
4+555	0.29					803.66	0.85	0.04	803.62	0.57	803.05		Φ=400mm
			O.T.	$0.5*\Delta hv$	0.04								n=0.015
			Trashrack	$fr*h_{v1}$	0.00							Φ	
		22	Syphon	$n^2*V^2*L/R^{4/3}$	0.23		1.48	0.11					
			O.T.	$0.7*\Delta hv$	0.05								
4+575	0.29					803.33	0.85	0.04	803.29	0.57	802.72		
		900	Open Canal	$n^2*V^2*L/R^{4/3}$	1.28								
5+475	0.29					802.05	0.85	0.04	802.01	0.57	801.44		
			O.T.	$0.5*\Delta hv$	0.04								
			Trashrack	$fr*h_{v1}$	0.00								
		22	Syphon	$n^2*V^2*L/R^{4/3}$	0.23		1.48	0.11					
			O.T.	$0.7*\Delta hv$	0.05								
5+495	0.29					801.72	0.85	0.04	801.69	0.57	801.12		
		20	Open Canal	$n^2*V^2*L/R^{4/3}$	0.03								
5+515	0.29					801.70	0.85	0.04	801.66	0.57	801.09		

Branch Canal (3)

Station	Dischage (Q m³/s)	Length (L m)	Canal Structures	Energy	Loss (m)	Height of Energy Line (EL m)	Velocity (m/s)	Velocity Head (m)	Water Surface Elevation (EL m)	Water Depth (d m)	Bottom Elevation (EL m)	Cross Section	Dimension of Cross Section Coefficient of Head Loss
0+000	0.23					845.03	0.72	0.03	845.00	0.40	844.60		
		2,670	Open Canal	$n^2*V^2*L/R^{4/3}$	2.67								d=0.40 m m=0.00
													b=0.80 m Fb=0.20 m
													n=0.015 i=1/1000
2+670	0.23					842.36	0.72	0.03	842.33	0.40	841.93		

Table XVII3.1.2　Monthly Mean Rainy Days and Workable Days

(Based on average value of 10yrs from 1991 to 2000) (Unit:days)

Site	Daily Rainfall Range (mm)	Monthly Mean Rainy Days													Monthly Mean Workable Days								
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Nov	Nov	Dec	Total	Excavation			Embankment			Concrete		
															SASD	ASD	WD	SASD	ASD	WD	SASD	ASD	WD
No.5	X=0	23.1	23.0	24.1	24.9	27.8	27.0	29.0	30.0	26.8	26.1	22.6	21.4	305.8	0.0	0.0	YWD	0.0	0.0	YWD	0.0	0.0	YWD
N'Fifikh	0<X≦5	5.0	2.9	5.1	3.1	2.7	2.7	2.0	1.0	2.4	3.5	5.0	6.3	41.7	0.0	0.0	300.5	0.0	0.0	305.8	0.0	0.0	305.8
	5<X≦10	1.7	0.9	1.0	0.9	0.3	0.0	0.0	0.0	0.3	0.6	1.1	1.3	8.1	0.0	0.0		0.0	0.0		0.0	0.0	
Station:	10<X≦30	0.9	1.5	0.8	1.1	0.2	0.3	0.0	0.0	0.3	0.5	1.1	1.9	8.6	0.5	4.3	MWD	1.0	8.6	MWD	0.0	0.0	MWD
Feddane Taba	30<X≦50	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.1	0.3	1.1	1.0	1.1		1.5	1.6		1.0	1.1	
	50<X	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	25.0	2.0	0.0	25.5	1.5	0.0	25.5
	Total	31.0	28.3	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0	365.3		5.4			0.0			0.0	
No.9	X=0	26.4	21.6	23.5	24.7	28.0	28.2	30.2	30.1	27.7	26.2	26.7	24.9	318.1	0.0	0.0	YWD	0.0	0.0	YWD	0.0	0.0	YWD
Taskourt	0<X≦5	2.3	3.3	3.4	3.0	2.0	1.0	0.8	0.6	1.4	2.3	1.2	3.2	24.6	0.0	0.0	309.3	0.0	0.0	318.1	0.0	0.0	318.1
	5<X≦10	0.5	0.9	1.6	0.8	0.6	0.2	0.0	0.2	0.4	0.8	1.0	1.2	8.3	0.0	0.0		0.0	0.0		0.0	0.0	
Station:	10<X≦30	1.7	2.0	2.1	1.1	0.3	0.3	0.0	0.1	0.2	1.2	0.9	1.2	11.2	0.5	5.6	MWD	1.0	11.2	MWD	0.0	0.0	MWD
Sidi Bouathamane	30<X≦50	0.1	0.6	0.4	0.4	0.1	0.2	0.0	0.0	0.2	0.2	0.2	0.4	3.0	1.0	3.0		1.5	4.4		1.0	3.0	
	50<X	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.2	1.5	0.3	25.8	2.0	0.4	26.5	1.5	0.3	26.5
	Total	31.0	28.3	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0	365.3		8.9			0.0			0.0	
No.10	X=0	29.0	26.3	28.7	28.0	29.8	26.3	30.0	29.4	28.7	27.7	26.8	28.3	338.9	0.0	0.0	YWD	0.0	0.0	YWD	0.0	0.0	YWD
Timkit	0<X≦5	0.6	0.6	0.7	1.0	0.8	1.3	0.7	0.2	0.7	0.7	1.8	1.0	9.9	0.0	0.0	334.6	0.0	0.0	338.9	0.0	0.0	338.9
	5<X≦10	0.6	0.3	0.8	0.8	0.5	2.0	0.0	1.0	0.3	1.3	0.8	0.9	9.1	0.0	0.0		0.0	0.0		0.0	0.0	
Station:	10<X≦30	0.9	1.0	0.7	0.3	0.0	0.3	0.3	0.4	0.3	1.0	0.8	0.7	6.6	0.5	3.3	MWD	1.0	6.6	MWD	0.0	0.0	MWD
Iffre	30<X≦50	0.0	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.1	0.9	1.0	0.9		1.5	1.4		1.0	0.9	
	50<X	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	27.9	2.0	0.0	28.2	1.5	0.0	28.2
	Total	31.0	28.4	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0	365.4		4.3			0.0			0.0	
No.17	X=0	23.6	19.8	22.2	20.6	24.0	25.4	30.1	27.8	24.8	26.6	23.3	22.3	290.3	0.0	0.0	YWD	0.0	0.0	YWD	0.0	0.0	YWD
Azghar	0<X≦5	4.6	5.3	4.0	6.4	4.8	3.8	0.9	2.7	3.1	2.8	4.8	5.1	48.1	0.0	0.0	282.6	0.0	0.0	290.3	0.0	0.0	290.3
	5<X≦10	1.4	1.0	2.3	1.7	1.0	0.3	0.0	0.4	1.0	1.1	1.0	1.5	12.8	0.0	0.0		0.0	0.0		0.0	0.0	
Station:	10<X≦30	1.1	2.1	2.4	1.3	1.1	0.3	0.0	0.1	1.1	0.6	1.0	1.9	13.0	0.5	6.5	MWD	1.0	13.0	MWD	0.0	0.0	MWD
Dar Hamra	30<X≦50	0.3	0.1	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.3	1.0	1.0	1.0		1.5	1.5		1.0	1.0	
	50<X	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.5	0.2	23.5	2.0	0.3	24.2	1.5	0.2	24.2
	Total	31.0	28.4	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0	365.4		7.7			0.0			0.0	

*1 SASD ; Standard Additional Suspension Days
*2 ASD ; Additional Suspension Days
*3 WD ; Workable Days
*4 YWD ; Yearly Workable Days
*5 MWD ; Monthly Workable Days

Table XVII3.1.3 Daily Rainfall of N'Fifikh

Station: FEDDANE TABA (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1991	1	44.0	29.2	20.7	10.0	0.4				42.0	35.0	3.0	17.9
	2	1.5	20.0	16.3	7.2	0.0				12.0	30.7	2.6	1.8
	3	0.4	19.4	10.2	1.5	0.0				0.6	26.3	1.4	1.2
	4	0.0	17.3	6.8	0.5	0.0				0.2	7.0	0.2	0.3
	5	0.0	13.5	6.7	0.5	0.0				0.2	5.4	0.0	0.3
	6	0.0	11.9	5.7	0.0	0.0				0.0	5.2	0.0	0.2
	7	0.0	5.0	5.1	0.0	0.0				0.0	1.0	0.0	0.2
	8	0.0	4.1	4.6	0.0	0.0				0.0	0.9	0.0	0.0
	9	0.0	3.9	4.3	0.0	0.0				0.0	0.4	0.0	0.0
	10	0.0	1.0	3.4	0.0	0.0				0.0	0.0	0.0	0.0
	11	0.0	0.5	3.4	0.0	0.0				0.0	0.0	0.0	0.0
	12	0.0	0.0	2.3	0.0	0.0				0.0	0.0	0.0	0.0
	13	0.0	0.0	1.3	0.0	0.0				0.0	0.0	0.0	0.0
	14	0.0	0.0	1.3	0.0	0.0				0.0	0.0	0.0	0.0
	15	0.0	0.0	0.5	0.0	0.0				0.0	0.0	0.0	0.0
	16	0.0	0.0	0.2	0.0	0.0				0.0	0.0	0.0	0.0
	17	0.0	0.0	0.2	0.0	0.0				0.0	0.0	0.0	0.0
	18	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0	0.0
	19	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0	0.0
	20	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0	0.0
	21	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0	0.0
	22	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0	0.0
	23	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0	0.0
	24	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0	0.0
	25	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0	0.0
	26	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0	0.0
	27	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0	0.0
	28	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0	0.0
	29	0.0		0.0	0.0	0.0				0.0	0.0	0.0	0.0
	30	0.0		0.0	0.0	0.0				0.0	0.0	0.0	0.0
	31	0.0		0.0		0.0					0.0		0.0

Table XVII3.1.3 Daily Rainfall of N'Fifikh

Station: FEDDANE TABA (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1992	1		7.8	12.3	28.2	3.6	20.0			1.1	16.2	9.2	7.2
	2		7.3	7.2	27.5	0.0	2.2			0.0	2.0	0.5	3.5
	3		5.8	4.5	21.6	0.0	0.9			0.0	1.8	0.0	1.7
	4		4.8	3.9	8.4	0.0	0.5			0.0	1.3	0.0	0.5
	5		4.4	1.6	2.6	0.0	0.4			0.0	1.0	0.0	0.4
	6		3.3	1.5	1.2	0.0	0.3			0.0	0.7	0.0	0.3
	7		0.0	0.2	0.0	0.0	0.0			0.0	0.4	0.0	0.2
	8		0.0	0.0	0.0	0.0	0.0			0.0	0.2	0.0	0.2
	9		0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
	10		0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
	11		0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
	12		0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
	13		0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
	14		0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
	15		0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
	16		0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
	17		0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
	18		0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
	19		0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
	20		0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
	21		0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
	22		0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
	23		0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
	24		0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
	25		0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
	26		0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
	27		0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
	28		0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
	29		0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
	30			0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
	31			0.0		0.0					0.0		0.0

Table XVII3.1.3 Daily Rainfall of N'Fifikh

Station: FEDDANE TABA (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1993	1	7.8	9.0	24.5	15.2					2.8	5.7	38.0	8.5
	2	5.5	5.5	5.0	7.9					1.2	5.4	14.0	4.5
	3	1.5	4.2	4.2	4.4					0.5	5.0	10.5	1.2
	4	0.0	2.6	3.5	4.0					0.0	3.5	7.0	0.4
	5	0.0	0.0	2.7	2.1					0.0	3.0	6.3	0.0
	6	0.0	0.0	2.0	1.2					0.0	1.6	6.0	0.0
	7	0.0	0.0	2.0	0.0					0.0	1.5	6.0	0.0
	8	0.0	0.0	1.5	0.0					0.0	0.2	4.8	0.0
	9	0.0	0.0	0.0	0.0					0.0	0.0	3.6	0.0
	10	0.0	0.0	0.0	0.0					0.0	0.0	3.6	0.0
	11	0.0	0.0	0.0	0.0					0.0	0.0	2.8	0.0
	12	0.0	0.0	0.0	0.0					0.0	0.0	2.0	0.0
	13	0.0	0.0	0.0	0.0					0.0	0.0	2.0	0.0
	14	0.0	0.0	0.0	0.0					0.0	0.0	1.7	0.0
	15	0.0	0.0	0.0	0.0					0.0	0.0	1.3	0.0
	16	0.0	0.0	0.0	0.0					0.0	0.0	0.0	0.0
	17	0.0	0.0	0.0	0.0					0.0	0.0	0.0	0.0
	18	0.0	0.0	0.0	0.0					0.0	0.0	0.0	0.0
	19	0.0	0.0	0.0	0.0					0.0	0.0	0.0	0.0
	20	0.0	0.0	0.0	0.0					0.0	0.0	0.0	0.0
	21	0.0	0.0	0.0	0.0					0.0	0.0	0.0	0.0
	22	0.0	0.0	0.0	0.0					0.0	0.0	0.0	0.0
	23	0.0	0.0	0.0	0.0					0.0	0.0	0.0	0.0
	24	0.0	0.0	0.0	0.0					0.0	0.0	0.0	0.0
	25	0.0	0.0	0.0	0.0					0.0	0.0	0.0	0.0
	26	0.0	0.0	0.0	0.0					0.0	0.0	0.0	0.0
	27	0.0	0.0	0.0	0.0					0.0	0.0	0.0	0.0
	28	0.0	0.0	0.0	0.0					0.0	0.0	0.0	0.0
	29	0.0		0.0	0.0					0.0	0.0	0.0	0.0
	30	0.0		0.0	0.0					0.0	0.0	0.0	0.0
	31	0.0		0.0							0.0		0.0

Table XVII3.1.3 Daily Rainfall of N'Fifikh

Station: FEDDANE TABA (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1994	1	30.2	18.5			1.0				1.0	3.4	16.1	
	2	2.8	15.1			0.0				0.0	1.9	1.3	
	3	2.5	10.5			0.0				0.0	1.4	0.0	
	4	1.3	0.0			0.0				0.0	0.5	0.0	
	5	0.0	0.0			0.0				0.0	0.0	0.0	
	6	0.0	0.0			0.0				0.0	0.0	0.0	
	7	0.0	0.0			0.0				0.0	0.0	0.0	
	8	0.0	0.0			0.0				0.0	0.0	0.0	
	9	0.0	0.0			0.0				0.0	0.0	0.0	
	10	0.0	0.0			0.0				0.0	0.0	0.0	
	11	0.0	0.0			0.0				0.0	0.0	0.0	
	12	0.0	0.0			0.0				0.0	0.0	0.0	
	13	0.0	0.0			0.0				0.0	0.0	0.0	
	14	0.0	0.0			0.0				0.0	0.0	0.0	
	15	0.0	0.0			0.0				0.0	0.0	0.0	
	16	0.0	0.0			0.0				0.0	0.0	0.0	
	17	0.0	0.0			0.0				0.0	0.0	0.0	
	18	0.0	0.0			0.0				0.0	0.0	0.0	
	19	0.0	0.0			0.0				0.0	0.0	0.0	
	20	0.0	0.0			0.0				0.0	0.0	0.0	
	21	0.0	0.0			0.0				0.0	0.0	0.0	
	22	0.0	0.0			0.0				0.0	0.0	0.0	
	23	0.0	0.0			0.0				0.0	0.0	0.0	
	24	0.0	0.0			0.0				0.0	0.0	0.0	
	25	0.0	0.0			0.0				0.0	0.0	0.0	
	26	0.0	0.0			0.0				0.0	0.0	0.0	
	27	0.0	0.0			0.0				0.0	0.0	0.0	
	28	0.0	0.0			0.0				0.0	0.0	0.0	
	29	0.0				0.0				0.0	0.0	0.0	
	30	0.0				0.0				0.0	0.0	0.0	
	31	0.0				0.0					0.0		

Table XVII3.1.3 Daily Rainfall of N'Fifikh

Station: FEDDANE TABA (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1995	1	3.5	16.7		10.3					1.0	4.0	19.2	17.2
	2	2.9	12.3		7.6					0.0	0.7	11.8	13.5
	3	0.0	1.0		3.2					0.0	0.4	6.9	7.8
	4	0.0	0.5		0.8					0.0	0.0	4.0	4.6
	5	0.0	0.0		0.8					0.0	0.0	2.2	4.2
	6	0.0	0.0		0.0					0.0	0.0	1.1	2.9
	7	0.0	0.0		0.0					0.0	0.0	0.5	2.8
	8	0.0	0.0		0.0					0.0	0.0	0.0	2.3
	9	0.0	0.0		0.0					0.0	0.0	0.0	1.5
	10	0.0	0.0		0.0					0.0	0.0	0.0	1.3
	11	0.0	0.0		0.0					0.0	0.0	0.0	0.8
	12	0.0	0.0		0.0					0.0	0.0	0.0	0.5
	13	0.0	0.0		0.0					0.0	0.0	0.0	0.3
	14	0.0	0.0		0.0					0.0	0.0	0.0	0.0
	15	0.0	0.0		0.0					0.0	0.0	0.0	0.0
	16	0.0	0.0		0.0					0.0	0.0	0.0	0.0
	17	0.0	0.0		0.0					0.0	0.0	0.0	0.0
	18	0.0	0.0		0.0					0.0	0.0	0.0	0.0
	19	0.0	0.0		0.0					0.0	0.0	0.0	0.0
	20	0.0	0.0		0.0					0.0	0.0	0.0	0.0
	21	0.0	0.0		0.0					0.0	0.0	0.0	0.0
	22	0.0	0.0		0.0					0.0	0.0	0.0	0.0
	23	0.0	0.0		0.0					0.0	0.0	0.0	0.0
	24	0.0	0.0		0.0					0.0	0.0	0.0	0.0
	25	0.0	0.0		0.0					0.0	0.0	0.0	0.0
	26	0.0	0.0		0.0					0.0	0.0	0.0	0.0
	27	0.0	0.0		0.0					0.0	0.0	0.0	0.0
	28	0.0	0.0		0.0					0.0	0.0	0.0	0.0
	29	0.0			0.0					0.0	0.0	0.0	0.0
	30	0.0			0.0					0.0	0.0	0.0	0.0
	31	0.0									0.0		0.0

Table XVII3.1.3 Daily Rainfall of N'Fifikh

Station: FEDDANE TABA (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1996	1	47.8	6.8	21.3	11.2	14.9				2.0	18.0	23.8	39.0
	2	25.9	6.6	8.7	7.6	6.1				1.2	0.0	4.5	38.2
	3	24.6	6.1	7.6	1.2	3.5				1.2	0.0	0.5	22.2
	4	14.2	5.6	5.9	0.0	3.3				0.7	0.0	0.2	18.6
	5	11.2	2.0	5.0	0.0	3.1				0.0	0.0	0.0	17.2
	6	7.1	1.9	4.6	0.0	2.1				0.0	0.0	0.0	13.7
	7	6.8	1.7	2.4	0.0	1.8				0.0	0.0	0.0	13.6
	8	5.3	1.3	2.3	0.0	1.5				0.0	0.0	0.0	13.6
	9	5.3	0.8	2.1	0.0	1.1				0.0	0.0	0.0	12.8
	10	4.0	0.7	1.2	0.0	1.0				0.0	0.0	0.0	11.9
	11	3.3	0.7	1.1	0.0	0.7				0.0	0.0	0.0	11.2
	12	3.2	0.4	0.6	0.0	0.0				0.0	0.0	0.0	8.7
	13	3.1	0.0	0.5	0.0	0.0				0.0	0.0	0.0	7.8
	14	2.4	0.0	0.0	0.0	0.0				0.0	0.0	0.0	7.8
	15	1.9	0.0	0.0	0.0	0.0				0.0	0.0	0.0	3.7
	16	1.9	0.0	0.0	0.0	0.0				0.0	0.0	0.0	3.2
	17	1.6	0.0	0.0	0.0	0.0				0.0	0.0	0.0	2.6
	18	1.5	0.0	0.0	0.0	0.0				0.0	0.0	0.0	2.0
	19	1.4	0.0	0.0	0.0	0.0				0.0	0.0	0.0	1.9
	20	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0	1.9
	21	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0	1.5
	22	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0	0.8
	23	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0	0.0
	24	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0	0.0
	25	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0	0.0
	26	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0	0.0
	27	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0	0.0
	28	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0	0.0
	29	0.0	0.0	0.0	0.0	0.0				0.0	0.0	0.0	0.0
	30	0.0		0.0	0.0	0.0				0.0	0.0	0.0	0.0
	31	0.0		0.0		0.0					0.0		0.0

Table XVII3.1.3 Daily Rainfall of N'Fifikh

Station: FEDDANE TABA (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1997	1	13.6	0.4	2.4	12.4		0.3	4.8		3.1	17.0	12.3	7.9
	2	12.0	0.0	0.0	11.8		0.0	1.2		3.1	3.7	10.0	6.5
	3	8.1	0.0	0.0	10.3		0.0	0.0		0.0	0.4	10.0	4.3
	4	5.5	0.0	0.0	1.0		0.0	0.0		0.0	0.0	7.1	3.0
	5	4.7	0.0	0.0	0.6		0.0	0.0		0.0	0.0	3.8	2.9
	6	3.9	0.0	0.0	0.6		0.0	0.0		0.0	0.0	3.3	2.4
	7	3.6	0.0	0.0	0.2		0.0	0.0		0.0	0.0	3.2	2.0
	8	3.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	2.7	1.8
	9	2.3	0.0	0.0	0.0		0.0	0.0		0.0	0.0	1.9	1.3
	10	2.3	0.0	0.0	0.0		0.0	0.0		0.0	0.0	1.5	0.7
	11	1.8	0.0	0.0	0.0		0.0	0.0		0.0	0.0	1.4	0.0
	12	1.6	0.0	0.0	0.0		0.0	0.0		0.0	0.0	0.7	0.0
	13	0.7	0.0	0.0	0.0		0.0	0.0		0.0	0.0	0.7	0.0
	14	0.6	0.0	0.0	0.0		0.0	0.0		0.0	0.0	0.6	0.0
	15	0.3	0.0	0.0	0.0		0.0	0.0		0.0	0.0	0.5	0.0
	16	0.2	0.0	0.0	0.0		0.0	0.0		0.0	0.0	0.4	0.0
	17	0.2	0.0	0.0	0.0		0.0	0.0		0.0	0.0	0.3	0.0
	18	0.1	0.0	0.0	0.0		0.0	0.0		0.0	0.0	0.2	0.0
	19	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	0.0	0.0
	20	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	0.0	0.0
	21	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	0.0	0.0
	22	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	0.0	0.0
	23	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	0.0	0.0
	24	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	0.0	0.0
	25	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	0.0	0.0
	26	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	0.0	0.0
	27	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	0.0	0.0
	28	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	0.0	0.0
	29	0.0		0.0	0.0		0.0	0.0		0.0	0.0	0.0	0.0
	30	0.0		0.0	0.0		0.0	0.0		0.0	0.0	0.0	0.0
	31	0.0		0.0				0.0			0.0		0.0

Table XVII3.1.3 Daily Rainfall of N'Fifikh

Station: FEDDANE TABA (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1998	1	7.0	18.7	4.3	2.5	0.9	4.3			4.2	2.0		23.0
	2	4.4	3.7	2.5	2.1	0.3	1.8			0.0	1.5		18.6
	3	3.5	3.7	0.0	1.9	0.0	0.0			0.0	0.3		14.0
	4	3.1	3.2	0.0	1.3	0.0	0.0			0.0	0.0		9.4
	5	1.3	2.8	0.0	0.7	0.0	0.0			0.0	0.0		7.7
	6	0.8	0.5	0.0	0.3	0.0	0.0			0.0	0.0		2.9
	7	0.2	0.2	0.0	0.0	0.0	0.0			0.0	0.0		1.9
	8	0.2	0.0	0.0	0.0	0.0	0.0			0.0	0.0		0.0
	9	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0		0.0
	10	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0		0.0
	11	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0		0.0
	12	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0		0.0
	13	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0		0.0
	14	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0		0.0
	15	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0		0.0
	16	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0		0.0
	17	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0		0.0
	18	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0		0.0
	19	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0		0.0
	20	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0		0.0
	21	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0		0.0
	22	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0		0.0
	23	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0		0.0
	24	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0		0.0
	25	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0		0.0
	26	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0		0.0
	27	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0		0.0
	28	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0		0.0
	29	0.0		0.0	0.0	0.0	0.0			0.0	0.0		0.0
	30	0.0		0.0	0.0	0.0	0.0			0.0	0.0		0.0
	31	0.0		0.0		0.0					0.0		0.0

Table XVII3.1.3 Daily Rainfall of N'Fifikh

Station: FEDDANE TABA (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1999	1	23.2	29.3	3.6	6.5	6.6						16.3	4.3
	2	17.5	15.0	1.1	0.8	3.8						11.5	2.8
	3	6.9	12.2	0.9	0.7	3.6						4.7	1.9
	4	6.2	3.7	0.9	0.0	0.0						4.5	1.1
	5	5.4	1.2	0.7	0.0	0.0						2.0	0.8
	6	5.4	0.0	0.3	0.0	0.0						0.5	0.4
	7	1.5	0.0	0.2	0.0	0.0						0.2	0.0
	8	0.9	0.0	0.0	0.0	0.0						0.0	0.0
	9	0.6	0.0	0.0	0.0	0.0						0.0	0.0
	10	0.0	0.0	0.0	0.0	0.0						0.0	0.0
	11	0.0	0.0	0.0	0.0	0.0						0.0	0.0
	12	0.0	0.0	0.0	0.0	0.0						0.0	0.0
	13	0.0	0.0	0.0	0.0	0.0						0.0	0.0
	14	0.0	0.0	0.0	0.0	0.0						0.0	0.0
	15	0.0	0.0	0.0	0.0	0.0						0.0	0.0
	16	0.0	0.0	0.0	0.0	0.0						0.0	0.0
	17	0.0	0.0	0.0	0.0	0.0						0.0	0.0
	18	0.0	0.0	0.0	0.0	0.0						0.0	0.0
	19	0.0	0.0	0.0	0.0	0.0						0.0	0.0
	20	0.0	0.0	0.0	0.0	0.0						0.0	0.0
	21	0.0	0.0	0.0	0.0	0.0						0.0	0.0
	22	0.0	0.0	0.0	0.0	0.0						0.0	0.0
	23	0.0	0.0	0.0	0.0	0.0						0.0	0.0
	24	0.0	0.0	0.0	0.0	0.0						0.0	0.0
	25	0.0	0.0	0.0	0.0	0.0						0.0	0.0
	26	0.0	0.0	0.0	0.0	0.0						0.0	0.0
	27	0.0	0.0	0.0	0.0	0.0						0.0	0.0
	28	0.0	0.0	0.0	0.0	0.0						0.0	0.0
	29	0.0		0.0	0.0	0.0						0.0	0.0
	30	0.0		0.0	0.0	0.0						0.0	0.0
	31	0.0		0.0		0.0							0.0

Table XVII3.1.3 Daily Rainfall of N'Fifikh

Station: FEDDANE TABA (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2000	1	5.6	0.0	0.0						21.0			
	2	5.6	0.0	0.0						10.6			
	3	4.2	0.0	0.0						8.4			
	4	3.8	0.0	0.0						5.9			
	5	1.0	0.0	0.0						5.3			
	6	0.0	0.0	0.0						4.2			
	7	0.0	0.0	0.0						2.5			
	8	0.0	0.0	0.0						1.9			
	9	0.0	0.0	0.0						1.2			
	10	0.0	0.0	0.0						0.7			
	11	0.0	0.0	0.0						0.6			
	12	0.0	0.0	0.0						0.0			
	13	0.0	0.0	0.0						0.0			
	14	0.0	0.0	0.0						0.0			
	15	0.0	0.0	0.0						0.0			
	16	0.0	0.0	0.0						0.0			
	17	0.0	0.0	0.0						0.0			
	18	0.0	0.0	0.0						0.0			
	19	0.0	0.0	0.0						0.0			
	20	0.0	0.0	0.0						0.0			
	21	0.0	0.0	0.0						0.0			
	22	0.0	0.0	0.0						0.0			
	23	0.0	0.0	0.0						0.0			
	24	0.0	0.0	0.0						0.0			
	25	0.0	0.0	0.0						0.0			
	26	0.0	0.0	0.0						0.0			
	27	0.0	0.0	0.0						0.0			
	28	0.0	0.0	0.0						0.0			
	29	0.0	0.0	0.0						0.0			
	30	0.0		0.0						0.0			
	31	0.0		0.0									

Table XVII3.1.5 Construction Volume of Dam and Irrigation Facilities (1/2)

	Work Item	Unit	Qauntity			
			No.5 N'Fifikh	No.9 Taskourt	No.10 Timkit	No.17 Azghar
	A. Dam					
1	River Diversion Works					
	Excavation / hauling, soil & gravel	m^3	2,800	-	-	53,400
	- ditto -, rock	m^3	24,200	-	-	22,900
	Backfill,soil	m^3	300	-	-	0
	Embankment, soil	m^3	64,600	-	-	34,100
	Reinforced concrete	m^3	12,984	3,614	2,660	13,320
	Plain concrete (Plugging)	m^3	5,000	2,592	1,615	6,000
	Form work	m^2	5,860	3,154	2,169	6,000
2	Foundation Excavation					
	Excavation / hauling, soil & gravel	m^3	123,900	102,300	73,400	211,100
	- ditto -, rock	m^3	49,000	139,800	92,500	46,900
3	Foundation Treatment Works					
	Curtain grouting work	m	3,146	6,437	13,193	4,791
	Consolidation grouting work	m	-	2,041	1,649	-
4	Dam Emnbankment					
	Impervious zone	m^3	142,500	-	-	130,900
	Filter and Transition zone	m^3	515,600	-	-	615,800
	Rip-rap	m^3	20,300	-	-	23,100
	Inner concrete	m^3	-	314,715	182,725	-
	Outer concrete	m^3	-	99,135	44,000	-
	Rinforced concrete	m^3	-	1,152	909	-
	Tie rod	ton	-	39	31	-
5	Spillway					
	Excavation / hauling, soil & gravel	m^3	343,300	-	-	156,000
	- ditto -, rock	m^3	85,800	-	-	39,000
	Backfill,soil	m^3	54,600	-	-	26,600
	Reinforced concrete	m^3	59,665	1,980	1,052	29,390
	Form work	m^2	24,405	2,840	1,522	22,565
6	Outlet Works					
	Reinforced concrete	m^3	1,260	2,360	615	1,099
	Plain concrete	m^3	4,642	-	-	324
	Form work	m^2	394	2,674	1,281	1,430
7	Gate and Pipe					
	Slide gate	pcs	2	2	2	2
	Steel pipe	m	280	73	50	260
	Jet flow gate	pcs	1	1	1	1
	Sleeve valve	pcs	-	-	-	1
	Flow meter	pcs	1	1	1	1
8	Sabo Dam					
	Excavation / hauling, soil & gravel	m^3	-	-	25,500	-
	- ditto -, rock	m^3	-	-	25,500	-
	Sabo dam body	m^3	-	-	47,815	-

Table XVII3.1.5 Construction Volume of Dam and Irrigation Facilities (2/2)

	Work Item	Unit	Qauntity			
			No.5 N'Fifikh	No.9 Taskourt	No.10 Timkit	No.17 Azghar
	B. Irrigation Facilities					
1	Main Canal					
	Main Canal	m	9,200	21,600	-	13,545
	Branch Canal (1)	m	9,250	15,280	-	2,580
	Branch Canal 2	m	-	-	-	5,515
	Branch Canal 3	m	-	-	-	2,670
	Main Feeder Canal 1	m	2,500	-	-	-
	Main Feeder Canal 2	m	4,450	-	-	-
	Flume Canal (rehabilitation)	m	-	-	3,600	-
	Masonry Canal (rehabilitation)	m	-	-	34,900	-
2	Structures					
	Head work (Diversion)	pcs	3	1	12	-
	Syphon	pcs	9	1	-	20
	Drop	m	-	4,790	-	875
	Offtake	pcs	32	18	-	50
	Spill way	pcs	4	6	-	7
	Check	pcs	8	-	-	13
	Aqueduct	pcs	1	-	-	-
	Cross Drain	pcs	63	102	-	60
	Bridge	pcs	25	37	-	26
	Box culvert	m	-	-	-	65
	On-farm facilities	ha	1,000	4,500	3,060	2,000
	Well	pcs	-	-	37	-
	River channel	m	-	-	5,000	-

Table XVII3.1.6 Dam Construction Period (1/2)

AT; Agitator Truck, BM; Boring Machine, CD; Crawler Drill, CP; Concrete Pump, DT; Dump Truck, GM; Grout Pump, RD; Ripperdozer, TR; Tamping Roller
BD; Bulldozer, C; Compresser, CM; Concrete Mixing Plant, DJ; Drill Jumbo, G; Generator, GP; Grout Pump, TC; Truck Crane, TS; Tractor Shovel

Work Item	Unit	Quantity	Critical Equipment	Production Rate /hour	Production Rate /day	Working Days	Working Rate	Construction Days	Set no.	Construction Period day	Construction Period month	Other Equipments 1st	no.	2nd	no.	3rd	no.	4th	no.	5th	no.
I N'fifikh																					
1 River Diversion Works										163	6										
Excavation / hauling, soil & gravel	m3	2,800	BD 44t	206.3	1,155.3	2.4	1.20	2.9	1	3		TS 5.4m3	1	DT 32t	4						
- ditto -, rock, ripping	m3	19,360	RD 32t	174.5	977.2	19.8	1.20	23.8	1	24		BD 32t	2	TS 5.4m3	1	DT 32t	4				
- ditto -, rock, blasting	m3	4,840	CD 150kg	-	168.0	28.8	1.20	34.6	1	35		BD 32t	1	TS 5.4m3	1	DT 32t	1				
Reinforced concrete	m3	12,984	AT 4.4m3	6.9	38.6	336.0	1.20	403.2	4	101		CM 1.5m3*2	1	TS 2.0m3	1	G 100kVA	1	CP 100m3/h	1	DT 4t	1
2 Foundation Excavation										92	4										
Excavation / hauling, soil & gravel	m3	123,900	BD 44t	206.3	1,155.3	107.2	1.20	128.6	3	43		TS 5.4m3	3	DT 32t	12						
- ditto -, rock, ripping	m3	39,200	RD 32t	174.5	977.2	40.1	1.20	48.1	2	25		BD 32t	4	TS 5.4m3	2	DT 32t	8				
- ditto -, rock, blasting	m3	9,800	CD 150kg	-	168.0	58.3	1.20	70.0	3	24		BD 32t	1	TS 5.4m3	1	DT 32t	1				
3 Foundation Treatment Works																					
Curtain grouting work	m	3,146	GP 7.8kw	-	8.5	370.1	1.20	444.1	2	223	8	BM 5.5kW	1	GM 2.2kW	2	G 60kVA	1				
4 Dam Emnbankment										469	16										
Impervious zone	m3	142,500	TR 30t	80.7	451.9	315.3	1.20	378.4	1	379		BD 21t	1								
Others	LS	1								90											
5 Spillway										540	18										
Excavation / hauling, soil & gravel	m3	343,300	BD 44t	206.3	1,155.3	297.2	1.20	356.6	3	119		TS 5.4m3	3	DT 32t	12						
- ditto -, rock, ripping	m3	68,700	RD 32t	174.5	977.2	70.3	1.20	84.4	2	43		BD 32t	4	TS 5.4m3	2	DT 32t	8				
- ditto -, rock, blasting	m3	17,100	CD 150kg	-	168.0	101.8	1.20	122.2	2	62		BD 32t	1	TS 5.4m3	1	DT 32t	1				
Reinforced concrete	m3	59,665	CM 1.5m3*2	40.5	226.8	263.1	1.20	315.7	1	316		AT 4.4m3	6	TS 2.0m3	1	G 100kVA	1	CP 100m3/h	1	TC 25t	1
6 Outlet Works										245	9										
Reinforced concrete	m3	1,260	AT 4.4m3	6.9	38.6	32.6	1.20	39.1	1	40		CM1.5m3*2	1	TS 2.0m3	1	G 100kVA	1	CP 100m3/h	1	DT 4t	1
Gate and pipe installation	LS	1								60		TC 25t	1	DT 4t	1						
Plain concrete (plugging)	m3	4,642	AT 4.4m3	6.9	38.6	120.1	1.20	144.1	1	145		CP 1.5m3*2	1	TS 2.0m3	1	G 100kVA	1	CP 100m3/h	1		
II Taskourt																					
1 River Diversion Works										143	5										
Excavation, Cutoff wall	LS	1							1	30		BD 44t	1	BH 1.2m3	1	TS 5.4m3	1	DT 32t	2		
Reinforced concrete	m3	3,614	AT 4.4m3	6.9	38.6	93.5	1.20	112.2	1	113		CM 2.0m3*3	1	TS 2.0m3	1	G 100kVA	1	CP 100m3/h	1	TC 25t	1
2 Foundation Excavation										223	8										
Excavation / hauling, soil & gravel	m3	102,300	BD 44t	206.3	1,155.3	88.5	1.20	106.2	2	54		TS 5.4m3	2	DT 32t	8						
- ditto -, rock, ripping	m3	111,840	RD 32t	174.5	977.2	114.4	1.20	137.3	2	69		BD 32t	4	TS 5.4m3	2	DT 32t	8				
- ditto -, rock, blasting	m3	27,960	CD 150kg	-	168.0	166.4	1.20	199.7	2	100		BD 32t	1	TS 5.4m3	1	DT 32t	1				
3 Foundation Treatment Works										744	25										
Curtain grouting work	m	6,437	GP 7.8kw	-	8.5	757.3	1.20	908.8	2	455		BM 5.5kW	1	GM 2.2kW	2	G 60kVA	1				
Consolidation grouting work	m	2,041	GP 7.8kw	-	8.5	240.1	1.20	288.1	1	289		CD 150kg	1	GM 2.2kW	1	G 60kVA	1				
4 Dam Emnbankment										898	30										
Concrete	m3	415,002	CM 2.0m3*3	98.6	552.2	751.6	1.15	867.2	1	868		DT 10t	15	TS 2.0m3	1	G 100kVA	1	TC 25t	1		
Others	LS	1								30											
5 Outlet Works										235	8										
Reinforced concrete	m3	2,360	AT 4.4m3	6.9	38.6	61.1	1.20	73.3	1	74		CM 2.0m3*3	1	TS 2.0m3	1	G 100kVA	1	CP 100m3/h	1	DT 4t	1
Gate and pipe installation	LS	1								80		TC 25t	1	DT 4t	1						
Plain concrete (plugging)	m3	2,592	AT 4.4m3	6.9	38.6	67.1	1.20	80.5	1	81		CM 2.0m3*3	1	TS 2.0m3	1	G 100kVA	1	CP 100m3/h	1		

Table XVII3.1.6 Dam Construction Period (2/2)

AT; Agitator Truck	BM; Boring Machine	CD; Crawler Drill	CP; Concrete Pump
BD; Bulldozer	C; Compresser	CM; Concrete Mixing Plant	DJ; Drill Jumbo
DT; Dump Truck	GM; Grout Pump	RD; Ripperdozer	TR; Tamping Roller
G; Generator	GP; Grout Pump	TC; Truck Crane	TS; Tractor Shovel

Work Item	Unit	Quantity	Critical Equipment	Production Rate		Working Days	Working Rate	Construction Days	Set	Construction Period		Other Equipments									
				/hour	/day				no.	day	month	1st	no.	2nd	no.	3rd	no.	4th	no.	5th	no.
III Timkit																					
1 River Diversion Works										152	6										
Excavation, Cutoff wall	LS	1							1	75		BD 44t	1	BH 1.2m3	1	TS 5.4m3	1	DT 32t	2		
Reinforced concrete	m3	2,660	AT 4.4m3	6.9	38.6	68.8	1.11	76.4	1	77		CM 1.0m3*2	1	TS 2.0m3	1	G 100kVA	1	CP 100m3/h	1	TC 25t	1
2 Foundation Excavation										183	7										
Excavation / hauling, soil & gravel	m3	73,400	BD 44t	206.3	1,155.3	63.5	1.11	70.6	2	36		TS 5.4m3	2	DT 32t	8						
- ditto -, rock, ripping	m3	74,000	RD 32t	174.5	977.2	75.7	1.11	84.1	1	85		BD 32t	2	TS 5.4m3	1	DT 32t	4				
- ditto -, rock, blasting	m3	18,500	CD 150kg	-	168.0	110.1	1.11	122.3	2	62		BD 32t	1	TS 5.4m3	1	DT 32t	1				
3 Foundation Treatment Works										683	23										
Curtain grouting work	m	13,193	GP 7.8kw	-	8.5	1,552.1	1.11	1,724.6	3	575		BM 5.5kW	2	GM 2.2kW	3	G 60kVA	1				
Consolidation grouting work	m	1,649	GP 7.8kw	-	8.5	194.0	1.11	215.6	2	108		CD 150kg	1	GM 2.2kW	2	G 60kVA	1				
4 Dam Emnbankment										773	26										
Inner concrete	m3	226,725	CM 1.0m3*2	58.4	327.0	693.3	1.07	742.8	1	743		DT 10t	5	TS 2.0m3	1	G 100kVA	1	TC 25t	1		
Others	LS	1								30											
5 Outlet Works										152	6										
Reinforced concrete	m3	615	AT 4.4m3	6.9	38.6	15.9	1.07	17.0	1	17		CM 1.0m3*2	1	TS 2.0m3	1	G 100kVA	1	CP 100m3/h	1	DT 4t	1
Gate and pipe installation	LS	1								90		TC 25t	1	DT 4t	1						
Plain concrete (plugging)	m3	1,615	AT 4.4m3	6.9	38.6	41.8	1.07	44.8	1	45		CM 1.0m3*2	1	TS 2.0m3	1	G 100kVA	1	CP 100m3/h	1		
6 Sabo Dam										316	11										
Excavation / hauling, soil & gravel	m3	25,500	BD 44t	206.3	1,155.3	22.1	1.20	26.5	2	14		TS 5.4m3	2	DT 32t	8						
- ditto -, rock, ripping	m3	20,400	RD 32t	174.5	977.2	20.9	1.20	25.1	1	26		BD 32t	2	TS 5.4m3	1	DT 32t	4				
- ditto -, rock, blasting	m3	5,100	CD 150kg	-	168.0	30.4	1.20	36.5	2	19		BD 32t	1	TS 5.4m3	1	DT 32t	1				
Masonry	m3	47,815	BH 0.6m3	-	100.0	478.2	1.07	512.4	2	257		CM 0.5m3*1	1	G 100kVA	1						
IV Azghar																					
1 River Diversion Works										216	8										
Excavation / hauling, soil & gravel	m3	53,400	BD 44t	206.3	1,155.3	46.2	1.20	55.4	1	56		TS 5.4m3	1	DT 32t	4						
- ditto -, rock, ripping	m3	18,320	RD 32t	174.5	977.2	18.7	1.20	22.4	1	23		BD 32t	2	TS 5.4m3	1	DT 32t	4				
- ditto -, rock, blasting	m3	4,580	CD 150kg	-	168.0	27.3	1.20	32.8	1	33		BD 32t	1	TS 5.4m3	1	DT 32t	1				
Reinforced concrete	m3	13,320	AT 4.4m3	6.9	38.6	344.7	1.20	413.6	4	104		CM 1.5m3*2	1	TS 2.0m3	1	G 100kVA	1	CP 100m3/h	1	DT 4t	1
2 Foundation Excavation										229	8										
Excavation / hauling, soil & gravel	m3	211,100	BD 44t	206.3	1,155.3	182.7	1.30	238.3	2	120		TS 5.4m3	2	DT 32t	8						
- ditto -, rock, ripping	m3	37,520	RD 32t	249.2	1,395.5	26.9	1.30	35.1	1	36		BD 32t	2	TS 5.4m3	1	DT 32t	4				
- ditto -, rock, blasting	m3	9,380	CD 150kg	-	168.0	55.8	1.30	72.8	1	73		BD 32t	1	TS 5.4m3	1	DT 32t	1				
3 Foundation Treatment Works																					
Curtain grouting work	m	4,791	GP 7.8kw	-	8.5	563.6	1.30	735.1	2	368	13	BM 5.5kW	1	GM 2.2kW	2	G 60kVA	1				
4 Dam Emnbankment										438	15										
Impervious zone	m3	130,900	TR 30t	80.7	451.9	289.7	1.20	347.6	1	348		BD 21t	1								
Others	LS	1								90											
5 Spillway										353	12										
Excavation / hauling, soil & gravel	m3	156,000	BD 44t	206.3	1,155.3	135.0	1.30	176.1	2	89		TS 5.4m3	2	DT 32t	8						
- ditto -, rock, ripping	m3	31,200	RD 32t	174.5	977.2	31.9	1.30	41.6	1	42		BD 32t	2	TS 5.4m3	1	DT 32t	4				
- ditto -, rock, blasting	m3	7,800	CD 150kg	-	168.0	46.4	1.30	60.5	2	31		BD 32t	1	TS 5.4m3	1	DT 32t	1				
Reinforced concrete	m3	29,390	AT 4.4m3	6.9	38.6	760.6	1.25	950.8	5	191		CM 0.5m3*1	1	TS 2.0m3	1	G 100kVA	1	CP 100m3/h	1	TC 25t	1
6 Outlet Works										262	9										
Reinforced concrete	m3	1,099	AT 4.4m3	6.9	38.6	28.4	1.25	35.5	1	36		CM 1.5m3*2	1	TS 2.0m3	1	G 100kVA	1	CP 100m3/h	1	DT 4t	1
Gate and pipe installation	LS	1								90		TC 25t	1	DT 4t	1						
Plain concrete (plugging)	m3	10,220	CM 0.5m3*1	16.8	94.1	108.6	1.25	135.8	1	136		AT 4.4m3	3	TS 2.0m3	1	G 100kVA	1	CP 100m3/h	1		

Table XVII3.1.7 Earth Moving Plan (1/2)

Concrete Gravity Dam

No.9 Taskourt				Embankment						
				Aggregate		Spoil Bank		Total		
Work	Material			Fine	Coarse	Soil	Rock	Soil	Rock	Total
		Vol. (m3)	Compacted	-	-	-	-	-	-	-
		Natural	Loose	144,600	348,900	36,800	0	181,400	348,900	530,300
Excavation: Dam	Soil	102,300	122,700	36,800	(49,100)	36,800		73,600	49,100	122,700
	Rock	139,800	202,700	(20,300)	182,400			20,300	182,400	202,700
Excavation: Quarry	Soil	72,900	87,500	87,500				87,500	0	87,500
	Rock	80,900	117,400		117,400			0	117,400	117,400
Excavation: Total	Soil	175,200	210,200	124,300	49,100	36,800	0	161,100	49,100	210,200
	Rock	220,700	320,100	20,300	299,800	0	0	20,300	299,800	320,100
	Total	395,900	530,300	144,600	348,900	36,800	0	181,400	348,900	530,300

No.10 Timkit				Embankment						
				Aggregate		Spoil Bank		Total		
Work	Material			Fine	Coarse	Soil	Rock	Soil	Rock	Total
		Vol. (m3)	Compacted	-	-	-	-	-	-	-
		Natural	Loose	79,400	191,500	26,400	0	105,800	191,500	297,300
Excavation: Dam	Soil	73,400	88,000	26,400	(35,200)	26,400		52,800	35,200	88,000
	Rock	92,500	134,100	(13,400)	120,700			13,400	120,700	134,100
Excavation: Quarry	Soil	33,000	39,600	39,600				39,600	0	39,600
	Rock	24,600	35,600		35,600			0	35,600	35,600
Excavation: Total	Soil	106,400	127,600	66,000	35,200	26,400	0	92,400	35,200	127,600
	Rock	117,100	169,700	13,400	156,300	0	0	13,400	156,300	169,700
	Total	223,500	297,300	79,400	191,500	26,400	0	105,800	191,500	297,300

Earth Moving Plan for Dam Construction

As for effective use of earth produced at site, an earth moving plan should be studied for each dam.

The conversion rate of earth materials are depending on their status as shown below. The conversion rate of natural condition is 1.00 for both soil and rock.

The same rates are assumed on every four site.

Materials		Status: Loose	Status: Compacted	Note
Soil		**1.20**	**0.93**	avg. of 2types soil
	Sandy	1.20	0.95	
	Clayey & Gravelly	1.20	0.90	
Rock		**1.45**	**1.20**	avg. of 2types rock
	Soft Rock	1.30	1.10	
	Hard Rock	1.60	1.30	

The average rate is used for both soil and rock on this plan.

Table XVII3.1.7 Earth Moving Plan (2/2)

Fill Type Dam

*Refer to (1/2) for conversion rate

No.5 N'fifikh

Work		Material	Vol. (m3)		Diversion Inlet etc. Soil	Diversion Inlet etc. Rock	Diversion Coffer Dam Soil	Diversion Coffer Dam Rock	Dam Core Soil	Dam Filter & Transition Soil	Dam Filter & Transition Rock	Dam Rip-rap Rock	Spillway Soil	Spillway Rock	Aggregate Fine	Aggregate Coarse	Total Soil	Total Rock	Total Total
			Vol. (m3)	Compacted	300	0	64,600	0	142,500	359,500	156,100	20,300	54,600	0	-	-	621,500	176,400	797,900
			Natural	Loose	300	0	83,300	0	183,800	434,300	201,400	24,500	70,400	0	28,400	68,500	800,500	294,400	1,094,900
Excavation: Diversion	Inlet etc.	Soil	2,800	3,300	300		3,000										3,300	0	3,300
		Rock	0	0													0	0	0
	Culvert	Soil	0	0													0	0	0
		Rock	24,200	35,000							35,000						0	35,000	35,000
Dam		Soil	123,900	148,600			80,300		20,400	47,900							148,600	0	148,600
		Rock	49,000	71,000							71,000						0	71,000	71,000
Spillway		Soil	343,300	411,900					163,400	178,100			70,400				411,900	0	411,900
		Rock	85,800	124,400							95,400					29,000	0	124,400	124,400
Quarry		Soil	197,300	236,700						208,300					28,400		236,700	0	236,700
		Rock	44,200	64,000								24,500				39,500	0	64,000	64,000
Total		Soil	667,300	800,500	300	0	83,300	0	183,800	434,300	0	0	70,400	0	28,400	0	800,500	0	800,500
		Rock	203,200	294,400	0	0	0	0	0	0	201,400	24,500	0	0	0	68,500	0	294,400	294,400
		Total	870,500	1,094,900	300	0	83,300	0	183,800	434,300	201,400	24,500	70,400	0	28,400	68,500	800,500	294,400	1,094,900

No.17 Azghar

Work		Material	Vol. (m3)		Diversion Inlet etc. Soil	Diversion Inlet etc. Rock	Diversion Coffer Dam Soil	Diversion Coffer Dam Rock	Dam Core Soil	Dam Filter & Transition Soil	Dam Filter & Transition Rock	Dam Rip-rap Rock	Spillway Soil	Spillway Rock	Aggregate Fine	Aggregate Coarse	Total Soil	Total Rock	Total Total
			Vol. (m3)	Compacted	0	0	34,100	0	130,900	592,600	23,200	23,100	26,600	0	-	-	784,200	46,300	830,500
			Natural	Loose	0	0	44,000	0	168,900	716,000	29,900	27,900	34,300	0	17,100	41,400	980,300	99,200	1,079,500
Excavation: Diversion	Inlet etc.	Soil	53,400	64,000			44,000		20,000								64,000	0	64,000
		Rock	0	0													0	0	0
	Culvert	Soil	0	0													0	0	0
		Rock	22,900	33,200						33,200							33,200	0	33,200
Dam		Soil	211,100	253,300					75,900	177,400							253,300	0	253,300
		Rock	46,900	68,000						10,200	29,900	27,900					10,200	57,800	68,000
Spillway		Soil	156,000	187,200					56,200	96,700			34,300				187,200	0	187,200
		Rock	39,000	56,500						15,100						41,400	15,100	41,400	56,500
Quarry		Soil	347,800	417,300					16,800	383,400					17,100		417,300	0	417,300
		Rock	0	0													0	0	0
Total		Soil	768,300	921,800	0	0	44,000	0	168,900	657,500	0	0	34,300	0	17,100	0	921,800	0	921,800
		Rock	108,800	157,700	0	0	0	0	0	58,500	29,900	27,900	0	0	0	41,400	58,500	99,200	157,700
		Total	877,100	1,079,500	0	0	44,000	0	168,900	716,000	29,900	27,900	34,300	0	17,100	41,400	980,300	99,200	1,079,500

Table XVII3.1.8: Basic Cost of Labor

No.	Description	Spec	Basic Cost (DH/day)
L1	Foreman	-	172.70
L2	Skilled Labor	-	79.90
L3	Common Labor	-	79.90
L4	Scaffolding Man	-	110.90
L5	Carpenter	-	110.90
L6	Reinforcement Worker	-	79.90
L7	Welder	-	117.60
L8	Plaster	-	110.90
L9	Mason	-	110.90
L10	Painter	-	98.20
L11	Electrician	-	117.60
L12	Mechanic	-	135.70
L13	Rock Driller	-	110.90
L14	Plumber	-	110.90
L15	Plant Operator	-	152.70
L16	Operator A	Heavy Equipment	152.70
L17	Operator B	Light Equipment	98.00
L18	Driver	-	98.00

Table XVII3.1.9 Basic Cost of Material (1/2)

No.	Description	Spec	Unit	Basic Cost (DH)
M1	Cement	-	ton	850
M2	Fine Aggregate	-	m^3	480
M3	Coarse Aggregate	5-15mm	m^3	320
M4	Coarse Aggregate	15-25mm	m^3	320
M5	Crusher Run	0-40mm	m^3	240
M6	Rubble	-	m^3	144
M7	Deformed Steel Bar	-	ton	10,200
M8	Gasoline	-	lit	9.09
M9	Diesel	-	lit	6.1
M10	Oil	-	lit	19.2
M11	Asphalt Mixture	-	ton	6,000
M12	Gunpowder	for blasting	kg	9.3
M13	Detonator	-	pcs	17
M14	Block	L;35cm	m^3	144
M15	Concrete Block	0.2*0.2*0.4m	pcs	5.82
M16	Brick	0.15*0.2*0.4m	pcs	5.16
M17	Plywood	15mm	m^2	204
M18	Timber	Plank	m^3	3,600
M19	Scaffolding Board	240*4,000mm	pcs	3,500
M20	Form Oil	20m2/lit	lit	36
M21	Nail	-	kg	11
M22	Binding Wire	-	kg	10
M23	Wire	D8mm	m	12
M24	Barbed Wire	#14, 50mm	m	68
M25	Gabion	-	m^3	500
M26	Channel Steel	100mm	ton	6,800
M27	Angle Steel	50*50*5mm	ton	7,000
M28	H Beam	200mm	ton	6,700
M29	Steel Water Tank	2,000lit	pcs	25,000
M30	Semicircular Pipe	D600<=800mm	m	750
M31	Semicircular Pipe	D300<=400mm	m	250
M32	Steel Pipe	D800, t;6mm	m	2,268
M33	Steel Pipe	D600, t;6mm	m	1,540
M34	PC Pipe PC10	D400, 7m	m	85
M35	PC Pipe PC10	D600, 7m	m	170
M36	PC Pipe PC10	D800, 7m	m	250
M37	RC Pipe	D300<=400mm	m	150
M38	RC Pipe	D500<=600mm	m	425
M39	RC Pipe	D600<=800mm	m	550
M40	RC Pipe	D800<=1,200mm	m	750
M41	PVC Pipe	10Bar, D110mm	m	88.67
M42	PVC Pipe	10Bar, D160mm	m	151.67
M43	PVC Pipe	10Bar, D200mm	m	235
M44	PVC Pipe	10Bar, D250mm	m	438.33
M45	PVC Pipe	10Bar, D3150mm	m	698.33
M46	Asbestos Pipe	D100mm, 5m	pcs	720
M47	Asbestos Pipe	D150mm, 5m	pcs	1110
M48	Asbestos Pipe	D200mm, 5m	pcs	1765
M49	Asbestos Pipe	D250mm, 5m	pcs	2270
M50	Asbestos Pipe	D300mm, 5m	pcs	2895

Table XVII3.1.9 Basic Cost of Material (2/2)

No.	Description	Spec	Unit	Basic Cost (DH)
M51	Sluice Valve	D100mm	pcs	173
M52	Sluice Valve	D200mm	pcs	334
M53	Sluice Valve	D250mm	pcs	495
M54	Sluice Valve	D300mm	pcs	743
M55	Butterfly Valve	D100mm	pcs	672
M56	Butterfly Valve	D200mm	pcs	1,815
M57	Butterfly Valve	D250mm	pcs	6,504
M58	Butterfly Valve	D300mm	pcs	7,740
M59	Survey Pole	4M stainless	pcs	16,000
M60	Helmet	-	pcs	51
M61	Boot	-	pcs	77
M62	Rope	9mm	kg	250
M63	Fire Extinguisher	Powder, p;6kg	pcs	780
M64	Light	300w10m code	pcs	750
M65	Gas Cutter	-	pcs	210
M66	Electric Drill	300w10m code	pcs	15,000
M67	Electric Saw	-	pcs	600
M68	Welding Rod	240pcs	pcs	500
M69	Admixture	-	kg	45
M70	Cross Bit	D65mm	pcs	350
M71	Rod	D38mm, L=3m	pcs	1,240
M72	Shank Lod	D38mm	pcs	2,319
M73	Diamond Bit	D46mm, 12ct	pcs	1,330
M74	Diamond Leaming Shell	D46mm, 4ct	pcs	185
M75	Core Tube	D46single, 1.5m	pcs	2,700
M76	Core Lifter	D46mm	pcs	2,700
M77	Boring Lod	D40.5mm, L=3m	pcs	1,240
M78	Electric Power Charge	40A	kwh	4,500
M79	Water Stop	PVC, B=300mm	m	300
M80	Net Fence	H=1.5m	m	1,200
M81	RC Pipe	D<=100mm	m	32
M82	RC Pipe	D100<=200mm	m	42.5
M83	RC Pipe	D200<=300mm	m	100
M84	RC Pipe	D400<=500mm	m	225
M85	RC Pipe	D1,200<=1,300mm	m	900
M86	Semicircular Pipe	D<=100mm	m	32.5
M87	Semicircular Pipe	D100<=200mm	m	42.5
M88	Semicircular Pipe	D200<=300mm	m	150
M89	Semicircular Pipe	D400<=500mm	m	350
M90	Semicircular Pipe	D500<=600mm	m	500
M91	Semicircular Pipe	D800<=1,200mm	m	900
M92	Timber	Square	m^3	130
M93	Timber	Log L=2m	kg	1
M94	Timber	Log L=3m	kg	1.1
M95	Timber	Log L=4m	kg	1.2
M96	Timber	Log L>4m	kg	1.5
M97	Sleeve	38mm	pcs	998
M98	Metal Crown	D46mm	pcs	400
M99	Injection Pipe (inner)	D46mm, 1.5m	pcs	322
M100	Injection Pipe (outer)	D46mm, 1.5m	pcs	322

Table XVII3.1.10: Basic Cost of Equipment

No.	Description	Spec	Basic Cost (DH/day)
E1	Bulldozer	44t	6,730
E2	Bulldozer	32t	5,050
E3	Bulldozer	21t	4,500
E4	Bulldozer	11t	2,050
E5	Swamp Bulldozer	16t	2,640
E6	Ripperdozer	44t	4,490
E7	Ripperdozer	32t	3,670
E8	Tractor Shovel	$5.4m^3$	6,080
E9	Tractor Shovel	$3.2m^3$	2,400
E10	Tractor Shovel	$2.0m^3$	1,570
E11	Backhoe	$1.2m^3$	5,820
E12	Backhoe	$0.6m^3$	2,590
E13	Backhoe w/slope bucket	$0.6m^3$	2,590
E14	Backhoe	$0.4m^3$	1,660
E15	Breaker (attachment)	$0.6m^3$	1,218
E16	Dump Truck	32t	5,140
E17	Dump Truck	10t	1,320
E18	Dump Truck	7t	940
E19	Dump Truck	4t	520
E20	Dump Truck (Tunnel)	14t	3,320
E21	Tamping Roller	30t	4,910
E22	Road Roller	10-12t	880
E23	Vibrating Roller	15-18t	2,700
E24	Vibrating Roller	11t	2,500
E25	Vibrating Roller	600kg	170
E26	Tire roller	8-20t	1,020
E27	Vibratory Compactor	90kg	36
E28	Tamper	60kg	45
E29	Motor Grader	3.1m, 115ps	2,560
E30	Pick Hammer	-	9
E31	Jack Hammer	20kg	50
E32	Leg Drill	40kg	70
E33	Crawler Drill	150kg(Oil)	5,930
E34	Boring Machine (Rotary)	5.5kw	304
E35	Air Compressor	$5m^3$/min	269
E36	Air Compressor	$10m^3$/min	547
E37	Ventilation Fun	$400m^3$/min	258
E38	Grouting Pump	7.8kw	220
E39	Grouting Pump	4.4kw	145
E40	Grouting Mixer	5.5kw	187
E41	Grouting Mixer	2.2kw	114
E42	Concrete Mixer	0.5m2	2,050
E43	Concrete Mixing Plant	$1.5m^3$*2	8,290
E44	Concrete Mixing Plant	$3.0m^3$*2	11,610
E45	Crushing Plant	576m3/d,100t/h	9,170
E46	Generator	60kVA	319
E47	Generator	100kVA	421
E48	Generator	150kVA	622
E49	Agitator Truck	4.4-4.5m3	1,160
E50	Concrete Pumping Car	90-110m3/h	4,740
E51	Truck Crane	25t	4,600
E52	Finisher (Asphalt)	2.4-4.5m	4,020
E53	Welding Machine	300A	17
E54	Watering Truck	5.5-6.5t	850
E55	Grout Central Plant	150l/min	1,358
E56	Grout Injection Gauge	120l/min	1,066
E57	Grout Data Recorder	-	505
E58	Screen	1500*3500	870
E59	Concrete Mixer	0.5m3	1,025
E60	Generator	10kVA	128

Remarks
All Equipement in this table
can be procured in Morocco

Table XVII3.1.11 Production Rate of Each Equipment

		Work	Object	Description	Spec	Capacity																						Note
						Q	Unit	Formula	q (m3)	f	E	D (m)	λ (1/C)	a (m2)	V (m/h)	W (m)	N	Cm (min)	Cm Formula	l (m)	α (min)	Cm1(s)	Cm2(s)	V(km/h)	L(km)	Cm3(s)	Cm4(s)	β (min)	
Ec 1	1	1 Excavation	Clayey Soil	Bulldozer	44t	201.5	m3/h	60*q*f*E/Cm	6.98	1.0	0.70							1.455	0.027l+0.78	25									
Ec 2	1	2 Excavation	Clayey Soil	Bulldozer	32t	133.9	m3/h	60*q*f*E/Cm	4.64	1.0	0.70							1.455	0.027l+0.78	25									
Ec 3	1	3 Excavation	Sandy Soil	Bulldozer	44t	244.7	m3/h	60*q*f*E/Cm	6.98	1.0	0.85							1.455	0.027l+0.78	25									
Ec 4	1	4 Excavation	Sandy Soil	Bulldozer	32t	162.6	m3/h	60*q*f*E/Cm	4.64	1.0	0.85							1.455	0.027l+0.78	25									
Ec 5	1	5 Excavation	Gravelly Soil	Bulldozer	44t	172.7	m3/h	60*q*f*E/Cm	6.98	1.0	0.60							1.455	0.027l+0.78	25									
Ec 6	1	6 Excavation	Gravelly Soil	Bulldozer	32t	133.9	m3/h	60*q*f*E/Cm	4.64	1.0	0.70							1.455	0.027l+0.78	25									
Ec 7	1	7 Embankment	Rock Zone	Bulldozer	32t	128.9	m3/h	60*λ*q*E/Cm	4.64		0.55		1.1					1.320	0.027l+0.78	20									
Ec 8	1	8 Excavation	Rock	Pick Hammer	-	rf. Eq																							
Ec 9	1	9 Ripping	Rock	Ripperdozer	44t	249.2	m3/h	60*a*l*E/Cm			0.50			0.45				1.083	1/24*l+0.25	20									2rippers, moving excluded
Ec 10	1	10 Ripping	Rock	Ripperdozer	32t	174.5	m3/h	60*a*l*E/Cm			0.45			0.35				1.083	1/24*l+0.25	20									2rippers, moving excluded
Ec 11	1	11 Blasting	Rock	Crawler Drill	150kg	rf. Eq																							
Ec 12	1	12 Loading	Sandy Soil	Tractor Shovel	5.4m3	274.0	m3/h	3600*q*f*E/Cm	4.51	0.9	0.75							40											Cm; second
Ec 13	1	13 Loading	Gravelly Soil	Tractor Shovel	5.4m3	237.5	m3/h	3600*q*f*E/Cm	4.51	0.9	0.65							40											Cm; second
Ec 14	1	14 Excavation	Clayey Soil	Backhoe	1.2m3	106.2	m3/h	3600*q*f*E/Cm	1.18	1.0	0.75							30											Cm; second
Ec 15	1	15 Excavation	Sandy Soil	Backhoe	1.2m3	113.3	m3/h	3600*q*f*E/Cm	1.18	1.0	0.80							30											Cm; second
Ec 16	1	16 Excavation	Gravelly Soil	Backhoe	1.2m3	106.2	m3/h	3600*q*f*E/Cm	1.18	1.0	0.75							30											Cm; second
Ec 17	1	17 Hauling	Soil	Dump Truck	32t	49.5	m3/h	60*q*f*E/Cm	17.7	0.9	0.90							17.38	4.6l+α	0.3	16								l; km
Ec 18	1	18 Hauling	Soil	Dump Truck	10t	15.6	m3/h	60*q*f*E/Cm	5.5	0.9	0.90							17.17	3.9l+α	0.3	16								l; km
Ec 19	1	19 Hauling	Rock	Dump Truck	32t	40.5	m3/h	60*q*f*E/Cm	14.5	0.9	0.90							17.38	4.6l+α	0.3	16								l; km
Ec 20	1	20 Hauling	Rock	Dump Truck	10t	12.7	m3/h	60*q*f*E/Cm	4.5	0.9	0.90							17.17	3.9l+α	0.3	16								l; km
Ec 21	1	21 Embankment	Core & Filter M.	Bulldozer	21t	86.5	m3/h	10*E*(18D+13)			0.65	0.30																	
Ec 22	1	22 Compaction	Core Material	Tamping Roller	30t	80.7	m3/h	V*W*D*E/N			0.55	0.20			4,000	2.20	12												
Ec 23	1	23 Compaction	Filter & Rock M.	Vibrating Roller	15-18t	446.6	m3/h	V*W*D*E/N			0.58	0.70			2,750	2.00	5												
Ec 24	1	24 Compaction	Sandy & Gravelly M.	Road Roller	10-12t	rf. Eq																							
Ec 25	1	25 Slope Shaping	Soil	Backhoe w/slope bucket	0.6m3	rf. Eq																							
Ec 26	1	26 Grading	Soil	Grader	3.1m	rf. Eq																							
Ec 27	1	27 Excavation/Loading	Clayey Soil	Backhoe	0.4m3	35.1	m3/h	3600*q*f*E/Cm	0.39	1.0	0.75							30											Cm; second
Ec 28	1	28 Excavation/Loading	Sandy Soil	Backhoe	0.4m3	35.1	m3/h	3600*q*f*E/Cm	0.39	1.0	0.75							30											Cm; second
Ec 29	1	29 Excavation/Loading	Gravelly Soil	Backhoe	0.4m3	35.1	m3/h	3600*q*f*E/Cm	0.39	1.0	0.75							30											Cm; second
Ec 30	1	30 Hauling	Soil	Dump Truck	4t	3.6	m3/h	10m3/(0.35day*8h)																					Backhoe0.4m3,<2.5km
Ec 31	1	31 Hauling	Rock	Dump Truck	4t	2.7	m3/h	10m3/(0.35*1.3day*8h)																					Backhoe0.4m3,<2.5km
Ec 32	1	32 Excavation etc.	Soil	Manual	-	0.3	m3/h	10m3/(4.2day*8h)																					
Ec 33	2	1 Concrete Production	Concrete	Concrete Plant	3m3*2	131.4	m3/h	E*q	180.00		0.73																		
Ec 34	2	2 Concrete Production	RCC	Concrete Plant	3m3*2	131.4	m3/h	E*q	180.0		0.73																		
Ec 35	2	3 Concrete Production	CSG	Concrete Plant	3m3*2	131.4	m3/h	E*q	180.0		0.73																		
Ec 36	2	4 Hauling	Concrete	Agitator Truck	4.4-4.5m3	6.9	m3/h	60*q*E/Cm	4.4		0.90							34.2	3.2*L+α+β		31				1			0	
Ec 37	2	5 Hauling	RCC & CSG	Dump Truck	10t	13.1	m3/h	3600*q*E/Cm	4.17		0.73							839	Cm1+Cm2+Cm3+Cm4	1.0		110	600	6.0	1.0	125	3.9		Cm;second, l;km(out of dam site), L;km(in dam site), 5 DT
Ec 38	2	6 Placing	Concrete	Truck Crane	25t	rf. Eq																							
Ec 39	2	7 Spreading	RCC & CSG	Swamp Bulldozer	16t	85.8	m3/h	10*E*(13*D+9)			0.70	0.25																	
Ec 40	2	8 Compaction	RCC & CSG	Vibrating Roller	11t	245.8	m3/h	V*W*D*E/N			0.69	0.75			1,000	1.90	4												N; designed by a test
Ec 41	2	9 Fromwork	Concrete, RCC & CSG	Manual	-	rf. Eq																							
Ec 42	2	10 Asphalt Pavement	Asphalt	Finisher, Road Roller	2.4-4.5km	rf. UC																							
Ec 43	2	11 Concrete	Reinforcement	Manual	-	rf. UC																							
Ec 44	2	12 Concrete	Masonry	Masonry	-	rf. UC																							
Ec 45	2	13 Concrete	Concrete	Concrete Pump	90-110m3/h	rf. UC																							
Ec 46	3	1 Grouting	Percussion Boring	Clawler Drill	150kg	17.38	m/d	22h*0.79/(1.0*1.0*1.0*1.0*1.0)																					
Ec 47	3	2 Grouting	Rotary Boring	Boring Machine, etc.	5.5kW	103.00	m/d	22h*0.79*60/(1/0.58+0.7+1.0+0.7+6.0)																					
Ec 48	3	3 Grouting	Grouting	Grout Pipe, etc.	7.8kW	5.79	St.no/d	22h*0.79/(1.5+0.5+0.5+0.5)																					
Ec 49	1	33 Excavation/Loading	Gravelly Soil	Backhoe	0.6m3	30.0	m3/h																						
Ec 50	1	34 Compaction	Gravelly Soil	Tamper	60kg	3.3	m3/h																						

Table XVII3.1.11 Attachment

Grouting: Drilling & Injection Rate Calculation

1 Drilling Rate

a Percussion Boring (for Consolidation Grouting)

Condition;

Hole length=	5.0	m
Stage length=	5.0	m

Calculation;

DR=Working hours of machine per day (WM)/ Accumulated time per m (AT)
WM=Working hours per day (WH) * Working rate (WR)
AT=(1m/net drilling time (DT)) + Rod extracting time (RE) + Rod connecting time (RC) + Moving time (MT) + Stage extra time (ST)

DR:	Drilling Rate (m/day)	
WH:	12	hours
WR:	0.79	
DT:	0.6	m/min
RE:	0.7	min/m
RC:	3	min/hole; Hole length 3-6m
MT:	10	min/hole
ST:	30	min/stage
AT=	11.0	min/m
WM=	9.5	hours
DS=	51.8	m/day

b Rotary Boring (for Curtain Grouting)

Condition;

Hole length=	30.0	m

Calculation;

DR=Working hours of machine per day (WM)/ Accumulated time per m (AT)
WM=Working hours per day (WH) * Working rate (WR)
AT=Net drilling time (DT)/m * a1 * a2 * a3 * a4

DR:	Drilling Rate (m/day)	
WH:	12	hours
WR:	0.79	
DT:	50	min/m
a1:	1	Depth coefficient
a2:	1	Direction coefficient
a3:	1	Location coefficient
a4:	1	Diameter coefficient
AT=	50.0	min/m
WM=	9.5	hours
DS=	11.4	m/day

2 Grouting Rate

NS=Working hours of machine per day (WM)/ Net working time per stage (WT)
WM=Working hours per day (WH) * Working rate (WR)
WT=Watering time (WA) + Injection time (IT)

NS:	Number of Stage (5m) /day	
WH:	12	hours
WR:	0.79	
WA:	2	hours/stage
IT:	3.5	hours/stage, Injection + off grouting (Source; 塩瀬さんBari)
WM=	9.5	hours
WT=	5.5	hours/stage
NS=	1.7	stage/day
=	8.5	m/day

3 Injection Pipe Consumption

Injection Pipe Consumption (PC) = m/a*H
m=L/l

m:	10	Average number from hole top EL to injection EL
a:	760	hours, Durable hours
H:	9.5	hours/day, Injection hours / day
L:	15	m, Average length from hole top EL to injection EL
l:	1.5	m, Length / 1pc of pipe
PC=	0.125	pcs/day

Table XVII3.1.12 Equipment Cost (1/4)

Equipment Cost No./Item	Item	Spec	Amount	Unit	Unit Cost (DH)	Amount (DH)	Note
Eq1	L1 Foreman	-	0.03	h	17.3	0.5	T; Working hours in working days
Bulldozer	L3 Common Labor	-	0.04	h	8.0	0.3	T=5.9h
44ton	L16 Operator A	-	0.17	h	15.3	2.6	
Unit:/1hr	M9 Diesel	-	49.96	lit	6.1	304.8	lit; 362ps*0.138
	E1 Bulldozer	44t	1.00	h	673.0	673.0	
	Total					981.2	
Eq2	L1 Foreman	-	0.03	h	17.3	0.5	T; Working hours in working days
Bulldozer	L3 Common Labor	-	0.04	h	8.0	0.3	T=5.9h
32ton	L16 Operator A	-	0.17	h	15.3	2.6	
Unit:/1hr	M9 Diesel	-	39.05	lit	6.1	238.2	lit; 283ps*0.138
	E2 Bulldozer	32t	1.00	h	505.0	505.0	
	Total					746.6	
Eq3	L1 Foreman	-	0.03	h	17.3	0.5	T; Working hours in working days
Bulldozer	L3 Common Labor	-	0.04	h	8.0	0.3	T=5.9h
21ton	L16 Operator A	-	0.17	h	15.3	2.6	
Unit:/1hr	M9 Diesel	-	28.57	lit	6.1	174.3	lit; 207ps*0.138
	E3 Bulldozer	21t	1.00	h	450.0	450.0	
	Total					627.7	
Eq4	L1 Foreman	-	0.03	h	17.3	0.5	T; Working hours in working days
Bulldozer	L3 Common Labor	-	0.04	h	8.0	0.3	T=5.9h
11ton	L16 Operator A	-	0.17	h	15.3	2.6	
Unit:/1hr	M9 Diesel	-	13.80	lit	6.1	84.2	lit; 100ps*0.138
	E4 Bulldozer	11t	1.00	h	205.0	205.0	
	Total					292.6	
Eq5	L1 Foreman	-	0.04	h	17.3	0.7	T; Working hours in working days
Swamp	L3 Common Labor	-	0.04	h	8.0	0.3	T=5.7h
Bulldozer	L16 Operator A	-	0.18	h	15.3	2.7	
16ton	M9 Diesel	-	18.77	lit	6.1	114.5	lit; 136ps*0.138
Unit:/1hr	E5 Swamp Bulldozer	16t	1.00	h	264.0	264.0	
	Total					382.2	
Eq6	L1 Foreman	-	0.03	h	17.3	0.5	T; Working hours in working days
Ripperdozer	L3 Common Labor	-	0.03	h	8.0	0.2	T=7.2h
44ton	L16 Operator A	-	0.14	h	15.3	2.1	
Unit:/1hr	M9 Diesel	-	54.51	lit	6.1	332.5	lit; 395ps*0.138
	E6 Ripperdozer	44t	1.00	h	449.0	449.0	
	Total					784.3	
Eq7	L1 Foreman	-	0.03	h	17.3	0.5	T; Working hours in working days
Ripperdozer	L3 Common Labor	-	0.03	h	8.0	0.2	T=7.2h
32ton	L16 Operator A	-	0.14	h	15.3	2.1	
Unit:/1hr	M9 Diesel	-	43.88	lit	6.1	267.7	lit; 318ps*0.138
	E7 Ripperdozer	32t	1.00	h	367.0	367.0	
	Total					637.5	
Eq8	L1 Foreman	-	0.04	h	17.3	0.7	T; Working hours in working days
Tractor Shovel	L3 Common Labor	-	0.05	h	8.0	0.4	T=4.6h
5.4m3	L16 Operator A	-	0.22	h	15.3	3.4	
Unit:/1hr	M9 Diesel	-	47.73	lit	6.1	291.2	lit; 415ps*0.115
	E8 Tractor Shovel	5.4m3	1.00	h	608.0	608.0	
	Total					903.7	
Eq9	L1 Foreman	-	0.04	h	17.3	0.7	T; Working hours in working days
Tractor Shovel	L3 Common Labor	-	0.05	h	8.0	0.4	T=4.6h
3.2m3	L16 Operator A	-	0.22	h	15.3	3.4	
Unit:/1hr	M9 Diesel	-	22.31	lit	6.1	136.1	lit; 194ps*0.115
	E9 Tractor Shovel	3.2m3	1.00	h	240.0	240.0	
	Total					380.6	
Eq10	L1 Foreman	-	0.04	h	17.3	0.7	T; Working hours in working days
Tractor Shovel	L3 Common Labor	-	0.05	h	8.0	0.4	T=4.6h
2.0m3	L16 Operator A	-	0.22	h	15.3	3.4	
Unit:/1hr	M9 Diesel	-	15.99	lit	6.1	97.5	lit; 139ps*0.115
	E10 Tractor Shovel	2.0m3	1.00	h	157.0	157.0	
	Total					259.0	

Table XVII3.1.12 Equipment Cost (2/4)

Equipment Cost No./Item		Item	Spec	Amount	Unit	Unit Cost (DH)	Amount (DH)	Note
Eq11		L1 Foreman	-	0.04	h	17.3	0.7	T; Working hours in working days
	Backhoe	L3 Common Labor	-	0.05	h	8.0	0.4	T=5.5h
	1.2m3	L16 Operator A	-	0.18	h	15.3	2.7	
	Unit:/1hr	M9 Diesel	-	28.70	lit	6.1	175.1	lit; 208ps*0.138
		E11 Backhoe	1.2m3	1.00	h	582.0	582.0	
		Total					760.9	
Eq12		L1 Foreman	-	0.04	h	17.3	0.7	T; Working hours in working days
	Backhoe	L3 Common Labor	-	0.05	h	8.0	0.4	T=5.5h
	0.6m3	L16 Operator A	-	0.18	h	15.3	2.7	
	Unit:/1hr	M9 Diesel	-	17.39	lit	6.1	106.1	lit; 126ps*0.138
		E12 Backhoe	0.6m3	1.00	h	259.0	259.0	
		Total					368.9	
Eq13		L16 Operator A	-	0.18	h	15.3	2.7	T; Working hours in in-site days
	Backhoe	M9 Diesel	-	11.87	lit	6.1	72.4	T=5.5h
	0.4m3	E14 Backhoe	0.4m3	1.00	h	166.0	166.0	lit; 86ps*0.138
	Unit:/1hr							
		Total					241.1	
Eq14		L1 Foreman	-	0.03	h	17.3	0.5	T; Working hours in working days
	Dump Truck	L3 Common Labor	-	0.04	h	8.0	0.3	T=6.1h
	32t	L16 Operator A	-	0.16	h	15.3	2.4	
	Unit:/1hr	M9 Diesel	-	29.74	lit	6.1	181.4	lit; 472ps*0.063
		E16 Dump Truck	32t	1.00	h	514.0	514.0	
		Tire Attrition	32t	1	h	95.6	95.6	
		Total					794.2	
Eq15		L1 Foreman	-	0.03	h	17.3	0.5	T; Working hours in working days
	Dump Truck	L3 Common Labor	-	0.04	h	8.0	0.3	T=6.1h
	10t	L16 Operator A	-	0.16	h	15.3	2.4	
	Unit:/1hr	M9 Diesel	-	21.11	lit	6.1	128.8	lit; 335ps*0.063
		E17 Dump Truck	10t	1.00	h	132.0	132.0	
		Tire Attrition	10t	1	h	44.3	44.3	
		Total					308.3	
Eq16		L1 Foreman	-	0.03	h	17.3	0.5	T; Working hours in working days
	Dump Truck	L3 Common Labor	-	0.04	h	8.0	0.3	T=6.1h
	7t	L16 Operator A	-	0.16	h	15.3	2.4	
	Unit:/1hr	M9 Diesel	-	14.18	lit	6.1	86.5	lit; 225ps*0.063
		E18 Dump Truck	7t	1.00	h	94.0	94.0	
		Tire Attrition	7t	1	h	19.6	19.6	
		Total					203.3	
Eq17		L16 Operator A	-	0.94	day	152.7	143.5	
	Dump Truck	M9 Diesel	-	44.00	lit	6.1	268.4	
	4t	E20 Dump Truck (Tunnel)	14t	1.16	day	3320.0	3851.2	
	Unit:/1day	Tire Attrition	4t	1	day	68.3	68.3	
		Total					4331.4	
Eq18		L1 Foreman	-	0.03	h	17.3	0.5	T; Working hours in working days
	Dump Truck	L3 Common Labor	-	0.04	h	8.0	0.3	T=6.8h
	14t Tunnel	L16 Operator A	-	0.15	h	15.3	2.3	
	Unit:/1hr	M9 Diesel	-	14.18	lit	6.1	86.5	lit; 225ps*0.063
		E19 Dump Truck	4t	1.00	h	52.0	52.0	
		Tire Attrition	7t	1	h	29.4	29.4	
		Total					171.0	
Eq19		L1 Foreman	-	0.03	h	17.3	0.5	T; Working hours in working days
	Tamping Roller	L3 Common Labor	-	0.04	h	8.0	0.3	T=6.0h
	30t	L16 Operator A	-	0.17	h	15.3	2.6	
	Unit:/1hr	M9 Diesel	-	28.57	lit	6.1	174.3	lit; 207ps*0.138
		E21 Tamping Roller	30t	1.00	h	491.0	491.0	
		Total					668.7	
Eq20		L16 Operator A	-	0.95	day	152.7	145.1	
	Road Roller 1	M9 Diesel	-	20.00	lit	6.1	122.0	
	10-12t	E22 Road Roller	10-12	1.00	day	880.0	880.0	
	Unit:/1day							
		Total					1147.1	

Table XVII3.1.12 Equipment Cost (3/4)

Equipment Cost No./Item		Item	Spec	Amount	Unit	Unit Cost (DH)	Amount (DH)	Note
Eq22		L1 Foreman	-	0.04	h	17.3	0.7	T; Working hours in working days
	Vibrating Roller	L3 Common Labor	-	0.05	h	8.0	0.4	T=5.0h
	15-18t	L16 Operator A	-	0.20	h	15.3	3.1	
	Unit:/1hr	M9 Diesel	-	16.99	lit	6.1	103.6	lit; 149ps*0.114
		E23 Vibrating Roller	15-18t	1.00	h	270.0	270.0	
		Total					377.8	
Eq23		L1 Foreman	-	0.04	h	17.3	0.7	T; Working hours in working days
	Vibrating Roller	L3 Common Labor	-	0.05	h	8.0	0.4	T=5.0h
	11t	L16 Operator A	-	0.20	h	15.3	3.1	
	Unit:/1hr	M9 Diesel	-	15.05	lit	6.1	91.8	lit; 132ps*0.114
		E24 Vibrating Roller	11t	1.00	h	250.0	250.0	
		Total					346.0	
Eq24		L1 Foreman	-	0.04	h	17.3	0.7	T; Working hours in working days
	Vibrating Roller	L3 Common Labor	-	0.05	h	8.0	0.4	T=5.0h
	600kg	L16 Operator A	-	0.20	h	15.3	3.1	
	Unit:/1hr	M9 Diesel	-	0.57	lit	6.1	3.5	lit; 5ps*0.114
		E25 Vibrating Roller	600kg	1.00	h	17.0	17.0	
		Total					24.7	
Eq25		L16 Operator A	-	0.95	day	152.7	145.1	
	Tire Roller 1	M9 Diesel	-	24.00	lit	6.1	146.4	
	8-20t	E26 Tire roller	8-20t	1.00	day	1020.0	1020.0	
	Unit:/1day							
		Total					1311.5	
Eq26		L16 Operator A	-	1.68	day	152.7	256.5	
	Motor Grader	M9 Diesel	-	56.00	lit	6.1	341.6	
	3.1m	E29 Motor Grader	3.1m, :	1.53	day	2560.0	3916.8	
	Unit:/1day							
		Total					4514.9	
Eq27		M9 Diesel	-	62.00	lit	6.1	378.2	lit; 50ps*0.155*8h
	Air Compressor	E35 Air Compressor	5m3/min	1.00	day	269.3	269.3	
	5m3/min							
	Unit:/1day							
		Total					647.5	
Eq28		M9 Diesel	-	136.40	lit	6.1	832.0	lit; 110ps*0.155*8h
	Air Compressor	E36 Air Compressor	10m3/min	1.00	day	547.4	547.4	
	10m3/min							
	Unit:/1day							
		Total					1379.4	
Eq29		L16 Operator A	-	0.19	h	15.3	2.9	T; Working hours in in-site days
	Agitator Truck	M9 Diesel	-	12.78	lit	6.1	78.0	T=5.2h
	4.4-4.5m3	E49 Agitator Truck	4.4-4.5m3	1.00	h	116.0	116.0	lit; 213ps*0.060
	Unit:/1hr							
		Total					196.9	
Eq30		L1 Foreman	-	0.10	h	17.3	1.7	T; Working hours in working days
	Truck Crane	L3 Common Labor	-	0.10	h	8.0	0.8	T=10.1h
	25t	L16 Operator A	-	0.10	h	15.3	1.5	
	Unit:/1hr	M9 Diesel	-	3.70	lit	6.1	22.6	lit; 100ps*0.037
		E51 Truck Crane	25t	1.00	h	460.0	460.0	
		Total					486.6	
Eq31		L16 Operator A	-	1.62	day	152.7	247.4	
	Asphalt Finisher	M9 Diesel	-	34.00	lit	6.1	207.4	
	2.4-4.5m	E52 Finisher (Asphalt	2.4-4.5m	1.67	day	4020.0	6713.4	
	Unit:/1day							
		Total					7168.2	

Table XVII3.1.12 Equipment Cost (4/4)

Equipment Cost No./Item	Item	Spec	Amount	Unit	Unit Cost (DH)	Amount (DH)	Note
Eq32	L16 Operator A	-	0.46	day	152.7	70.2	
Watering Truck	M9 Diesel	-	12.00	lit	6.1	73.2	
5.5-6.5t	E54 Watering Truck	5.5-6.5t	1.00	day	850.0	850.0	
Unit:/1day							
	Total					993.4	
Eq33	L16 Operator A	-	1.45	day	152.7	221.4	
Road Roller 2	M9 Diesel	-	30.00	lit	6.1	183.0	
10-12t	E22 Road Roller	10-12	1.27	day	880.0	1117.6	
Unit:/1day							
	Total					1522.0	
Eq34	L16 Operator A	-	1.50	day	152.7	229.1	
Tire Roller 2	M9 Diesel	-	39.00	lit	6.1	237.9	
8-20t	E26 Tire roller	8-20t	1.36	day	1020.0	1387.2	
Unit:/1day							
	Total					1854.2	
Eq35	M9 Diesel	-	17.00	lit	6.1	103.7	lit; 133*0.128
Crawler Drill	E33 Crawler Drill	150kg(Oil)	1.00	h	593.0	593.0	
150kg							
Unit:/1hr							
	Total					696.7	
Eq36	L2 Skilled Labor	-	11.00	day	79.9	878.9	
Crushing Plant	L3 Common Labor	-	16.00	day	79.9	1278.4	
576m3/d,100t/h	E45 Crushing Plant	576m3/d,100t/h	1.00	day	21100.0	21100.0	
Unit:/1day	Others		10.00	%		2325.7	
	Total					25583.0	
Eq37	L1 Foreman	-	0.50	day	172.7	86.4	
Grouting Central Plant	L2 Skilled Labor	-	0.50	day	79.9	40.0	
150l/min	L3 Common Labor	-	0.50	day	79.9	40.0	
Unit:/1day	L12 Mechanic	-	0.10	day	135.7	13.6	
=3party	L11 Electrician	-	0.10	day	117.6	11.8	
	M9 Diesel	-	161.93	lit	6.1	987.8	
	E46 Generator	60kVA	1.00	day	319.0	319.0	
	E55 Grout Central Plant	150l/min	1.00	day	1358.0	1358.0	
	Others		10.00	%		285.7	
	Total					3142.3	
	Cost/party					1047.4	
Eq38	L2 Skilled Labor	-	1.00	day	79.9	79.9	
Tamper	M9 Diesel	-	1.55	lit	6.1	9.5	5h*0.31
60kg	E28 Tamper	60kg	1.00	day	44.5	44.5	
Unit:/1day							
	Total					133.9	

Table XVII3.1.13 Unit Cost (1/7)

Unit Cost No./Item		Item	Spec	Amount	Unit	Unit Cost (DH)	Amount (DH)	Note
UC1 Excavation Clayey Soil Bulldozer 44t Unit; /1000m3	Eq1	Bulldozer	44t	4.96	h	981.2	4866.8	Ec1
		Total					4866.8	
		Cost/m3					4.87	
UC2 Excavation Clayey Soil Bulldozer 32t Unit; /1000m3	Eq2	Bulldozer	32t	7.47	h	746.6	5577.1	Ec2
		Total					5577.1	
		Cost/m3					5.58	
UC3 Excavation Sandy Soil Bulldozer 44t Unit; /1000m3	Eq1	Bulldozer	44t	4.09	h	981.2	4013.1	Ec3
		Total					4013.1	
		Cost/m3					4.01	
UC4 Excavation Sandy Soil Bulldozer 32t Unit; /1000m3	Eq2	Bulldozer	32t	6.15	h	746.6	4591.6	Ec4
		Total					4591.6	
		Cost/m3					4.59	
UC5 Excavation Gravelly Soil Bulldozer 44t Unit; /1000m3	Eq1	Bulldozer	44t	5.79	h	981.2	5681.1	Ec5
		Total					5681.1	
		Cost/m3					5.68	
UC6 Excavation Gravelly Soil Bulldozer 32t Unit; /1000m3	Eq2	Bulldozer	32t	7.47	h	746.6	5577.1	Ec6
		Total					5577.1	
		Cost/m3					5.58	
UC7 Excavation Rock Material Bulldozer 32t Unit; /1000m3	Eq2	Bulldozer	32t	7.76	h	746.6	5793.6	Ec7
		Total					5793.6	
		Cost/m3					5.79	
UC8 Excavation	L1	Foreman	-	4.00	h	17.3	69.1	
Rock	L2	Skilled Labor	-	32.00	h	8.0	255.7	
Pick Hammer -	L3	Common Labor	-	28.00	h	8.0	223.7	
Unit;	E30	Pick Hammer	-	16.00	day	8.9	142.4	
/100m2	Eq27	Air Compressor	5m3/min	4.00	day	647.5	2590.0	
		Total					3280.9	
		Cost/m2					32.81	
UC9 Excavation Weathered Rock Ripperdozer 44t Unit; /1000m3	Eq6	Ripperdozer	44t	4.01	h	784.3	3145.0	Ec9
		Total					3145.0	
		Cost/m3					3.15	

Table XVII3.1.13 Unit Cost (2/7)

Unit Cost No./Item			Item	Spec	Amount	Unit	Unit Cost (DH)	Amount (DH)	Note
UC10	Excavation	Eq7	Ripperdozer	32t	5.73	h	637.5	3652.9	Ec10
	Weathered Rock								
	Ripperdozer 32t								
	Unit;								
	/1000m3								
			Total					3652.9	
			Cost/m3					3.65	
UC11	Excavation	L1	Foreman	-	0.70	h	17.3	12.1	
	Rock	L13	Rock Driller	-	1.20	h	11.1	13.3	
	Blasting -	L2	Skilled Labor	-	0.90	h	8.0	7.2	
	Unit;	L3	Common Labor	-	1.70	h	8.0	13.6	
	/100m3	M12	Gunpowder	for blasting	29.00	kg	9.3	269.7	
		M13	Detonator	-	5.20	pcs	17.0	88.4	
		M9	Diesel	-	51.00	lit	6.1	311.1	
		M70	Cross Bit	D65mm	0.36	pcs	350.0	126.0	
		M71	Rod	D38mm, L=3m	0.18	pcs	1240.0	223.2	
		M72	Shank Lod	D38mm	0.15	pcs	2319.0	347.9	
		E33	Crawler Drill	150kg(Oil)	3.00	h	593.0	1779.0	
			Total					3191.5	
			Cost/m3					31.92	
UC12	Loading	Eq8	Tractor Shovel	5.4m3	3.65	h	903.7	3298.5	Ec12
	Sandy Soil								
	Tractor Shovel 5.4m3								
	Unit;								
	/1000m3								
			Total					3298.5	
			Cost/m3					3.30	
UC13	Loading	Eq8	Tractor Shovel	5.4m3	4.21	h	903.7	3804.6	Ec13
	Gravelly Soil								
	Tractor Shovel 5.4m3								
	Unit;								
	/1000m3								
			Total					3804.6	
			Cost/m3					3.80	
UC14	Excavation/Loading	Eq11	Backhoe	1.2m3	9.42	h	760.9	7167.7	Ec14
	Clayey Soil								
	Backhoe 1.2m3								
	Unit;								
	/1000m3								
			Total					7167.7	
			Cost/m3					7.17	
UC15	Excavation/Loading	Eq11	Backhoe	1.2m3	8.83	h	760.9	6718.7	Ec15
	Sandy Soil								
	Backhoe 1.2m3								
	Unit;								
	/1000m3								
			Total					6718.7	
			Cost/m3					6.72	
UC16	Excavation/Loading	Eq11	Backhoe	1.2m3	9.42	h	760.9	7167.7	Ec16
	Gravelly Soil								
	Backhoe 1.2m3								
	Unit;								
	/1000m3								
			Total					7167.7	
			Cost/m3					7.17	
UC17	Hauling	Eq14	Dump Truck	32t	20.20	h	794.2	16042.8	Ec17
	Soil								
	Dump Truck 32t								
	Unit;								
	/1000m3								
			Total					16042.8	
			Cost/m3					16.04	
UC18	Hauling	Eq15	Dump Truck	10t	64.10	h	308.3	19762.0	Ec18
	Soil								
	Dump Truck 10t								
	Unit;								
	/1000m3								
			Total					19762.0	
			Cost/m3					19.76	

Table XVII3.1.13 Unit Cost (3/7)

Unit Cost No./Item		Item	Spec	Amount	Unit	Unit Cost (DH)	Amount (DH)	Note
UC19 Hauling Rock Dump Truck 32t Unit; /1000m3	Eq14	Dump Truck	32t	24.69	h	794.2	19608.8	Ec19
		Total					19608.8	
		Cost/m3					19.61	
UC20 Hauling Rock Dump Truck 10t Unit; /1000m3	Eq15	Dump Truck	10t	78.74	h	308.3	24275.5	Ec20
		Total					24275.5	
		Cost/m3					24.28	
UC21 Embankment Core & Filter M Bulldozer 21t Unit; /1000m3	Eq3	Bulldozer	21t	11.56	h	627.7	7256.2	Ec21
		Total					7256.2	
		Cost/m3					7.26	
UC22 Embankment Core Material Tamping Roller 30t Unit; /1000m3	Eq19	Tamping Roller	30t	12.39	h	668.7	8285.2	Ec22
		Total					8285.2	
		Cost/m3					8.29	
UC23 Embankment Filter & Rock M Vibrating Roller 15-18t Unit; /1000m3	Eq23	Vibrating Roller	11t	2.24	h	346.0	775.0	Ec23
		Total					775.0	
		Cost/m3					0.78	
UC24 Compaction	L3	Common Labor	-	0.22	h	8.0	1.8	900m2/day
Sandy & Gravelly M	Eq26	Motor Grader	3.1m, 115ps	0.11	day	4514.9	496.6	
Road Roller etc. 10-12t	Eq20	Road Roller 1	10-12t	0.11	day	1147.1	126.2	
Unit;	Eq25	Tire Roller 1	8-20t	0.11	day	1311.5	144.3	
/100m2	Eq32	Watering Truck	5.5-6.5t	0.11	day	993.4	109.3	
		Total					878.2	
		Cost/m2					8.78	
UC25 Earth Lining	L1	Foreman	-	0.20	h	17.3	3.5	
Soil	L3	Common Labor	-	1.30	h	8.0	10.4	
Backhoe w/bucket 0.6m3 Unit; /100m2	Eq12	Backhoe	0.6m3	3.90	h	368.9	1438.7	
		Total					1452.6	
		Cost/m2					14.53	
UC26 Grading	L3	Common Labor	-	0.08	h	8.0	0.6	1300m2/day
Soil	Eq26	Motor Grader	3.1m, 115ps	0.08	day	4514.9	361.2	
Road Roller etc. 10-12t	Eq20	Road Roller 1	10-12t	0.08	day	1147.1	91.8	
Unit;	Eq25	Tire Roller 1	8-20t	0.08	day	1311.5	104.9	
/100m2	Eq32	Watering Truck	5.5-6.5t	0.08	day	993.4	79.5	
		Total					638.0	
		Cost/m2					6.38	
UC27 Excavation/Loading	L3	Common Labor	-	4.00	h	8.0	32.0	
Soil Backhoe 0.4m3 Unit; /100m3	Eq13	Backhoe	0.4m3	6.00	h	241.1	1446.6	
		Total					1478.6	
		Cost/m3					14.79	
UC28 Hauling Soil Dump Truck 4t Unit; /10m3	Eq17	Dump Truck	4t	0.25	day	4331.4	1082.9	d<1.0km
		Total					1082.9	
		Cost/m3					108.29	

Table XVII3.1.13 Unit Cost (4/7)

Unit Cost No./Item			Item	Spec	Amount	Unit	Unit Cost (DH)	Amount (DH)	Note
UC29	Hauling		Eq17	Dump Truck	4t	0.33	day	4331.4	1429.4	d<1.0km
	Rock									
	Dump Truck	4t								
	Unit;									
	/10m3									
				Total					1429.4	
				Cost/m3					142.94	
UC30	Earth Lining		L3	Common Labor	-	4.20	h	8.0	33.6	
	Soil									
	Manual	-								
	Unit;									
	/10m3									
				Total					33.6	
				Cost/m3					3.36	
UC31	Concrete Production		L16	Operator A	-	1.50	day	152.7	229.1	rf.Ouergha CU42
	Concrete		L3	Common Labor	-	2.00	day	79.9	159.8	
	Concrete Plant etc.	1.5m3*2	M1	Cement	-	150.00	ton	850.0	127500.0	300kg/m3
	Unit;		UC48	Aggregate Production	Aggregate	170.00	m3	109.6	18625.2	fine aggregate
	/1day		UC48	Aggregate Production	Aggregate	410.00	m3	109.6	44919.6	coarse aggregate
	=500m3		M69	Admixture	-	575.00	kg	45.0	25875.0	
			M9	Diesel	-	216.42	lit	6.1	1320.2	125.1*0.173*10
			E43	Concrete Mixing Plant	1.5m3*2	1.00	day	8290.0	8290.0	
			Eq10	Tractor Shovel	2.0m3	10.00	h	259.0	2590.0	
			E47	Generator	100kVA	1.00	day	421.1	421.1	
				Total					229930.0	
				Cost/m3					459.86	
UC32	Concrete Production		L16	Operator A	-	1.50	day	152.7	229.1	rf.Ouergha CU42
	RCC		L3	Common Labor	-	2.00	day	79.9	159.8	
	Concrete Plant etc.	1.5m3*2	M1	Cement	-	87.50	ton	850.0	74375.0	175kg/m3
	Unit;		UC48	Aggregate Production	Aggregate	170.00	m3	109.6	18625.2	fine aggregate
	/1day		UC48	Aggregate Production	Aggregate	410.00	m3	109.6	44919.6	coarse aggregate
	=500m3		M69	Admixture	-	0.00	kg	45.0	0.0	
			M9	Diesel	-	216.42	lit	6.1	1320.2	125.1*0.173*10
			E43	Concrete Mixing Plant	1.5m3*2	1.00	day	8290.0	8290.0	
			Eq10	Tractor Shovel	2.0m3	10.00	h	259.0	2590.0	
			E47	Generator	100kVA	1.00	day	421.1	421.1	
				Total					150930.0	
				Cost/m3					301.86	
UC33	Concrete Production		L16	Operator A	-	1.50	day	152.7	229.1	rf.Ouergha CU42
	CSG		L3	Common Labor	-	2.00	day	79.9	159.8	
	Concrete Plant etc	1.5m3*2	M1	Cement	-	116.67	ton	850.0	99169.5	2/3 of concrete
	Unit;		UC48	Aggregate Production	Aggregate	170.00	m3	87.6	14900.2	fine aggregate* 0.8
	/1day		UC48	Aggregate Production	Aggregate	410.00	m3	87.6	35935.7	coarse aggregate* 0.8
	=500m3		M69	Admixture	-	0.00	kg	45.0	0.0	
			M9	Diesel	-	216.42	lit	6.1	1320.2	125.1*0.173*10
			E43	Concrete Mixing Plant	1.5m3*2	1.00	day	8290.0	8290.0	
			Eq10	Tractor Shovel	2.0m3	10.00	h	259.0	2590.0	
			E47	Generator	100kVA	1.00	day	421.1	421.1	
				Total					163015.6	
				Cost/m3					326.03	
UC34	Hauling		Eq29	Agitator Truck	4.4-4.5m3	0.14	h	196.9	27.6	Ec36
	Concrete									
	Agitator Truck	4.4-4.5m3								
	Unit;									
	/1m3									
				Total					27.6	
				Cost/m3					27.60	
UC35	Hauling		Eq15	Dump Truck	10t	7.63	h	308.3	2352.3	Ec37
	RCC & CSG									
	Dump Truck	10t								
	Unit;									
	/100m3									
				Total					2352.3	
				Cost/m3					23.52	
UC36	Concrete Placing		L1	Foreman	-	0.18	h	17.3	3.1	
	Concrete		L2	Skilled Labor	-	0.50	h	8.0	4.0	
	Truck Crane	25t	L3	Common Labor	-	0.65	h	8.0	5.2	
	Unit;		E51	Truck Crane	25t	0.20	day	4600.0	920.0	
	/10m3									
				Total					932.3	
				Cost/m3					93.23	

Table XVII3.1.13 Unit Cost (5/7)

Unit Cost No.	Unit Cost No./Item		Item	Spec	Amount	Unit	Unit Cost (DH)	Amount (DH)	Note
UC37	Spreading	Eq5	Swamp Bulldozer	16t	11.66	h	382.2	4456.5	Ec39
	RCC & CSG								
	Swamp Bulldozer 16t								
	Unit;								
	/1000m3								
			Total					4456.5	
			Cost/m3					4.46	
UC38	Compaction	Eq23	Vibrating Roller	11t	4.07	h	346.0	1408.2	Ec40
	RCC & CSG								
	Vibrating Roller 11t								
	Unit;								
	/1000m3								
			Total					1408.2	
			Cost/m3					1.41	
UC39	Formwork	L1	Foreman	-	3.60	h	17.3	62.2	
	Concrete Form	L4	Scaffolding Man	-	18.20	h	11.1	201.8	
	Truck Crane etc. 25t	L3	Common Labor	-	11.20	h	8.0	89.5	
	Unit;	E51	Truck Crane	25t	0.80	day	4600.0	3680.0	
	/100m2		Miscellaneous		9.00	%		31.8	9% of labor cost incl. plywood
			Total					4065.3	
			Cost/m2					40.65	
UC40	Pavement	L1	Foreman	-	0.05	h	17.3	0.9	1900 m2/day
	Asphalt	L2	Skilled Labor	-	0.16	h	8.0	1.3	
	Asphalt Finisher et 2.4-4.6m	L3	Common Labor	-	0.32	h	8.0	2.6	
	Unit;	M11	Asphalt Mixture	-	63.18	ton	6000.0	379080.0	
	/100m2	E52	Finisher (Asphalt	2.4-4.5m	0.05	day	4020.0	201.0	
		Eq33	Road Roller 2	10-12t	0.05	day	1522.0	76.1	
		Eq34	Tire Roller 2	8-20t	0.05	day	1854.2	92.7	
		Eq17	Dump Truck	4t	0.05	day	4331.4	216.6	
			Total					379671.2	
			Cost/m2					3796.71	
UC41	Reinforcement	L1	Foreman	-	0.50	h	17.3	8.6	
	Reinforcing Concrete	L6	Reinforcement Worker	-	2.40	h	8.0	19.2	
	Manual -	L3	Common Labor	-	1.90	h	8.0	15.2	
	Unit;	M7	Deformed Steel I	-	1.03	ton	10200.0	10506.0	
	/1t		Miscellaneous		5.00	%		2.2	5% of labor cost
			Total					10551.2	
			Cost/t					10551.20	
UC42	Masonry	L1	Foreman	-	0.20	day	172.7	34.5	
	Masonry	L2	Skilled Labor	-	1.00	day	79.9	79.9	
	Manual -	M6	Rubble	-	1.00	m3	144.0	144.0	
	Unit;	UC59	Mortar Production		0.05	m3	608.1	30.4	
	/1m2								
			Total					288.8	
			Cost/m2					288.80	
UC43	Concrete Placing	L1	Foreman	-	0.07	h	17.3	1.2	100-300 m3/day
	Concrete	L2	Skilled Labor	-	0.28	h	8.0	2.2	
	Concrete Pump 90-110 m3/h	L3	Common Labor	-	0.31	h	8.0	2.5	
	Unit;	L16	Operator A	-	0.06	h	15.3	0.9	T=6.69h
	/10m3	M9	Diesel	-	7.20	lit	6.1	43.9	lit; 270ps*0.062
		E50	Concrete Pumpir	90-110m3/h	0.43	h	474.0	203.8	
			Total					254.5	
			Cost/m3					25.45	
UC44	Embankment	L1	Foreman	-	0.60	h	17.3	10.4	t=1.0m
	Riprap	L2	Skilled Labor	-	1.30	h	8.0	10.4	
	Bulldozer etc. 32t	L3	Common Labor	-	3.00	h	8.0	24.0	
	Unit;	Eq11	Backhoe	1.2m3	4.90	h	760.9	3728.4	
	/100m2	Eq2	Bulldozer	32t	1.20	h	746.6	895.9	
			Total					4669.1	
			Cost/m2					46.69	
UC45	Consolidation Grout	L1	Foreman	-	0.50	day	172.7	86.4	5m/stage, L=10m/hol
	Percussion Boring	L13	Rock Driller	-	1.00	day	110.9	110.9	no core, D65mm
	Crawler Drill 150kg	L2	Skilled Labor	-	1.00	day	79.9	79.9	
	Unit;	L3	Common Labor	-	1.00	day	79.9	79.9	
	/1day	M70	Cross Bit	D65mm	0.62	pcs	350.0	217.0	
	=51.8m	M71	Rod	D38mm, L=3m	0.31	pcs	1240.0	384.4	
		M72	Shank Lod	D38mm	0.26	pcs	2319.0	602.9	
		M97	Sleeve	38mm	0.36	pcs	998.0	359.3	
		Eq35	Crawler Drill	150kg(Oil)	9.50	h	696.7	6618.7	12h*0.79
			Total					8539.4	
			Cost/m					164.85	

Table XVII3.1.13 Unit Cost (6/7)

Unit Cost No.	Unit Cost Item	Code	Item	Spec	Amount	Unit	Unit Cost (DH)	Amount (DH)	Note
UC46	Curtain Grout	L1	Foreman	-	0.50	day	172.7	86.4	Depth; 0-50m, vertical
	Rotary Boring	L2	Skilled Labor	-	1.00	day	79.9	79.9	no core, D46mm
	Boring Machine 5.5kW	L3	Common Labor	-	1.00	day	79.9	79.9	
	Unit;	L12	Mechanic	-	0.10	day	135.7	13.6	
	/1day	L11	Electrician	-	0.10	day	117.6	11.8	
	=11.4m	M98	Metal Crown	D46mm	5.47	pcs	400.0	2188.0	
		M75	Core Tube	D46single, 1.5m	0.23	pcs	2700.0	621.0	
		M76	Core Lifter	D46mm	0.46	pcs	2700.0	1242.0	
		M77	Boring Lod	D40.5mm, L=3m	0.23	pcs	1240.0	285.2	
		M9	Diesel	-	161.93	lit	6.1	987.8	78*0.173*12
		E34	Boring Machine (Rotary)	5.5kw	1.00	day	304.3	304.3	
		E46	Generator	60kVA	1.00	day	319.0	319.0	
			Total					6218.9	
			Cost/m					545.52	
UC47	Grouting	L1	Foreman	-	0.50	day	172.7	86.4	1.7st/day, 1st=5m
	Normal Grout	L2	Skilled Labor	-	1.00	day	79.9	79.9	single shift, D46mm
	Grouting Pump etc. 7.8kW	L3	Common Labor	-	1.00	day	79.9	79.9	
	Unit;	L12	Mechanic	-	0.10	day	135.7	13.6	
	/1day	L11	Electrician	-	0.10	day	117.6	11.8	
	=1.7st	M1	Cement	-	0.05	ton	850.0	42.5	
	=1.7m	M9	Diesel	-	161.93	lit	6.1	987.8	78*0.173*12
		M99	Injection Pipe (inner)	D46mm, 1.5m	0.125	pcs	322.0	40.3	
		M100	Injection Pipe (outer)	D46mm, 1.5m	0.125	pcs	322.0	40.3	
		M	Packer etc.		1.00	no	322.0	322.0	
		E38	Grouting Pump	7.8kw	1.00	day	220.3	220.3	
		E41	Grouting Mixer	2.2kw	1.00	day	114.4	114.4	
		E56	Grout Injection Gauge	120l/min	1.00	day	1066.0	1066.0	
		E57	Grout Data Recorder	-	1.00	day	505.0	505.0	
		Eq37	Grouting Central Plant	150l/min	1.00	day	1047.4	1047.4	
		E46	Generator	60kVA	1.00	day	319.0	319.0	
			Total					4976.6	
			Cost/st					2927.41	
			Cost/m					2927.41	
UC48	Aggregate Production	Eq36	Crushing Plant	576m3/d,100t/h	1.00	day	25583.0	25583.0	
	Aggregate	UC11	Excavation	Rock	678.00	m3	31.9	21641.8	15% loss included
	Crushing Plant 576m3/d,100t/h	UC13	Loading	Gravelly Soil	678.00	m3	3.8	2583.2	15% loss included
	Unit;	UC19	Hauling	Rock	678.00	m3	19.6	13295.6	15% loss included
	/1day								
	=576m3								
			Total					63103.6	
			Cost/m3					109.55	
UC49	Grouting	L1	Foreman	-	0.50	day	172.7	86.4	1.7st/day, 1st=5m
	Dense Grout	L2	Skilled Labor	-	1.00	day	79.9	79.9	single shift, D46mm
	Grouting Pump etc. 7.8kW	L3	Common Labor	-	1.00	day	79.9	79.9	
	Unit;	L12	Mechanic	-	0.10	day	135.7	13.6	
	/1day	L11	Electrician	-	0.10	day	117.6	11.8	
	=1.7st	M1	Cement	-	0.50	ton	850.0	425.0	
	=8.5m	M9	Diesel	-	161.93	lit	6.1	987.8	78*0.173*12
		M99	Injection Pipe (inner)	D46mm, 1.5m	0.125	pcs	322.0	40.3	
		M100	Injection Pipe (outer)	D46mm, 1.5m	0.125	pcs	322.0	40.3	
		M	Packer etc.		1.00	no	322.0	322.0	
		E38	Grouting Pump	7.8kw	1.00	day	220.3	220.3	
		E41	Grouting Mixer	2.2kw	1.00	day	114.4	114.4	
		E56	Grout Injection Gauge	120l/min	1.00	day	1066.0	1066.0	
		E57	Grout Data Recorder	-	1.00	day	505.0	505.0	
		Eq37	Grouting Central Plant	150l/min	1.00	day	1047.4	1047.4	
		E46	Generator	60kVA	1.00	day	319.0	319.0	
			Total					5359.1	
			Cost/st					3152.41	
			Cost/m					630.48	
UC50	Excavation/Loading	Eq12	Backhoe	0.6m3	33.33	h	368.9	12295.4	Ec49
	Soil								
	Backhoe 0.6m3								
	Unit;								
	/1000m3								
			Total					12295.4	
			Cost/m3					12.30	
UC51	Excavation/Loading	Eq13	Backhoe	0.4m3	2.85	h	241.1	687.1	
	Soil								
	Backhoe 0.4m3								
	Unit;								
	/100m3								
			Total					687.1	
			Cost/m3					6.87	

Table XVII3.1.13 Unit Cost (7/7)

Unit Cost No./Item			Item	Spec	Amount	Unit	Unit Cost (DH)	Amount (DH)	Note
UC52 Compaction		L3	Common Labor	-	3.00	day	79.9	239.7	
Soil		Eq38	Tamper	60kg	3.00	day	133.9	401.7	
Tamper	60kg								
Unit;									
/100m3									
			Total					641.4	
			Cost/m3					6.41	
UC53 Backfill		L3	Common Labor	-	4.00	day	79.9	319.6	
Soil		Eq13	Backhoe	0.4m3	3.00	h	241.1	723.3	
Backhoe, Tamper	-	UC52	Tamper	60kg	100.00	m3	6.4	641.0	
Unit;									
/100m3									
			Total					1683.9	
			Cost/m3					16.84	
UC54 Aggregate Production		E58	Screen	1500*3500	1.00	day	870.0	870.0	
Aggregate		UC51	Excavation/Loading	Soil	117.60	m3	6.9	807.9	15% loss included
Screen	1500*3600	UC13	Loading	Gravelly Soil	117.60	m3	3.8	448.1	15% loss included
Unit;		UC28	Hauling	Soil	117.60	m3	108.3	12734.9	15% loss included
/1day									
=100m3									
			Total					14860.9	
			Cost/m3					148.61	
UC55 Concrete Production		L16	Operator A	-	1.50	day	152.7	229.1	rf.Ouergha CU42
Concrete		L3	Common Labor	-	2.00	day	79.9	159.8	
Concrete Mixer	0.5m3	M1	Cement	-	15.00	ton	850.0	12750.0	300kg/m3
Unit;		UC54	Aggregate Production	Aggregate	17.00	m3	148.6	2526.4	fine aggregate
/1day		UC54	Aggregate Production	Aggregate	41.00	m3	148.6	6093.0	coarse aggregate
=50m3		M69	Admixture	-	57.50	kg	45.0	2587.5	
		M9	Diesel	-	29.93	lit	6.1	182.6	17.3*0.173*10
		E59	Concrete Mixer	0.5m3	1.00	day	1025.0	1025.0	
		E60	Generator	10kVA	1.00	day	128.4	128.4	
			Total					25681.8	
			Cost/m3					513.64	
UC56 Embankment		L1	Foreman	-	0.50	day	172.7	86.4	
Riprap		L2	Skilled Labor	-	0.00	day	79.9	0.0	
Backhoe	0.6m3	L3	Common Labor	-	0.69	day	79.9	55.1	
Unit;		M6	Rubble	-	121.00	m3	144.0	17424.0	loss 21% included
/100m3		Eq12	Backhoe	0.6m3	7.60	h	368.9	2803.6	
			Total					20369.1	
			Cost/m2					203.69	
UC57 Pipe Setting		L1	Foreman	-	0.59	day	172.7	101.9	D1,000mm
RC Pipe (D1,000)		L2	Skilled Labor	-	0.59	day	79.9	47.1	
Backhoe	0.4m3	L3	Common Labor	-	1.18	day	79.9	94.3	
Unit;		Eq13	Backhoe	0.4m3	5.88	h	241.1	1417.7	
/10m									
			Total					1661.0	
			Cost/m					166.10	
UC58 Gabion Work		M25	Gabion	-	1.00	m3	500.0	500.0	
Gabion	t=0.3m								
Backhoe	0.6m3								
Unit;									
/1m3			Total					500.0	
			Cost/m3					500.00	
UC59 Mortar Production		L16	Operator A	-	1.50	day	152.7	229.1	
Mortar		L3	Common Labor	-	2.00	day	79.9	159.8	
Concrete Mixer	0.5m3	M1	Cement	-	25.00	ton	850.0	21250.0	500kg/m3
Unit;		UC54	Aggregate Production	Aggregate	50.00	m3	148.6	7430.5	fine aggregate
/1day		M9	Diesel	-	29.93	lit	6.1	182.6	17.3*0.173*10
=50m3		E59	Concrete Mixer	0.5m3	1.00	day	1025.0	1025.0	
		E60	Generator	10kVA	1.00	day	128.4	128.4	
			Total					30405.4	
			Cost/m3					608.11	

Table XVII3.1.14 Table of Unit Cost for Dam Construction

Code		Work	Item	Spec		Unit	Unit Cost		
							Local (DH)	Foreign (DH)	Total (DH)
1	UC1	Excavation	Clayey Soil	Bulldozer	44t	m3	1.70	3.17	4.87
2	UC2	Excavation	Clayey Soil	Bulldozer	32t	m3	1.95	3.63	5.58
3	UC3	Excavation	Sandy Soil	Bulldozer	44t	m3	1.40	2.61	4.01
4	UC4	Excavation	Sandy Soil	Bulldozer	32t	m3	1.61	2.98	4.59
5	UC5	Excavation	Gravelly Soil	Bulldozer	44t	m3	1.99	3.69	5.68
6	UC6	Excavation	Gravelly Soil	Bulldozer	32t	m3	1.95	3.63	5.58
7	UC7	Excavation	Rock Material	Bulldozer	32t	m3	2.03	3.77	5.80
8	UC8	Excavation	Rock	Pick Hammer	-	m2	11.48	21.33	32.81
9	UC9	Excavation	Weathered Rock	Ripperdozer	44t	m3	1.10	2.04	3.14
10	UC10	Excavation	Weathered Rock	Ripperdozer	32t	m3	1.28	2.38	3.66
11	UC11	Excavation	Rock	Blasting	-	m3	11.17	20.75	31.92
12	UC12	Loading	Sandy Soil	Tractor Shovel	5.4m3	m3	1.16	2.14	3.30
13	UC13	Loading	Gravelly Soil	Tractor Shovel	5.4m3	m3	1.33	2.48	3.81
14	UC14	Excavation/Loading	Clayey Soil	Backhoe	1.2m3	m3	2.51	4.66	7.17
15	UC15	Excavation/Loading	Sandy Soil	Backhoe	1.2m3	m3	2.35	4.37	6.72
16	UC16	Excavation/Loading	Gravelly Soil	Backhoe	1.2m3	m3	2.51	4.66	7.17
17	UC17	Hauling	Soil	Dump Truck	32t	m3	5.62	10.43	16.05
18	UC18	Hauling	Soil	Dump Truck	10t	m3	6.92	12.84	19.76
19	UC19	Hauling	Rock	Dump Truck	32t	m3	6.86	12.75	19.61
20	UC20	Hauling	Rock	Dump Truck	10t	m3	8.50	15.78	24.28
21	UC21	Embankment	Core & Filter M	Bulldozer	21t	m3	2.54	4.72	7.26
22	UC22	Embankment	Core Material	Tamping Roller	30t	m3	2.90	5.38	8.28
23	UC23	Embankment	Filter & Rock M	Vibrating Roller	15-18t	m3	0.27	0.51	0.78
24	UC24	Compaction	Sandy & Gravelly M	Road Roller etc.	10-12t	m2	3.08	5.71	8.79
25	UC25	Earth Lining	Soil	Backhoe w/bucket	0.6m3	m2	5.09	9.44	14.53
26	UC26	Grading	Soil	Road Roller etc.	10-12t	m2	2.23	4.15	6.38
27	UC27	Excavation/Loading	Soil	Backhoe	0.4m3	m3	5.17	9.61	14.78
28	UC28	Hauling	Soil	Dump Truck	4t	m3	37.90	70.39	108.29
29	UC29	Hauling	Rock	Dump Truck	4t	m3	50.03	92.91	142.94
30	UC30	Earth Lining	Soil	Manual	-	m3	1.18	2.18	3.36
31	UC31	Concrete Production	Concrete	Concrete Plant etc.	1.5m3*2	m3	160.95	298.91	459.86
32	UC32	Concrete Production	RCC	Concrete Plant etc.	1.5m3*2	m3	105.65	196.21	301.86
33	UC33	Concrete Production	CSG	Concrete Plant etc.	1.5m3*2	m3	114.11	211.92	326.03
34	UC34	Hauling	Concrete	Agitator Truck	4.4-4.5m3	m3	9.66	17.94	27.60
35	UC35	Hauling	RCC & CSG	Dump Truck	10t	m3	8.23	15.29	23.52
36	UC36	Concrete Placing	Concrete	Truck Crane	25t	m3	32.63	60.60	93.23
37	UC37	Spreading	RCC & CSG	Swamp Bulldozer	16t	m3	1.56	2.89	4.45
38	UC38	Compaction	RCC & CSG	Vibrating Roller	11t	m3	0.49	0.92	1.41
39	UC39	Formwork	Concrete Form	Truck Crane etc.	25t	m2	14.23	26.42	40.65
40	UC40	Pavement	Asphalt	Asphalt Finisher etc.	2.4-4.6m	m2	1328.85	2467.86	3796.71
41	UC41	Reinforcement	Reinforcing Concrete	Manual	-	t	3692.92	6858.28	10551.20
42	UC42	Masonry	Masonry	Manual	-	m2	101.08	187.72	288.80
43	UC43	Concrete Placing	Concrete	Concrete Pump	90-110 m3/h	m3	8.91	16.54	25.45
44	UC44	Embankment	Riprap	Bulldozer etc.	32t	m2	16.35	30.35	46.70
45	UC45	Consolidation Grout	Percussion Boring	Crawler Drill	150kg	m	57.70	107.15	164.85
46	UC46	Curtain Grout	Rotary Boring	Boring Machine	5.5kW	m	190.93	354.58	545.51
47	UC47	Grouting	Normal Grout	Grouting Pump etc.	7.8kW	m	204.92	380.56	585.48
48	UC48	Aggregate Production	Aggregate	Crushing Plant	576m3/d,100t/h	m3	38.35	71.21	109.56
49	UC49	Grouting	Dense Grout	Grouting Pump etc.	7.8kW	m	220.67	409.81	630.48

Table XVII3.1.15 Table of Unit Cost for Irrigation Facility Construction

Code		Work	Item	Spec		Unit	Unit Cost		
							Local (DH)	Foreign (DH)	Total (DH)
1	UC1	Excavation	Clayey Soil	Bulldozer	44t	m3	2.44	2.43	4.87
2	UC2	Excavation	Clayey Soil	Bulldozer	32t	m3	2.79	2.79	5.58
3	UC3	Excavation	Sandy Soil	Bulldozer	44t	m3	2.01	2.00	4.01
4	UC4	Excavation	Sandy Soil	Bulldozer	32t	m3	2.30	2.29	4.59
5	UC5	Excavation	Gravelly Soil	Bulldozer	44t	m3	2.84	2.84	5.68
6	UC6	Excavation	Gravelly Soil	Bulldozer	32t	m3	2.79	2.79	5.58
7	UC7	Excavation	Rock Material	Bulldozer	32t	m3	2.90	2.90	5.80
8	UC8	Excavation	Rock	Pick Hammer	-	m2	16.41	16.40	32.81
9	UC9	Excavation	Weathered Rock	Ripperdozer	44t	m3	1.57	1.57	3.14
10	UC10	Excavation	Weathered Rock	Ripperdozer	32t	m3	1.83	1.83	3.66
11	UC11	Excavation	Rock	Blasting	-	m3	15.96	15.96	31.92
12	UC12	Loading	Sandy Soil	Tractor Shovel	5.4m3	m3	1.65	1.65	3.30
13	UC13	Loading	Gravelly Soil	Tractor Shovel	5.4m3	m3	1.91	1.90	3.81
14	UC14	Excavation/Loading	Clayey Soil	Backhoe	1.2m3	m3	3.59	3.58	7.17
15	UC15	Excavation/Loading	Sandy Soil	Backhoe	1.2m3	m3	3.36	3.36	6.72
16	UC16	Excavation/Loading	Gravelly Soil	Backhoe	1.2m3	m3	3.59	3.58	7.17
17	UC17	Hauling	Soil	Dump Truck	32t	m3	8.03	8.02	16.05
18	UC18	Hauling	Soil	Dump Truck	10t	m3	9.88	9.88	19.76
19	UC19	Hauling	Rock	Dump Truck	32t	m3	9.81	9.80	19.61
20	UC20	Hauling	Rock	Dump Truck	10t	m3	12.14	12.14	24.28
21	UC21	Embankment	Core & Filter M	Bulldozer	21t	m3	3.63	3.63	7.26
22	UC22	Embankment	Core Material	Tamping Roller	30t	m3	4.14	4.14	8.28
23	UC23	Embankment	Filter & Rock M	Vibrating Roller	15-18t	m3	0.39	0.39	0.78
24	UC24	Compaction	Sandy & Gravelly M	Road Roller etc.	10-12t	m2	4.40	4.39	8.79
25	UC25	Earth Lining	Soil	Backhoe w/bucket	0.6m3	m2	7.27	7.26	14.53
26	UC26	Grading	Soil	Road Roller etc.	10-12t	m2	3.19	3.19	6.38
27	UC27	Excavation/Loading	Soil	Backhoe	0.4m3	m3	7.39	7.39	14.78
28	UC28	Hauling	Soil	Dump Truck	4t	m3	54.15	54.14	108.29
29	UC29	Hauling	Rock	Dump Truck	4t	m3	71.47	71.47	142.94
30	UC30	Earth Lining	Soil	Manual	-	m3	1.68	1.68	3.36
31	UC31	Concrete Production	Concrete	Concrete Plant etc.	1.5m3*2	m3	229.93	229.93	459.86
32	UC32	Concrete Production	RCC	Concrete Plant etc.	1.5m3*2	m3	150.93	150.93	301.86
33	UC33	Concrete Production	CSG	Concrete Plant etc.	1.5m3*2	m3	163.02	163.01	326.03
34	UC34	Hauling	Concrete	Agitator Truck	4.4-4.5m3	m3	13.80	13.80	27.60
35	UC35	Hauling	RCC & CSG	Dump Truck	10t	m3	11.76	11.76	23.52
36	UC36	Concrete Placing	Concrete	Truck Crane	25t	m3	46.62	46.61	93.23
37	UC37	Spreading	RCC & CSG	Swamp Bulldozer	16t	m3	2.23	2.22	4.45
38	UC38	Compaction	RCC & CSG	Vibrating Roller	11t	m3	0.71	0.70	1.41
39	UC39	Formwork	Concrete Form	Truck Crane etc.	25t	m2	20.33	20.32	40.65
40	UC40	Pavement	Asphalt	Asphalt Finisher etc.	2.4-4.6m	m2	1898.36	1898.35	3796.71
41	UC41	Reinforcement	Reinforcing Concrete	Manual	-	t	5275.60	5275.60	10551.20
42	UC42	Masonry	Masonry	Manual	-	m2	144.40	144.40	288.80
43	UC43	Concrete Placing	Concrete	Concrete Pump	90-110 m3/h	m3	12.73	12.72	25.45
44	UC44	Embankment	Riprap	Bulldozer etc.	32t	m2	23.35	23.35	46.70
45	UC45	Consolidation Grout	Percussion Boring	Crawler Drill	150kg	m	82.43	82.42	164.85
46	UC46	Curtain Grout	Rotary Boring	Boring Machine	5.5kW	m	272.76	272.75	545.51
47	UC47	Grouting	Normal Grout	Grouting Pump etc.	7.8kW	m	292.74	292.74	585.48
48	UC48	Aggregate Production	Aggregate	Crushing Plant	576m3/d,100t/h	m3	54.78	54.78	109.56
49	UC49	Grouting	Dense Grout	Grouting Pump etc.	7.8kW	m	315.24	315.24	630.48
50	UC50	Excavation/Loading	Soil	Backhoe	0.6m3	m3	6.15	6.15	12.30
51	UC51	Excavation/Loading	Soil	Backhoe	0.4m3	m3	3.44	3.43	6.87
52	UC52	Compaction	Soil	Tamper	60kg	m3	3.21	3.20	6.41
53	UC53	Backfill	Soil	Backhoe, Tamper	-	m3	8.42	8.42	16.84
54	UC54	Aggregate Production	Aggregate	Screen	1500*3600	m3	74.31	74.30	148.61
55	UC55	Concrete Production	Concrete	Concrete Mixer	0.5m3	m3	256.82	256.82	513.64
56	UC56	Embankment	Riprap	Backhoe	0.6m3	m3	101.85	101.84	203.69
57	UC57	Pipe Setting	RC Pipe (D1,000)	Backhoe	0.4m3	m	83.05	83.05	166.10
58	UC58	Gabion Work	Gabion	Backhoe	0.6m3	m3	250.00	250.00	500.00
59	UC59	Mortar Production	Mortar	Concrete Mixer	0.5m3	m3	304.06	304.05	608.11

Table XVII3.1.16 Implementation Cost of Dam Construction

Unit Cost No./Item		Item	Spec	Amount	Unit	Base Cost			Cost			Note
						Local (DH)	Foreign (DH)	Total (DH)	Local (DH)	Foreign (DH)	Total (DH)	
IC1 Excavation	UC1	Bulldozer	44t	1.00	m3	1.70	3.17	4.87	1.70	3.17	4.87	UC1, Excavation (Clay)
Excavation-	UC3	Bulldozer	44t	1.00	m3	1.40	2.61	4.01	1.40	2.61	4.01	UC3, Excavation (Sand)
Hauling	UC5	Bulldozer	44t	1.00	m3	1.99	3.69	5.68	1.99	3.69	5.68	UC5, Excavation (Gravel)
Soil	UC13	Tractor Shovel	5.4m3	2.00	m3	1.33	2.48	3.81	2.66	4.96	7.62	UC13, Loading(Clay & Gravel)
/3m3	UC12	Tractor Shovel	5.4m3	1.00	m3	1.16	2.14	3.30	1.16	2.14	3.30	UC12, Loading(Sand)
	UC17	Dump Truck	32t	3.00	m3	5.62	10.43	16.05	16.86	31.29	48.15	UC17, Hauling
		Total							25.77	47.86	73.63	
		Cost/m3							8.59	15.95	24.54	/m3
IC2 Excavation	UC10	Ripperdozer	32t	1.00	m3	1.28	2.38	3.66	1.28	2.38	3.66	UC10, Ripping
	UC11	Blasting	-	1.00	m3	11.17	20.75	31.92	11.17	20.75	31.92	UC11, Blasting
Excavation-	UC7	Bulldozer	32t	2.00	m3	2.03	3.77	5.80	4.06	7.54	11.60	UC7, Moving
Hauling	UC13	Tractor Shovel	5.4m3	2.00	m3	1.33	2.48	3.81	2.66	4.96	7.62	UC13, Loading
Rock	UC19	Dump Truck	32t	2.00	m3	6.86	12.75	19.61	13.72	25.50	39.22	UC19, Hauling
/2m3		Total							32.89	61.13	94.02	
		Cost/m3							16.45	30.57	47.02	/m3
IC3 Embankment	UC1	Bulldozer	44t	1.00	m3	1.70	3.17	4.87	1.70	3.17	4.87	UC1, Excavation
Excavation-	UC13	Tractor Shovel	5.4m3	1.00	m3	1.33	2.48	3.81	1.33	2.48	3.81	UC13, Loading
Compaction	UC17	Dump Truck	32t	1.00	m3	5.62	10.43	16.05	5.62	10.43	16.05	UC17, Hauling
Core Material	UC21	Bulldozer	21t	1.00	m3	2.54	4.72	7.26	2.54	4.72	7.26	UC21, Spreading
/1m3	UC22	Tamping Roller	30t	1.00	m3	2.90	5.38	8.28	2.90	5.38	8.28	UC22, Compaction
		Total							14.09	26.18	40.27	/m3
IC4 Embankment	UC3	Bulldozer	44t	0.12	m3	1.40	2.61	4.01	0.17	0.31	0.48	UC3, Excavation
Excavation-	UC12	Tractor Shovel	5.4m3	0.12	m3	1.16	2.14	3.30	0.14	0.26	0.40	UC12, Loading
Compaction	UC17	Dump Truck	32t	0.12	m3	5.62	10.43	16.05	0.67	1.25	1.92	UC17, Hauling
Random Material	UC21	Bulldozer	21t	0.12	m3	2.54	4.72	7.26	0.30	0.57	0.87	UC21, Spreading
Filter Material	UC23	Vibrating Roller	15-18t	0.12	m3	0.27	0.51	0.78	0.03	0.06	0.09	UC23, Compaction
/0.12m3	UC9	Ripperdozer	44t	0.22	m3	1.10	2.04	3.14	0.24	0.45	0.69	UC9, Excavation, 1/4 volume
Rock Material	UC6	Bulldozer	32t	0.66	m3	1.95	3.63	5.58	1.29	2.40	3.69	UC6, Excavation, 3/4 volume
/0.88m3	UC7	Bulldozer	32t	0.22	m3	2.03	3.77	5.80	0.45	0.83	1.28	UC7, Excavation, 1/4 volume
	UC13	Tractor Shovel	5.4m3	0.88	m3	1.33	2.48	3.81	1.17	2.18	3.35	UC13, Loading
	UC19	Dump Truck	32t	0.88	m3	6.86	12.75	19.61	6.04	11.22	17.26	UC19, Hauling
	UC7	Bulldozer	32t	0.88	m3	2.03	3.77	5.80	1.79	3.32	5.11	UC7, Spreading
	UC23	Vibrating Roller	15-18t	0.88	m3	0.27	0.51	0.78	0.24	0.45	0.69	UC23, Compaction
		Total							12.53	23.30	35.83	/m3
IC5 Dam Riprap (reuse; t=1m)	UC44	Bulldozer etc.	32t	1.00	m2	16.35	30.35	46.70	16.35	30.35	46.70	UC44, Rock setting
Excavation-												
Placing												
Rock Material												
/1m2												
		Total							16.35	30.35	46.70	/m3=m2
IC6 RCD Embankment	UC32	Concrete Plant	1.5m3*2	1.00	m3	105.65	196.21	301.86	105.65	196.21	301.86	UC32, RCC Production
RCC Production-	UC35	Dump Truck	10t	1.00	m3	8.23	15.29	23.52	8.23	15.29	23.52	UC35, Hauling
Placing	UC37	Swamp Bulldoze	16t	1.00	m3	1.56	2.89	4.45	1.56	2.89	4.45	UC37, Spreading
RCC	UC38	Vibrating Roller	11t	1.00	m3	0.49	0.92	1.41	0.49	0.92	1.41	UC38, Compaction
		Total							115.93	215.31	331.24	/m3
IC7 Concrete	UC31	Concrete Plant	1.5m3*2	1.00	m3	160.95	298.91	459.86	160.95	298.91	459.86	UC31, Concrete Production
Concrete Production-	UC34	Agitator Truck	4.4-4.5m3	1.00	m3	9.66	17.94	27.60	9.66	17.94	27.60	UC34, Hauling
Placing	UC36	Truck Crane	25t	0.50	m3	32.63	60.60	93.23	16.32	30.30	46.62	UC36, Placing
Plain Concrete	UC43	Concrete Pump	90-110 m3/h	0.50	m3	8.91	16.54	25.45	4.46	8.27	12.73	UC43, Placing
		Total							191.39	355.42	546.81	/m3
IC8 Concrete	UC31	Concrete Plant	1.5m3*2	1.00	m3	160.95	298.91	459.86	160.95	298.91	459.86	UC31, Concrete Production
Concrete Production-	UC34	Agitator Truck	4.4-4.5m3	1.00	m3	9.66	17.94	27.60	9.66	17.94	27.60	UC34, Hauling
Placing	UC41	Manual	-	0.035	t	3692.92	6858.28	10551.20	129.25	240.04	369.29	UC41, Reinforcement (35kg/m3)
Reinforced Concrete	UC36	Truck Crane	25t	0.00	m3	32.63	60.60	93.23	0.00	0.00	0.00	UC36, Placing
	UC43	Concrete Pump	90-110 m3/h	1.00	m3	8.91	16.54	25.45	8.91	16.54	25.45	UC43, Placing
		Total							308.77	573.43	882.20	/m3
IC9 Formwork	UC39	Truck Crane etc	25t	1.00	m2	14.23	26.42	40.65	14.23	26.42	40.65	UC39, Formwork
Material-												
Setting												
Plywood		Total							14.23	26.42	40.65	/m2
IC10 Normal Curtain Grout	UC46	Boring Machine	5.5kW	1.00	m	190.93	354.58	545.51	190.93	354.58	545.51	UC46, Rotary Boring
Boring-	UC47	Grouting Pump etc.	7.8kW	1.00	m	204.92	380.56	585.48	204.92	380.56	585.48	UC47, Normal Grout
Grouting												
Cement Milk		Total							395.85	735.14	1130.99	/m
IC11 Dense Curtain Grout	UC46	Boring Machine	5.5kW	1.00	m	190.93	354.58	545.51	190.93	354.58	545.51	UC46, Rotary Boring
Boring-	UC49	Grouting Pump etc.	7.8kW	1.00	m	220.67	409.81	630.48	220.67	409.81	630.48	UC48, Dense Grout
Grouting												
Cement Milk		Total							411.60	764.39	1175.99	/m
IC12 Normal Consolidation Grout	UC45	Crawler Drill	150kg	1.00	m	57.70	107.15	164.85	57.70	107.15	164.85	UC46, Rotary Boring
Boring-	UC47	Grouting Pump etc.	7.8kW	1.00	m	204.92	380.56	585.48	204.92	380.56	585.48	UC47, Normal Grout
Grouting												
Cement Milk		Total							262.62	487.71	750.33	/m
IC13 Dense Consolidation Grout	UC45	Crawler Drill	150kg	1.00	m	57.70	107.15	164.85	57.70	107.15	164.85	UC46, Rotary Boring
Boring-	UC49	Grouting Pump etc.	7.8kW	1.00	m	220.67	409.81	630.48	220.67	409.81	630.48	UC48, Dense Grout
Grouting												
Cement Milk		Total							278.37	516.96	795.33	/m
IC14 Embankment (reuse)	UC21	Bulldozer	21t	1.00	m3	2.54	4.72	7.26	2.54	4.72	7.26	UC21, Spreading
Spreading-	UC22	Tamping Roller	30t	1.00	m3	2.90	5.38	8.28	2.90	5.38	8.28	UC22, Compaction
Compaction												
Core Material												
/1m3												
		Total							5.44	10.10	15.54	/m3
IC15 Embankment (reuse)	UC21	Bulldozer	21t	0.12	m3	2.54	4.72	7.26	0.30	0.57	0.87	UC21, Spreading
Spreading-	UC23	Vibrating Roller	15-18t	0.12	m3	0.27	0.51	0.78	0.03	0.06	0.09	UC23, Compaction
Compaction	UC7	Bulldozer	32t	0.88	m3	2.03	3.77	5.80	1.79	3.32	5.11	UC7, Spreading
Random Material	UC23	Vibrating Roller	15-18t	0.88	m3	0.27	0.51	0.78	0.24	0.45	0.69	UC23, Compaction
Filter Material												
/0.12m3												
Rock Material												
/0.88m3												
		Total							2.36	4.40	6.76	/m3

Table XVII3.1.17 Implementation Cost of Irrigation Facility Construction

Unit Cost No./Item	Item		Spec	Amount	Unit	Base Cost			Cost			Note
						Local (DH)	Foreign (DH)	Total (DH)	Local (DH)	Foreign (DH)	Total (DH)	
IC16 Excavation	UC16	Backhoe	1.2m3	1.00	m3	3.59	3.58	7.17	3.59	3.58	7.17	UC16, Excavation/Loading
Excavation-Hauling	UC18	Dump Truck	10t	1.00	m3	9.88	9.88	19.76	9.88	9.88	19.76	UC18, Hauling
Soil		Total							13.47	13.46	26.93	/m3
IC17 Backfill	UC53	Backhoe, Tamper	-	1.00	m3	8.42	8.42	16.84	8.42	8.42	16.84	UC53, Excavation/Loading
Loading-Compaction												
Soil		Total							8.42	8.42	16.84	/m3
IC18 Riprap	UC56	Backhoe	0.6m3	1.00	m3	101.85	101.84	203.69	101.85	101.84	203.69	UC56, Riprap
Material-Placing												
Rock Material /1m3												
		Total							101.85	101.84	203.69	/m3
IC19 Concrete	UC55	Concrete Mixer	0.5m3	1.00	m3	256.82	256.82	513.64	256.82	256.82	513.64	UC55, Concrete Production
Concrete Production-	UC34	Agitator Truck	4.4-4.5m3	1.00	m3	13.80	13.80	27.60	13.80	13.80	27.60	UC34, Hauling
Placing	UC36	Truck Crane	25t	0.50	m3	46.62	46.61	93.23	23.31	23.31	46.62	UC36, Placing
Plain Concrete	UC43	Concrete Pump	90-110 m3/h	0.50	m3	12.73	12.72	25.45	6.37	6.36	12.73	UC43, Placing
	UC39	Truck Crane etc.	25t	6.00	m2	20.33	20.32	40.65	121.98	121.92	243.90	UC39, Formwork
		Total							300.30	300.29	600.59	/m3
IC20 Reinforcement	UC41	Manual	-	1.000	t	5275.60	5275.60	10551.20	5275.60	5275.60	10551.20	UC41, Reinforcement
Manual												
Steel Bar /1t												
		Total							5275.60	5275.60	10551.20	/1t
IC21 Formwork	UC39	Truck Crane etc.	25t	1.00	m2	20.33	20.32	40.65	20.33	20.32	40.65	UC39, Formwork
Material-Setting												
Plywood		Total							20.33	20.32	40.65	/m2
IC22 Masonry	UC42	Manual	-	1.00	m2	144.40	144.40	288.80	144.40	144.40	288.80	UC42, Masonry
Material-Construction												
Rubble		Total							144.40	144.40	288.80	/m3
IC23 Pipe Setting	UC57	Backhoe	0.4m3	1.00	m	83.05	83.05	166.10	83.05	83.05	166.10	UC57, Pipe Setting
Material-Installation												
RC Pipe (D1,000)		Total							83.05	83.05	166.10	/m
IC24 Gabion Work	UC58	Backhoe	0.6m3	1.00	m3	250.00	250.00	500.00	250.00	250.00	500.00	UC58, Gabion Work
Material-Installation												
Gabion (t=0.3m)		Total							250.00	250.00	500.00	/m3

Table XVII3.1.18 Table of Implementation Cost

Code		Work	Item	Unit	Unit Cost Local (DH)	Foreign (DH)	Total (DH)	Note
Dam Construction Work								
1	IC1	Excavation	Soil	m3	8.59	15.95	24.54	sand:clay:gravel=1:1:1
2	IC2	Excavation	Rock	m3	32.89	61.13	94.02	weathered:hard=1:1
3	IC3	Embankment	Core Material	m3	14.09	26.18	40.27	
4	IC4	Embankment	Random Material	m3	12.53	23.30	35.83	filter:12%, rock:88%
5	IC5	Dam Riprap (reuse; t=1m)	Rock Material	m3	16.35	30.35	46.70	ripper:blasting=1:1
6	IC6	RCD Embankment	RCC	m3	115.93	215.31	331.24	
7	IC7	Concrete	Plain Concrete	m3	191.39	355.42	546.81	
8	IC8	Concrete	Reinforced Concrete	m3	308.77	573.43	882.20	
9	IC9	Formwork	Plywood	m2	14.23	26.42	40.65	
10	IC10	Normal Curtain Grout	Cement Milk	m	395.85	735.14	1130.99	
11	IC11	Dense Curtain Grout	Cement Milk	m	411.60	764.39	1175.99	
12	IC12	Normal Consolidation Grout	Cement Milk	m	262.62	487.71	750.33	
13	IC13	Dense Consolidation Grout	Cement Milk	m	278.37	516.96	795.33	
14	IC14	Embankment (reuse)	Core Material	m3	5.44	10.10	15.54	in-situ material
15	IC15	Embankment (reuse)	Random Material	m3	2.36	4.40	6.76	filter:12%, rock:88%, in-situ material
Irrigation Facility Construction Work								
16	IC16	Excavation	Soil	m3	13.47	13.46	26.93	
17	IC17	Backfill	Soil	m3	8.42	8.42	16.84	
18	IC18	Riprap	Rock Material	m3	101.85	101.84	203.69	
19	IC19	Concrete	Plain Concrete	m3	300.30	300.29	600.59	
20	IC20	Reinforcement	Steel Bar	kg	5275.60	5275.60	10551.20	
21	IC21	Formwork	Plywood	m2	20.33	20.32	40.65	
22	IC22	Masonry	Rubble	m3	144.40	144.40	288.80	
23	IC23	Pipe Setting	RC Pipe (D1,000)	m	83.05	83.05	166.10	
24	IC24	Gabion Work	Gabion (t=0.3m)	m3	250.00	250.00	500.00	

Table XVIII3.1.19: Cost Estimate Table

	Cost Amount (1,000DH)														
	No.5 N'Fifikh			**No.9 Taskourt**			**No.10 Timkit**			**No.17 Azghar**			**Total**		
	Local	**Foreign**	**Total**	**Local**	**Foreign**	**Total**	**Local**	**Foreign**	**Total**	**Local**	**Foreign**	**Total**	**Local**	**Foreign**	**Total**
A Dam	H=47.5m, Vol.=678,400m3			H=73.5m, Vol.=415,000m3			H=64.5m, Vol.=227,600m3			H=42.5m, Vol.=769,800m3					
1 River Diversion Works	6,325	11,745	18,070	1,823	3,384	5,207	1,161	2,156	3,317	6,776	12,588	19,364	16,085	29,873	45,958
2 Foundation Excavation	2,676	4,971	7,647	6,025	11,196	17,221	3,673	6,826	10,499	3,356	6,234	9,590	15,730	29,227	44,957
3 Foundation Treatment Works	1,245	2,313	3,558	3,392	6,300	9,692	6,183	11,484	17,667	1,897	3,522	5,419	12,717	23,619	36,336
4 Dam Emnbankment	4,041	7,515	11,556	61,548	114,308	175,856	29,996	55,708	85,704	5,606	10,425	16,031	101,191	187,956	289,147
5 Spillway	24,670	45,820	70,490	716	1,331	2,047	347	643	990	12,352	22,941	35,293	38,085	70,735	108,820
6 Outlet Works	1,283	2,383	3,666	842	1,565	2,407	208	386	594	422	783	1,205	2,755	5,117	7,872
7 Gate and Pipe	2,998	5,566	8,564	4,340	8,059	12,398	1,203	2,235	3,438	4,347	8,072	12,419	12,888	23,932	36,820
(8 Sabo Dam, No.10 Timkit only)	-	-	-	-	-	-	6,601	12,261	18,862	-	-	-	6,601	12,261	18,862
Sub-total	43,238	80,313	123,551	78,686	146,143	224,828	49,372	91,699	141,071	34,756	64,565	99,321	206,052	382,720	588,772
8 Overhead and Profit of Contractor	6,860	12,742	19,602	17,692	32,860	50,552	7,457	13,850	21,307	4,612	8,566	13,178	36,621	68,018	104,639
Sub-total (Direct Construction Cost)	50,098	93,055	143,153	96,378	179,003	275,380	56,829	105,549	162,378	39,368	73,131	112,499	242,673	450,738	693,411
9 Physical Contingency (10%)	5,010	9,306	14,316	9,638	17,900	27,538	5,683	10,555	16,238	3,937	7,313	11,250	24,268	45,074	69,342
Sub-total (1-9)	55,108	102,361	157,469	106,016	196,903	302,918	62,512	116,104	178,616	43,305	80,444	123,749	266,941	495,812	762,753
10 Price Contingency (3%/year)	12,668	23,530	36,198	24,370	45,263	69,633	14,370	26,689	41,059	9,955	18,492	28,447	61,363	113,974	175,337
Sub-total (1-10)	67,776	125,891	193,667	130,386	242,166	372,551	76,882	142,793	219,675	53,260	98,936	152,196	328,304	609,786	938,090
11 Value Added Tax (14%)	9,489	17,625	27,114	18,254	33,903	52,157	10,764	19,991	30,755	7,456	13,851	21,307	45,963	85,370	131,333
Grand Total	77,200	143,500	220,700	148,600	276,000	424,600	87,600	162,700	250,300	60,700	112,700	173,400	374,100	694,900	1,069,000
Unit Cost (DH/m3)			325			1,023			1,100			225			
B Irrigation Facilities	Area=1,000ha			Area=4,500ha			Area=3,060ha			Area=2,000ha					
1 Miain Canal	6,410	6,410	12,820	19,276	19,276	38,552	7,946	7,946	15,892	6,111	6,111	12,222	39,743	39,743	79,486
2 Structures	10,647	10,647	21,294	42,268	42,268	84,536	44,535	44,535	89,070	28,159	28,159	56,318	125,609	125,609	251,218
Sub-total	17,057	17,057	34,114	61,544	61,544	123,088	52,481	52,481	104,962	34,270	34,270	68,540	165,352	165,352	330,704
3 Overhead and Profit of Contractor	1,194	1,194	2,388	4,308	4,308	8,616	3,674	3,674	7,348	2,399	2,399	4,798	11,575	11,575	23,150
Sub-total (Direct Construction Cost)	18,251	18,251	36,502	65,852	65,852	131,704	56,155	56,155	112,310	36,669	36,669	73,338	176,927	176,927	353,854
4 Physical Contingency (10%)	1,825	1,825	3,650	6,585	6,585	13,170	5,616	5,616	11,232	3,667	3,667	7,334	17,693	17,693	35,386
Sub-total (1-9)	20,076	20,076	40,152	72,437	72,437	144,874	61,771	61,771	123,542	40,336	40,336	80,672	183,045	183,045	366,090
5 Price Contingency (3%/year)	4,617	4,617	9,234	16,661	16,661	33,322	14,207	14,207	28,414	9,277	9,277	18,554	44,762	44,762	89,524
Sub-total (1-10)	24,693	24,693	49,386	89,098	89,098	178,196	75,978	75,978	151,956	49,613	49,613	99,226	227,807	227,807	455,614
6 Value Added Tax (14%)	3,457	3,457	6,914	12,474	12,474	24,948	10,637	10,637	21,274	6,946	6,946	13,892	33,514	33,514	67,028
Grand Total	28,150	28,150	56,300	101,570	101,570	203,100	86,610	86,610	173,200	56,550	56,550	113,100	272,880	272,880	545,760
Unit Cost (DH/ha)			56,300			45,100			56,600			56,600			
C Total of Dam and Irrigation			277,000			627,700			423,500			286,500			1,614,760

Table XVII3.1.20: Breakdown of Construction Cost for N'Fifikh Dam (1/5)

	Work Item	Unit	Quantity	Local Currency Unit Cost (DH)	Local Currency Amount (1,000DH)	Foreign Unit Cost (DH)	Foreign Amount (1,000DH)	Total (1,000DH)	Remarks
A	Dam								
1	River Diversion Works								
1-1	Inlet/Outlet Channel								
	Excavation / hauling, soil & gravel	m^3	2,800	8.59	24	15.95	45	69	
	- ditto -, rock	m^3	0	32.89	0	61.13	0	0	
	Backfill, soil	m^3	300	2.36	1	4.40	1	2	
	Reinforced concrete	m^3	1,224	308.77	378	573.43	702	1,080	
	Form work	m^2	810	14.23	12	26.42	21	33	
	Miscellaneous works	L.S	1	20,750.00	21	38,450.00	38	59	5% above
	Sub-total				436		807	1,243	
1-2	Culvert Channel								
	Excavation and hauling, gravel		0	8.59	0	15.95	0	0	
	- ditto -, rock		24,200	32.89	796	61.13	1,479	2,275	
	Reinforced concrete	m^3	11,760	308.77	3,631	573.43	6,744	10,375	
	Plain concrete (Plugging)	m^3	5,000	191.39	957	355.42	1,777	2,734	
	Form work	m^2	5,050	14.23	72	26.42	133	205	
	Consolidation grouting	m			0		0	0	Estimated in
	Curtain grouting	m			0		0	0	foundation treatment
	Miscellaneous works	L.S	1	272,800.00	273	506,650.00	507	780	5% above
	Sub-total				5,729		10,640	16,369	
1-3	Coffer Dam								
	Excavation, gravel	m^3			0		0	0	Estimated in dam foundation excavation
	Embankment, soil	m^3	64,600	2.36	152	4.40	284	436	
	Miscellaneous works	L.S	1	7,600.00	8	14,200.00	14	22	5% above
	Sub-total				160		298	458	
	Total				6,325		11,745	18,070	

Table XVII3.1.20: Breakdown of Construction Cost for N'Fifikh Dam (2/5)

	Work Item	Unit	Quantity	Local Currency Unit Cost (DH)	Local Currency Amount (1,000DH)	Foreign Unit Cost (DH)	Foreign Amount (1,000DH)	Total (1,000DH)	Remarks
2	Foundation Excavation								
	Excavation / hauling, soil & gravel	m^3	123,900	8.59	1,064	15.95	1,976	3,040	
	- ditto -, rock	m^3	49,000	32.89	1,612	61.13	2,995	4,607	
	Miscellaneous works	L.S	1	0.00	0	0.00	0	0	0% above
	Sub-total				2,676		4,971	7,647	
3	Foundation Treatment Works								
	Curtain grouting work	m	3,146	395.85	1,245	735.14	2,313	3,558	
	Miscellaneous works	L.S	1	0.00	0	0.00	0	0	0% above
	Sub-total				1,245		2,313	3,558	
4	Dam Embankment								
	Impervious zone	m^3	142,500	5.44	775	10.10	1,439	2,214	in-situ material
	Filter and Transition zone	m^3	346,700	2.36	818	4.40	1,525	2,343	in-situ material
	Filter and Transition zone	m^3	168,900	12.53	2,116	23.30	3,935	6,051	quarry
	Rip-rap	m^3	20,300	16.35	332	30.35	616	948	
	Miscellaneous works	L.S	1	0.00	0	0.00	0	0	0% above
	Sub-total				4,041		7,515	11,556	
	Total				7,962		14,799	22,761	

Table XVII3.1.20: Breakdown of Construction Cost for N'Fifikh Dam (3/5)

	Work Item	Unit	Quantity	Local Currency Unit Cost (DH)	Local Currency Amount (1,000DH)	Foreign Unit Cost (DH)	Foreign Amount (1,000DH)	Total (1,000DH)	Remarks
5	Spillway								
	Excavation / hauling, soil & gravel	m^3	343,300	8.59	2,949	15.95	5,476	8,425	
	- ditto -, rock	m^3	85,800	32.89	2,822	61.13	5,245	8,067	
	Backfill, soil	m^3	54,600	2.36	129	4.40	240	369	
	Reinforced concrete	m^3	59,665	308.77	18,423	573.43	34,214	52,637	
	Form work	m^2	24,405	14.23	347	26.42	645	992	
	Miscellaneous works	L.S	1	0.00	0	0.00	0	0	0% above
	Sub-total				24,670		45,820	70,490	
6	Outlet Works								
6-1	Inlet Structure								
	Reinforced concrete	m^3	1,180	308.77	364	573.43	677	1,041	
	Form work	m^2	193	14.23	3	26.42	5	8	
	Miscellaneous works	L.S	1	0.00	0	0.00	0	0	0% above
	Sub-total				367		682	1,049	
6-2	Plug Works								
	Plain concrete	m^3	4,642	191.39	888	355.42	1,650	2,538	
	Miscellaneous works	L.S	1	0.00	0	0.00	0	0	0% above
	Sub-total				888		1,650	2,538	
6-3	Outlet Structure								
	Reinforced concrete	m^3	80	308.77	25	573.43	46	71	
	Form work	m^2	201	14.23	3	26.42	5	8	
	Miscellaneous works	L.S	1	0.00	0	0.00	0	0	0% above
	Sub-total				28		51	79	
	Total				25,953		48,203	74,156	

Table XVII3.1.20: Breakdown of Construction Cost for N'Fifikh Dam (4/5)

	Work Item	Unit	Quantity	Local Currency Unit Cost (DH)	Local Currency Amount (1,000DH)	Foreign Unit Cost (DH)	Foreign Amount (1,000DH)	Total (1,000DH)	Remarks
7	Gate and Pipe								
7-1	Inlet works								
	D500mm Slide gate with hoist	pcs	2	350,000	700	650,000	1,300	2,000	2,000 DH/mm, incl. installation
	D1000mm Steel pipe	m	75	2,380	179	4,420	332	511	6,800 DH/m, -do-
	Sub-total				879		1,632	2,511	
7-2	Outlet works								
	D1000mm Steel pipe	m	205	2,380	488	4,420	906	1,394	6,800 DH/m, incl. installation
	D1000mm Jet flow gate with hoist	pcs	1	1,400,000	1,400	2,600,000	2,600	4,000	4,000 DH/mm, -do-
	Flow meter	pcs	1	87,500	88	162,500	163	251	250,000 DH/pcs, -do-
	Sub-total				1,976		3,669	5,645	
7-3	Others	L.S	1	142,750	143	265,050	265	408	5% above
	Total				2,998		5,566	8,564	
	Total (1-7)				**43,238**		**80,313**	**123,551**	
8	Overhead and Profit of Contractor								
	Overhead	L.S	1	4,024,000	4,024	7,474,700	7,475	11,499	10% total of 1-6
	Profit of Contractor	L.S	1	2,835,720	2,836	5,267,283	5,267	8,103	6% above
	Total				6,860		12,742	19,602	
	Total (Direct Construction Cost; 1-8)				**50,098**		**93,055**	**143,153**	
9	Physical Contingency	L.S	1	5,009,800	5,010	9,305,505	9,306	14,316	10% total of 1-8
	Total (1-9)				**55,108**		**102,361**	**157,469**	
10	Price Contingency (3% / year)	L.S	1	12,667,889	12,668	23,530,130	23,530	36,198	23% total of 1-9, 7years
	Total (1-10)				**67,776**		**125,891**	**193,667**	
11	Value Added Tax	L.S	1	9,488,640	9,489	17,624,747	17,625	27,114	14% total of 1-10
	Grand Total				**77,200**		**143,500**	**220,700**	

Table XVII3.1.20: Breakdown of Construction Cost for N'Fifikh Dam (5/5)

	Work Item	Unit	Quantity	Local Currency Unit Cost (DH)	Local Currency Amount (1,000DH)	Foreign Unit Cost (DH)	Foreign Amount (1,000DH)	Total (1,000DH)	Remarks
B	Irrigation Facilities								
1	Main Canal								
	Main Canal	m	9,200	233.60	2,149	233.60	2,149	4,298	
	Branch Canal	m	9,250	315.36	2,917	315.36	2,917	5,834	
	Main Feeder Canal 1	m	2,500	97.20	243	97.20	243	486	
	Main Feeder Canal 2	m	4,450	247.44	1,101	247.44	1,101	2,202	
	Sub-total				6,410		6,410	12,820	
2	Structures								
	Head work	pcs	3	190,675	572	190,675	572	1,144	
	Siphon	pcs	9	188,845	1,700	188,845	1,700	3,400	
	Offtake	pcs	32	167,810	5,370	167,810	5,370	10,740	
	Spill way	pcs	4	3,555	14	3,555	14	28	
	Check	pcs	8	113,100	905	113,100	905	1,810	
	Aqueduct	pcs	1	15,250	15	15,250	15	30	
	Cross Drain	pcs	63	10,725	676	10,725	676	1,352	
	Bridge	pcs	25	8,405	210	8,405	210	420	
	On-farm facilities	ha	1,000	1,185	1,185	1,185	1,185	2,370	
	Sub-total				10,647		10,647	21,294	
	Total (1-2)				**17,057**		**17,057**	**34,114**	
3	Overhead and Profit of Contractor	L.S	1	1,193,990	1,194	1,193,990.00	1,194	2,388	7% above
	Total (Direct Construction Cost; 1-3)				**18,251**		**18,251**	**36,502**	
4	Physical Contingency	L.S	1	1,825,100	1,825	1,825,100.00	1,825	3,650	10% total of 1-3
	Total (1-4)				**20,076**		**20,076**	**40,152**	
5	Price Contingency	L.S	1	4,617,480	4,617	4,617,480.00	4,617	9,234	23% total of 1-4, 7years
	Total (1-5)				**24,693**		**24,693**	**49,386**	
6	Value Added Tax	L.S	1	3,457,020	3,457	3,457,020.00	3,457	6,914	14% total of 1-5
	Grand Total				**28,150**		**28,150**	**56,300**	

Table XVII3.1.21 Irrigation Facility ; Construction Volume & Cost Estimate (Main Canal) (1/3)

Item	St.	Dis.	Type	Condition					Area				Volume (m3) & Amount (1,000DH)											Unit Cost
				B	H	Wall (top, bottom)		Slab	Excavation	Backfill	Concrete	Masonry	Excavation		Backfill		Concrete (m3)		Steel Bar (t)		Masonry		Total	Cost
				(m)	(m)	t1 (m)	t2 (m)	t3 (m)	(m2)	(m2)	(m2)	(m2)	Vol.	Amount	Vol.	Amount	Vol.	Amount	Vol.	Amount	Vol.	Amount	Amount	(DH/m)
												Unit Cost (DH)	26.93		16.84		600.59		10,551.20		288.80			
1 No.5 N'Fifikh																								
1.1 Main Canal	0+ 0		Stone Lining	0.8	1	-	-	-	7.32	6.61	0	0.61												
	2+ 200	2200	Stone Lining	0.8	1	-	-	-	7.32	6.61	0	0.61	16,104	433.7	14,542	244.9					1,342	387.6		
	2+ 200	0	Stone Lining	0.62	0.8	-	-	-	5.8	5.74	0	0.53												
	6+ 900	4700	Stone Lining	0.62	0.8	-	-	-	5.8	5.74	0	0.53	27,260	734.1	26,978	454.3					2,491	719.4		
	6+ 900	0	Flume	0.65	0.8	0.2	-	0.2	2.45	1.4	0.53	0												
	9+ 200	2300	Flume	0.65	0.8	0.2	-	0.2	2.45	1.4	0.53	0	5,635	151.8	3,220	54.2	1,219	732.12	36.6	386.17	0	0.0		
												Sub-total	48,999	1,320	44,740	753	1,219	732	37	386	3,833	1,107	4,298	467.20
1.2 Branch	0+ 0		Flume	1.35	0.89	0.2	-	0.2	3.532	1.624	0.706	0												
	0+ 59	59	Flume	1.35	0.89	0.2	-	0.2	3.532	1.624	0.706	0	208	5.6	96	1.6	42	25.0	1.2	12.7	0	0.0		
	0+ 67		Flume	1.35	0.89	0.2	-	0.2	3.532	1.624	0.706	0												
	0+ 175	108	Flume	1.35	0.89	0.2	-	0.2	3.532	1.624	0.706	0	381	10.3	175	3.0	76	45.8	2.3	24.3	0	0.0		
	0+ 195		Flume	1.35	0.89	0.2	-	0.2	3.532	1.624	0.706	0												
	1+ 0	805	Flume	1.35	0.89	0.2	-	0.2	3.532	1.624	0.706	0	2,843	76.6	1,307	22.0	568	341.3	17.0	179.4	0			
	2+ 0	1000	Flume	1.35	0.89	0.2	-	0.2	3.532	1.624	0.706	0	3,532	95.1	1,624	27.4	706	424.0	21.2	223.7	0			
	3+ 0	1000	Flume	1.35	0.89	0.2	-	0.2	3.532	1.624	0.706	0	3,532	95.1	1,624	27.4	706	424.0	21.2	223.7	0			
	3+ 800	800	Flume	1.35	0.89	0.2	-	0.2	3.532	1.624	0.706	0	2,825	76.1	1,299	21.9	565	339.2	16.9	178.3	0			
	3+ 860		Flume	1.35	0.89	0.2	-	0.2	3.532	1.624	0.706	0												
	4+ 0	140	Flume	1.35	0.89	0.2	-	0.2	3.532	1.624	0.706	0	494	13.3	227	3.8	99	59.4	3.0	31.7	0			
	4+ 150	150	Flume	1.35	0.89	0.2	-	0.2	3.532	1.624	0.706	0	530	14.3	244	4.1	106	63.6	3.2	33.8	0			
	4+ 900	750	Flume	1.35	0.89	0.2	-	0.2	3.532	1.624	0.706	0	2,649	71.3	1,218	20.5	530	318.0	15.9	167.8	0			
	5+ 60		Flume	1.1	0.76	0.2	-	0.2	2.746	1.306	0.604	0												
	5+ 80	20	Flume	1.1	0.76	0.2	-	0.2	2.746	1.306	0.604	0	55	1.5	26	0.4	12	7.3	0.4	4.2	0			
	5+ 260		Flume	1.1	0.76	0.2	-	0.2	2.746	1.306	0.604	0												
	6+ 0	740	Flume	1.1	0.76	0.2	-	0.2	2.746	1.306	0.604	0	2,032	54.7	966	16.3	447	268.4	13.4	141.4	0			
	6+ 50	50	Flume	1.1	0.76	0.2	-	0.2	2.746	1.306	0.604	0	137	3.7	65	1.1	30	18.1	0.9	9.5	0			
	6+ 80		Flume	1.1	0.76	0.2	-	0.2	2.746	1.306	0.604	0												
	7+ 0	920	Flume	1.1	0.76	0.2	-	0.2	2.746	1.306	0.604	0	2,526	68.0	1,201	20.2	556	333.7	16.7	176.2	0			
	7+ 150	150	Flume	1.1	0.76	0.2	-	0.2	2.746	1.306	0.604	0	412	11.1	196	3.3	91	54.4	2.7	28.5	0			
	7+ 830	680	Flume	0.7	0.57	0.2	-	0.2	1.748	0.901	0.448	0	1,189	32.0	613	10.3	305	183.0	9.1	96.0	0			
	7+ 870		Flume	0.7	0.57	0.2	-	0.2	1.748	0.901	0.448	0												
	8+ 0	130	Flume	0.7	0.57	0.2	-	0.2	1.748	0.901	0.448	0	227	6.1	117	2.0	58	35.0	1.7	17.9	0			
	8+ 640	640	Flume	0.7	0.57	0.2	-	0.2	1.748	0.901	0.448	0	1,119	30.1	577	9.7	287	172.2	8.6	90.7	0			
	8+ 660		Flume	0.7	0.57	0.2	-	0.2	1.748	0.901	0.448	0												
	8+ 700	40	Flume	0.7	0.57	0.2	-	0.2	1.748	0.901	0.448	0	70	1.9	36	0.6	18	10.8	0.5	5.3	0			
	8+ 720		Flume	0.7	0.57	0.2	-	0.2	1.748	0.901	0.448	0												
	9+ 0	280	Flume	0.7	0.57	0.2	-	0.2	1.748	0.901	0.448	0	489	13.2	252	4.3	125	75.3	3.8	40.1	0			
	9+ 150	150	Flume	0.7	0.57	0.2	-	0.2	1.748	0.901	0.448	0	262	7.1	135	2.3	67	40.4	2.0	21.1	0			
												Sub-total	25,512	687	11,999	202	5,393	3,239	162	1,706	0	0	5,834	637.62
1.3 Feeder 1	0+ 0		Flume	0.15	0.2	0.2	-	0.2	0.54	0.32	0.19	0												
	2+ 500	2500	Flume	0.15	0.2	0.2	-	0.2	0.54	0.32	0.19	0	1,350	36.4	800	13.5	475	285.3	14.3	150.9	0			
												Sub-total	1,350	36	800	13	475	285	14	151	0	0	486	194.40
1.4 Feeder 2	0+ 0		Flume	0.5	0.7	0.2	-	0.2	1.98	1.17	0.46	0												
	4+ 450	4450	Flume	0.5	0.7	0.2	-	0.2	1.98	1.17	0.46	0	8,811	237.3	5,207	87.7	2,047	1,229.4	61.4	647.8	0			
												Sub-total	8,811	237	5,207	88	2,047	1,229	61	648	0	0	2,202	494.88
												Total	84,672	2,280	62,746	1,057	9,134	5,486	274	2,891	3,833	1,107	12,821	470.48

Table XVII3.1.21 Irrigation Facility ; Construction Volume & Cost Estimate (Main Canal) (2/3)

Item	St.	Dis.	Type	Condition					Area				Volume (m3) & Amount (1,000DH)											Unit Cost
				B	H	Wall (top, bottom)		Slab	Excavation	Backfill	Concrete	Masonry	Excavation		Backfill		Concrete (m3)		Steel Bar (t)		Masonry		Total	Cost
				(m)	(m)	t1 (m)	t2 (m)	t3 (m)	(m2)	(m2)	(m2)	(m2)	Vol.	Amount	Vol.	Amount	Vol.	Amount	Vol.	Amount	Vol.	Amount	Amount	(DH/m)
												Unit Cost (DH)	26.93		16.84		600.59		10,551.20		288.80			
2 No.9 Taskourt																								
2.1 Main Canal	0+ 0		Flume	1.55	2.1	0.2	-	0.2	12.08	7.59	1.23	0												
	5+ 0	5000	Flume	1.55	2.1	0.2	-	0.2	12.08	7.59	1.23	0	60,375	1,625.9	37,950	639.1	6,150	3,693.6	184.5	1,946.7	0			
	5+ 0	0	Masonry	1.85	2.2	0.4	1.15	0.3	19.13	10.63	0	4.43												
	5+ 450	450	Masonry	1.85	2.2	0.4	1.15	0.3	19.13	10.63	0	4.43	8,606	231.8	4,781	80.5					1,994	575.7		
	5+ 450	0	Masonry	1.6	1.95	0.4	1.08	0.3	15.77	8.831	0	3.81												
	9+ 60	3610	Masonry	1.6	1.95	0.4	1.08	0.3	15.77	8.831	0	3.81	56,939	1,533.4	31,881	536.9					13,754	3,972.2		
	9+ 60	0	Masonry	1.25	1.6	0.4	0.97	0.3	11.57	6.593	0	2.978												
	10+ 800	1740	Masonry	1.25	1.6	0.4	0.97	0.3	11.57	6.593	0	2.978	20,134	542.2	11,472	193.2					5,182	1,496.5		
	10+ 800	0	Masonry	1.35	1.05	0.4	0.81	0.3	7.182	3.719	0	2.039												
	13+ 730	2930	Masonry	1.35	1.05	0.4	0.81	0.3	7.182	3.719	0	2.039	21,043	566.7	10,897	183.5					5,973	1,725.0		
	13+ 730	0	Masonry	1.35	1	0.4	0.79	0.3	6.799	3.497	0	1.952												
	14+ 700	970	Masonry	1.35	1	0.4	0.79	0.3	6.799	3.497	0	1.952	6,595	177.6	3,392	57.1					1,893	546.8		
	14+ 700	0	Masonry	1.3	1	0.4	0.79	0.3	6.734	3.497	0	1.937												
	16+ 100	1400	Masonry	1.3	1	0.4	0.79	0.3	6.734	3.497	0	1.937	9,428	253.9	4,896	82.5					2,712	783.2		
	16+ 100	0	Masonry	1.2	0.8	0.4	0.73	0.3	5.236	2.673	0	1.603												
	16+ 710	610	Masonry	1.2	0.8	0.4	0.73	0.3	5.236	2.673	0	1.603	3,194	86.0	1,631	27.5					978	282.4		
	16+ 710	0	Masonry	1.2	0.9	0.4	0.76	0.3	5.904	3.072	0	1.752												
	21+ 600	4890	Masonry	1.2	0.9	0.4	0.76	0.3	5.904	3.072	0	1.752	28,871	777.5	15,022	253.0					8,567	2,474.2		
												Sub-total	215,184	5,795	121,922	2,053	6,150	3,694	185	1,947	41,052	11,856	25,344	1,173.35
2.2 Branch	0+ 0		Flume	1.35	1.5	0.2	-	0.2	7.565	4.59	0.95	0												
	0+ 500	500	Flume	1.35	1.5	0.2	-	0.2	7.565	4.59	0.95	0	3,783	101.9	2,295	38.7	475	285.3	14.3	150.9	0			
	0+ 500	0	Flume	1.5	1.6	0.2	-	0.2	8.46	5.04	1.02	0												
	2+ 650	2150	Flume	1.5	1.6	0.2	-	0.2	8.46	5.04	1.02	0	18,189	489.8	10,836	182.5	2,193	1,317.1	65.8	694.3	0			
	2+ 650	0	Flume	1.25	1.35	0.2	-	0.2	6.51	3.953	0.87	0												
	6+ 0	3350	Flume	1.25	1.35	0.2	-	0.2	6.51	3.953	0.87	0	21,809	587.3	13,241	223.0	2,915	1,750.4	87.4	922.2	0			
	6+ 0	0	Flume	1.1	0.8	0.2	-	0.2	3.5	2	0.62	0												
	15+ 280	9280	Flume	1.1	0.8	0.2	-	0.2	3.5	2	0.62	0	32,480	874.7	18,560	312.6	5,754	3,455.6	172.6	1,821.1	0			
												Sub-total	76,260	2,054	44,932	757	11,336	6,808	340	3,588	0	0	13,207	864.34
												Total	291,444	7,849	166,854	2,810	17,486	10,502	525	5,535	41,052	11,856	38,552	1,045.32

Table XVII3.1.21 Irrigation Facility ; Construction Volume & Cost Estimate (Main Canal) (3/3)

Item	St.	Dis.	Type	Condition					Area				Volume (m3) & Amount (1,000DH)											Unit Cost
				B	H	Wall (top, bottom)		Slab	Excavation	Backfill	Concrete	Masonry	Excavation		Backfill		Concrete (m3)		Steel Bar (t)		Masonry		Total	
				(m)	(m)	t1 (m)	t2 (m)	t3 (m)	(m2)	(m2)	(m2)	(m2)	Vol.	Amount	Vol.	Amount	Vol.	Amount	Vol.	Amount	Vol.	Amount	Amount	(DH/m)
												Unit Cost (DH)	26.93		16.84		600.59		10,551.20		288.80			
4 No.17 Azghar																								
4.1 Main	0+ 220		Stone Lining	1	1.25	-	-	-	9.43	7.69	0	0.71												
Canal	0+ 670	450	Stone Lining	1	1.25	-	-	-	9.43	7.69	0	0.71	4,244	114.3	3,461	58.3					320	92.3		
	0+ 675		Stone Lining	1	1.25	-	-	-	9.43	7.69	0	0.71												
	2+ 30	1355	Stone Lining	1	1.25	-	-	-	9.43	7.69	0	0.71	12,778	344.1	10,420	175.5					962	277.8		
	2+ 60		Stone Lining	1	1.25	-	-	-	9.43	7.69	0	0.71												
	3+ 720	1660	Stone Lining	1	1.25	-	-	-	9.43	7.69	0	0.71	15,654	421.6	12,765	215.0					1,179	340.4		
	3+ 720	0	Stone Lining	0.8	1.05	-	-	-	7.64	6.78	0	0.62												
	4+ 560	840	Stone Lining	0.8	1.05	-	-	-	7.64	6.78	0	0.62	6,418	172.8	5,695	95.9					521	150.4		
	4+ 580		Stone Lining	0.8	1.05	-	-	-	7.64	6.78	0	0.62												
	5+ 790	1210	Stone Lining	0.8	1.05	-	-	-	7.64	6.78	0	0.62	9,244	249.0	8,204	138.2					750	216.7		
	5+ 805		Stone Lining	0.75	0.95	-	-	-	6.91	6.38	0	0.59												
	6+ 25	220	Stone Lining	0.75	0.95	-	-	-	6.91	6.38	0	0.59	1,520	40.9	1,404	23.6					130	37.5		
	6+ 65		Stone Lining	0.75	0.95	-	-	-	6.91	6.38	0	0.59												
	6+ 115	50	Stone Lining	0.75	0.95	-	-	-	6.91	6.38	0	0.59	346	9.3	319	5.4					30	8.5		
	6+ 145		Stone Lining	0.75	0.95	-	-	-	6.91	6.38	0	0.59												
	6+ 745	600	Stone Lining	0.75	0.95	-	-	-	6.91	6.38	0	0.59	4,146	111.7	3,828	64.5					354	102.2		
	6+ 775		Stone Lining	0.75	0.95	-	-	-	6.91	6.38	0	0.59												
	6+ 885	110	Stone Lining	0.75	0.95	-	-	-	6.91	6.38	0	0.59	760	20.5	702	11.8					65	18.7		
	6+ 915		Stone Lining	0.75	0.95	-	-	-	6.91	6.38	0	0.59												
	8+ 515	1600	Stone Lining	0.75	0.95	-	-	-	6.91	6.38	0	0.59	11,056	297.7	10,208	171.9					944	272.6		
	8+ 615		Stone Lining	0.75	0.95	-	-	-	6.91	6.38	0	0.59												
	8+ 745	130	Stone Lining	0.75	0.95	-	-	-	6.91	6.38	0	0.59	898	24.2	829	14.0					77	22.2		
	8+ 795		Stone Lining	0.75	0.9	-	-	-	6.61	6.2	0	0.58												
	9+ 55	260	Stone Lining	0.75	0.9	-	-	-	6.61	6.2	0	0.58	1,719	46.3	1,612	27.2					151	43.6		
	9+ 95		Stone Lining	0.75	0.9	-	-	-	6.61	6.2	0	0.58												
	9+ 745	650	Stone Lining	0.75	0.9	-	-	-	6.61	6.2	0	0.58	4,297	115.7	4,030	67.9					377	108.9		
	9+ 795		Stone Lining	0.75	0.9	-	-	-	6.61	6.2	0	0.58												
	11+ 745	1950	Stone Lining	0.75	0.9	-	-	-	6.61	6.2	0	0.58	12,890	347.1	12,090	203.6					1,131	326.6		
	11+ 745		Stone Lining	0.6	0.8	-	-	-	5.77	5.71	0	0.53												
	13+ 545	1800	Stone Lining	0.6	0.8	-	-	-	5.77	5.71	0	0.53	10,386	279.7	10,278	173.1					954	275.5		
												Sub-total	96,354	2,595	85,845	1,446	0	0	0	0	7,943	2,294	6,334	467.65
4.2 Branch	0+ 0		Flume	0.5	0.6	0.2	-	0.2	2.16	1.44	0.42	0												
1	0+ 325	325	Flume	0.5	0.6	0.2	-	0.2	2.16	1.44	0.42	0	702	18.9	468	7.9	137	82.0	4.1	43.3	0			
	0+ 340		Flume	0.5	0.6	0.2	-	0.2	2.16	1.44	0.42	0												
	2+ 490	2150	Flume	0.5	0.6	0.2	-	0.2	2.16	1.44	0.42	0	4,644	125.1	3,096	52.1	903	542.3	27.1	285.9	0			
	2+ 490		Flume	0.4	0.5	0.2	-	0.2	1.75	1.19	0.36	0												
	2+ 540	50	Flume	0.4	0.5	0.2	-	0.2	1.75	1.19	0.36	0	88	2.4	60	1.0	18	10.8	0.5	5.3	0			
												Sub-total	5,434	146	3,624	61	1,058	635	32	334	0	0	1,177	456.18
4.3 Branch	0+ 0		Flume	1	1	0.2	-	0.2	4.32	2.64	0.68	0												
2	0+ 580	580	Flume	1	1	0.2	-	0.2	4.32	2.64	0.68	0	2,506	67.5	1,531	25.8	394	236.9	11.8	124.5	0			
	0+ 580		Flume	1	0.7	0.2	-	0.2	2.97	1.71	0.56	0												
	1+ 300	720	Flume	1	0.7	0.2	-	0.2	2.97	1.71	0.56	0	2,138	57.6	1,231	20.7	403	242.2	12.1	127.7	0			
	1+ 320		Flume	1	0.7	0.2	-	0.2	2.97	1.71	0.56	0												
	2+ 550	1230	Flume	1	0.7	0.2	-	0.2	2.97	1.71	0.56	0	3,653	98.4	2,103	35.4	689	413.7	20.7	218.4	0			
	2+ 570		Flume	1	0.7	0.2	-	0.2	2.97	1.71	0.56	0												
	2+ 690	120	Flume	1	0.7	0.2	-	0.2	2.97	1.71	0.56	0	356	9.6	205	3.5	67	40.4	2.0	21.1	0			
	2+ 710		Flume	1	0.7	0.2	-	0.2	2.97	1.71	0.56	0												
	3+ 370	660	Flume	1	0.7	0.2	-	0.2	2.97	1.71	0.56	0	1,960	52.8	1,129	19.0	370	222.0	11.1	117.1	0			
	3+ 390		Flume	1	0.7	0.2	-	0.2	2.97	1.71	0.56	0												
	3+ 775	385	Flume	1	0.7	0.2	-	0.2	2.97	1.71	0.56	0	1,143	30.8	658	11.1	216	129.5	6.5	68.6	0			
	3+ 775		Flume	0.6	0.7	0.2	-	0.2	2.61	1.71	0.48	0												
	4+ 95	320	Flume	0.6	0.7	0.2	-	0.2	2.61	1.71	0.48	0	835	22.5	547	9.2	154	92.3	4.6	48.5	0			
	4+ 115		Flume	0.6	0.7	0.2	-	0.2	2.61	1.71	0.48	0												
	4+ 555	440	Flume	0.6	0.7	0.2	-	0.2	2.61	1.71	0.48	0	1,148	30.9	752	12.7	211	126.8	6.3	66.5	0			
	4+ 575		Flume	0.6	0.7	0.2	-	0.2	2.61	1.71	0.48	0												
	5+ 475	900	Flume	0.6	0.7	0.2	-	0.2	2.61	1.71	0.48	0	2,349	63.3	1,539	25.9	432	259.5	13.0	137.2	0			
	5+ 495		Flume	0.6	0.7	0.2	-	0.2	2.61	1.71	0.48	0												
	5+ 515	20	Flume	0.6	0.7	0.2	-	0.2	2.61	1.71	0.48	0	52	1.4	34	0.6	10	5.8	0.3	3.2	0			
												Sub-total	16,142	435	9,731	164	2,945	1,769	88	933	0	0	3,300	598.40
4.4 Branch	0+ 0		Flume	0.8	0.6	0.2	-	0.2	2.4	1.44	0.48	0												
3	2+ 670	2670	Flume	0.8	0.6	0.2	-	0.2	2.4	1.44	0.48	0	6,408	172.6	3,845	64.8	1,282	769.7	38.4	405.2	0			
												Sub-total	6,408	173	3,845	65	1,282	770	38	405	0	0	1,412	528.92
												Total	124,337	3,348	103,044	1,735	5,284	3,174	159	1,672	7,943	2,294	12,224	503.65

Table XVII3.1.22 Irrigation Facility ; Construction Volume & Cost Estimate (Structures)

	Site & Structure	No. of Structure (no.)	Unit	Excavation Vol.(m3)	Excavation Amount	Backfill Vol.(m3)	Backfill Amount	Concrete w steel Concrete Vol.(m3)	Concrete w steel Concrete Amount	Concrete w steel Steel Bar Vol.(t)	Concrete w steel Steel Bar Amount	Concrete wo steel Vol.(m3)	Concrete wo steel Amount	Masonry Vol.(m3)	Masonry Amount	Riprap Vol.(m3)	Riprap Amount	RC Pipe D (mm)	RC Pipe Length Vol.(m)	RC Pipe Amount	Gabion Vol.(m3)	Gabion Amount	Gate Spec	Gate Vol.(no)	Gate Amount	Screen Vol.(no)	Screen Amount	Others Spec	Others Vol.	Others Amount	Sub-Total	Miscellaneous 10 (%)	Miscellaneous Amount	Unit Amount	Total Amount
		Unit Cost (DH)		26.93		16.84		600.59		10551.20		600.59		288.80		203.69					500.00														
1	No.5 N'Fifikh																																		21,293
1.1	Headwork	3		80	2.15			15	9.01	0.75	7.91	120	72.07	150	43.32	60	12.22							1	200						346.68	10	34.67	381.35	1,144
1.2	Siphon	9		640	17.24	520	8.76					100	60.06					700	80	57.29						2	200				343.35	10	34.34	377.69	3,399
1.3	Offtake	32		15	0.4	10	0.17	2.4	1.44	0.07	0.74							600	4	2.36			D600,300	1,2	300						305.11	10	30.51	335.62	10,740
1.4	Spillway	4		27.5	0.74	13.1	0.22	6	3.6	0.18	1.9																				6.46	10	0.65	7.11	28
1.5	Check	8						5	3	0.25	2.64												1,000*1,000	1	200						205.64	10	20.56	226.20	1,810
1.6	Aqueduct	1						15	9.01	0.75	7.91	18	10.81																		27.73	10	2.77	30.50	31
1.7	Cross Drain	63		100	2.69	95	1.6					8	4.8					600	10	5.91	9	4.5									19.5	10	1.95	21.45	1,351
1.8	Bridge	25						8	4.8	0.5	5.28			18	5.2																15.28	10	1.53	16.81	420
1.9	Feeder Canal	1000	ha	80	2.15									0	0																2.15	10	0.22	2.37	2,370
2	No.9 Taskourt																																		84,535
2.1	Headwork	1		1200	32.32			220	132.13	11.2	118.17	1800	1081.1	750	216.6	1000	203.69						2*2m	2	800						2584	10	258.4	2842.37	2,842
2.2	Siphon	1		2700	72.71	2000	33.68					400	240.24					1200	190	174.06						3m2	300				820.69	10	82.07	902.76	903
2.3	Drop	4790	m	31.5	0.85	17.7	0.3							7.6	2.19																3.34	10	0.33	3.67	17,579
2.4	Offtake	18		15	0.4	10	0.17	2.4	1.44	0.07	0.74							600	4	2.36			D600,300	1,2	300						305.11	10	30.51	335.62	6,041
2.5	Spillway	6		157.7	4.25	88.3	1.49							3.4	0.98																6.72	10	0.67	7.39	44
2.6	Cross Drain	102		100	2.69	95	1.6					8	4.8					600	10	5.91	9	4.5									19.5	10	1.95	21.45	2,188
2.7	Bridge	37						8	4.8	0.5	5.28			18	5.2																15.28	10	1.53	16.81	622
2.8	Feeder Canal	4500	ha	300	8.08									10	2.89																10.97	10	1.1	12.07	54,315
3	No.10 Timkit (Improvement)																																		104,963
3.1	Canal (Flume)	3600	m					0.14	0.08	0.0011	0.01																	anchor bolt, D10 (kg)	1.68	0.02	0.11	10	0.01	0.12	432
	Canal (Masonry)	34900	m	0.9	0.02							0.005	0.003	1.3	0.38																0.40	10	0.04	0.44	15,461
3.2	Diversion	12		400	10.77							530	318.31											1	200						529.08	10	52.91	581.99	6,984
3.3	Feeder Canal	3060	ha	300	8.08									42	12.13																20.21	10	2.02	22.23	68,024
3.4	Well	37		20m	60.00			5	3	0.25	2.64																	Water Pump, Generator	1, 1	250.4	316.04	10	31.6	347.64	12,863
3.5	River Channel	5000	m	8	0.22																										0.22	10	0.02	0.24	1,200
4	No.17 Azghar																																		56,315
4.1	Siphon	20		400	10.77	330	5.56					65	39.04					700	50	35.81						2m2	200				291.18	10	29.12	320.30	6,406
4.2	Drop	875	m	4.3	0.12	2.9	0.05	0.8	0.48	0.024	0.25																				0.9	10	0.09	0.99	866
4.3	Offtake	50		15	0.4	10	0.17	2.4	1.44	0.07	0.74							600	4	2.36			D600,300	1,2	300						305.11	10	30.51	335.62	16,781
4.4	Spillway	7		21.6	0.58	14.4	0.24	4.2	2.52	0.126	1.33																				4.67	10	0.47	5.14	36
4.5	Check	13						5	3	0.25	2.64												1,000*1,000	1	200						205.64	10	20.56	226.20	2,941
4.6	Cross Drain	60		100	2.69	95	1.6					8	4.8					600	10	5.91	9	4.5									19.5	10	1.95	21.45	1,287
4.7	Bridge	26						8	4.8	0.5	5.28			18	5.2																15.28	10	1.53	16.81	437
4.8	Box Culvert	65	m	28.5	0.77	24	0.4	2.2	1.32	0.11	1.16																				3.65	10	0.37	4.02	261
4.9	Feeder Canal	2000	ha	300	8.08									15	4.33																12.41	10	1.24	13.65	27,300

Volume & Amount (1,000DH)

*3.4 Well ; Excavation & Machines

- Excavation
  On the table, "Excavation" means drilling with 300mm diameter.
  Its cost is about 10,000 DH/m in Japan, which consist of 80 % of labor cost..
  Then, labor cost in Morocco is about 1/10 of the one in Japan.
  Therefore, 10,000*0.2+8,000*0.1=3,000 DH/m

- Machines
  A generator and a water pump are needed for a well.
  They shall be purchased on the project.

	Price (1,000DH)
Water Pump (D125mm, H=35m, 15kW)	98.4
Generator (20kVA)	152.0

Table XVII3.2.1 Daily Rainfall of Taskourt

Station: SIDI BOUATHAMANE (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1991	1	8.9	34.7	31.6	2.8	2.2	5.1	3.1	5.5	34.1	20.5	7.4	20.3
	2	0.0	30.8	16.6	2.4	2.1	0.0	0.7	0.6	10.5	1.3	5.6	4.6
	3	0.0	21.8	14.7	0.9	1.9	0.0	0.2	0.0	0.1	0.7	0.0	1.6
	4	0.0	19.6	13.6	0.1	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.7
	5	0.0	14.9	12.6	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.4
	6	0.0	8.7	9.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	7	0.0	5.6	9.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	8	0.0	3.3	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	9	0.0	0.6	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	10	0.0	0.3	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	11	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	12	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	29	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	30	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	31	0.0		0.0		0.0		0.0	0.0		0.0		0.0

Table XVII3.2.1 Daily Rainfall of Taskourt (2/10)

Station: SIDI BOUATHAMANE (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1992	1	0.0	19.9	31.2	30.9	6.2	40.4	3.5	1.4	0.2	29.3	14.2	6.2
	2	0.0	12.7	14.0	17.0	1.2	5.1	0.0	0.0	0.0	21.5	0.0	0.9
	3	0.0	6.1	12.0	4.1	0.0	4.1	0.0	0.0	0.0	3.3	0.0	0.8
	4	0.0	4.3	11.3	4.0	0.0	0.2	0.0	0.0	0.0	3.1	0.0	0.6
	5	0.0	1.5	5.3	3.5	0.0	0.0	0.0	0.0	0.0	2.9	0.0	0.1
	6	0.0	1.4	5.1	0.2	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0
	7	0.0	1.3	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
	8	0.0	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	9	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	29	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	30	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	31	0.0		0.0		0.0		0.0	0.0		0.0		0.0

Table XVII3.2.1 Daily Rainfall of Taskourt (3/10)

Station: SIDI BOUATHAMANE (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1993	1	14.3	10.1	5.7	12.7	7.2	0.0	0.0	0.0	0.1	16.5	34.1	44.2
	2	14.3	7.9	5.3	6.5	0.0	0.0	0.0	0.0	0.0	6.2	16.4	0.2
	3	6.7	2.9	4.3	5.6	0.0	0.0	0.0	0.0	0.0	2.4	15.6	0.0
	4	0.0	2.6	2.8	0.1	0.0	0.0	0.0	0.0	0.0	2.3	9.5	0.0
	5	0.0	2.4	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.6	0.0
	6	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.1	0.0
	7	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.5	0.0
	8	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	0.0
	9	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	0.0
	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0
	11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0
	12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0
	13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	29	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	30	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	31	0.0		0.0		0.0		0.0	0.0		0.0		0.0

Table XVII3.2.1 Daily Rainfall of Taskourt (4/10)

Station: SIDI BOUATHAMANE (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1994	1	24.1	25.6	12.1	8.1		0.0	0.0	11.3	0.0	70.7	0.0	0.1
	2	14.5	21.0	10.8	0.0		0.0	0.0	7.5	0.0	7.6	0.0	0.0
	3	14.0	15.8	10.3	0.0		0.0	0.0	0.0	0.0	6.5	0.0	0.0
	4	5.8	10.2	1.5	0.0		0.0	0.0	0.0	0.0	5.4	0.0	0.0
	5	3.7	7.5	1.1	0.0		0.0	0.0	0.0	0.0	1.2	0.0	0.0
	6	3.4	0.0	0.5	0.0		0.0	0.0	0.0	0.0	0.1	0.0	0.0
	7	1.2	0.0	0.2	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	8	0.4	0.0	0.1	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	9	0.0	0.0	0.1	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	10	0.0	0.0	0.1	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	11	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	12	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	13	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	14	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	15	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	16	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	17	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	18	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	19	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	20	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	21	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	22	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	23	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	24	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	25	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	26	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	27	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	28	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	29	0.0		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	30	0.0		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	31	0.0		0.0				0.0	0.0		0.0		0.0

Table XVII3.2.1 Daily Rainfall of Taskourt

Station: SIDI BOUATHAMANE (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1995	1	0.0	35.6	19.5	48.9	0.0	0.2	0.4	0.0	5.8	29.5	11.3	44.7
	2	0.0	14.5	11.7	38.2	0.0	0.0	0.2	0.0	2.2	9.2	1.3	13.3
	3	0.0	14.0	9.5	25.1	0.0	0.0	0.0	0.0	0.0	2.1	0.0	12.2
	4	0.0	11.0	9.4	22.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2
	5	0.0	2.1	5.6	21.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6
	6	0.0	0.0	2.5	11.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5
	7	0.0	0.0	0.0	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
	8	0.0	0.0	0.0	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
	9	0.0	0.0	0.0	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
	10	0.0	0.0	0.0	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	11	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	12	0.0	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	13	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	14	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	15	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	29	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	30	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	31	0.0		0.0		0.0		0.0	0.0		0.0		0.0

Table XVII3.2.1 Daily Rainfall of Taskourt (6/10)

Station: SIDI BOUATHAMANE (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1996	1	38.0	36.5	25.5	5.0	10.2	33.6	0.0	0.0	5.9	0.9	35.2	32.9
	2	26.3	24.3	20.9	2.5	7.5	17.4	0.0	0.0	0.3	0.0	23.5	12.1
	3	13.0	11.4	20.8	0.1	3.9	10.5	0.0	0.0	0.0	0.0	0.0	11.5
	4	9.2	10.0	20.0	0.0	2.9	1.5	0.0	0.0	0.0	0.0	0.0	8.0
	5	1.9	6.4	12.8	0.0	1.7	0.4	0.0	0.0	0.0	0.0	0.0	7.0
	6	1.2	4.2	11.4	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	6.9
	7	1.1	3.6	5.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1
	8	0.7	2.3	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0
	9	0.5	1.9	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
	10	0.3	1.5	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
	11	0.2	1.3	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	12	0.0	0.9	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	13	0.0	0.9	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	14	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	29	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	30	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	31	0.0		0.0		0.0		0.0	0.0		0.0		0.0

Table XVII3.2.1 Daily Rainfall of Taskourt

Station: SIDI BOUATHAMANE (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1997	1	18.0		15.5	39.8	30.2	2.4	0.0	0.2	50.0	15.5	18.4	45.0
	2	16.5		14.7	15.1	1.8	1.2	0.0	0.0	21.6	13.5	7.6	15.4
	3	13.9		6.0	12.2	0.1	0.0	0.0	0.0	5.3	11.5	5.1	10.0
	4	10.9		4.1	8.9	0.0	0.0	0.0	0.0	1.0	0.1	2.0	7.3
	5	2.3		1.3	8.8	0.0	0.0	0.0	0.0	0.8	0.0	0.6	6.6
	6	0.5		1.0	8.4	0.0	0.0	0.0	0.0	0.5	0.0	0.0	2.5
	7	0.2		0.3	2.5	0.0	0.0	0.0	0.0	0.5	0.0	0.0	2.2
	8	0.1		0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4
	9	0.1		0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2
	10	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	11	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	12	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	13	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	14	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	15	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	16	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	17	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	18	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	19	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	20	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	21	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	22	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	23	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	24	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	25	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	26	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	27	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	28	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	29	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	30	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	31	0.0		0.0		0.0		0.0	0.0		0.0		0.0

Table XVII3.2.1 Daily Rainfall of Taskourt (8/10)

Station: SIDI BOUATHAMANE (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1998	1	14.2	21.6	10.9	26.7	11.8	0.1	0.0	0.0	9.1	32.5	0.1	11.5
	2	11.0	7.9	5.5	18.1	5.8	0.0	0.0	0.0	4.1	13.6	0.0	8.4
	3	0.4	2.5	2.5	7.2	2.9	0.0	0.0	0.0	0.0	0.0	0.0	8.1
	4	0.2	1.8	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	5.3
	5	0.0	1.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	2.5
	6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5
	7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
	8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	29	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	30	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	31	0.0		0.0		0.0		0.0	0.0		0.0		0.0

Table XVII3.2.1 Daily Rainfall of Taskourt

Station: SIDI BOUATHAMANE (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1999	1	23.2	36.4	38.0	3.2	7.0	11.0	0.2	3.8	4.0	54.1	18.1	20.0
	2	16.2	27.1	33.0	1.2	0.8	3.3	0.0	0.2	0.2	34.5	12.0	14.0
	3	12.6	25.2	8.5	0.2	0.6	0.0	0.0	0.0	0.1	25.1	8.0	12.8
	4	12.4	0.0	6.4	0.0	0.6	0.0	0.0	0.0	0.0	20.0	4.4	11.3
	5	7.2	0.0	5.2	0.0	0.0	0.0	0.0	0.0	0.0	10.0	2.7	8.6
	6	4.0	0.0	3.5	0.0	0.0	0.0	0.0	0.0	0.0	8.5	0.0	2.8
	7	2.3	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.1
	8	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0
	9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0
	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
	11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
	12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	29	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	30	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	31	0.0		0.0		0.0		0.0	0.0		0.0		0.0

Table XVII3.2.1 Daily Rainfall of Taskourt

Station: SIDI BOUATHAMANE

(unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2000	1	4.1	0.5	0.2									
	2	1.2	0.0	0.1									
	3	0.2	0.0	0.0									
	4	0.0	0.0	0.0									
	5	0.0	0.0	0.0									
	6	0.0	0.0	0.0									
	7	0.0	0.0	0.0									
	8	0.0	0.0	0.0									
	9	0.0	0.0	0.0									
	10	0.0	0.0	0.0									
	11	0.0	0.0	0.0									
	12	0.0	0.0	0.0									
	13	0.0	0.0	0.0									
	14	0.0	0.0	0.0									
	15	0.0	0.0	0.0									
	16	0.0	0.0	0.0									
	17	0.0	0.0	0.0									
	18	0.0	0.0	0.0									
	19	0.0	0.0	0.0									
	20	0.0	0.0	0.0									
	21	0.0	0.0	0.0									
	22	0.0	0.0	0.0									
	23	0.0	0.0	0.0									
	24	0.0	0.0	0.0									
	25	0.0	0.0	0.0									
	26	0.0	0.0	0.0									
	27	0.0	0.0	0.0									
	28	0.0	0.0	0.0									
	29	0.0	0.0	0.0									
	30	0.0		0.0									
	31	0.0		0.0									

Table XVII3.2.2: Breakdown of Construction Cost for TASKOURT Dam (1/5)

	Work Item	Unit	Quantity	Local Currency Unit Cost (DH)	Local Currency Amount (1,000DH)	Foreign Unit Cost (DH)	Foreign Amount (1,000DH)	Total (1,000DH)	Remarks
A	Dam								
1	River Diversion Works								
1-1	Inlet/Outlet Channel								
	Excavation / hauling, soil & gravel	m^3	0	8.59	0	15.95	0	0	
	- ditto -, rock	m^3	0	32.89	0	61.13	0	0	
	Backfill, soil	m^3	0	2.36	0	4.40	0	0	
	Reinforced concrete	m^3	0	308.77	0	573.43	0	0	
	Form work	m^2	0	14.23	0	26.42	0	0	
	Miscellaneous works	L.S	1	0.00	0	0.00	0	0	10% above
	Sub-total				0		0	0	
1-2	Culvert Channel								
	Excavation and hauling, gravel		0	8.59	0	15.95	0	0	
	- ditto -, rock		0	32.89	0	61.13	0	0	
	Reinforced concrete	m^3	3,614	308.77	1,116	573.43	2,072	3,188	
	Plain concrete (Plugging)	m^3	2,592	191.39	496	355.42	921	1,417	
	Form work	m^2	3,154	14.23	45	26.42	83	128	
	Consolidation grouting	m			0		0	0	Estimated in
	Curtain grouting	m			0		0	0	foundation treatment
	Miscellaneous works	L.S	1	165,700.00	166	307,600.00	308	474	10% above
	Sub-total				1,823		3,384	5,207	
1-3	Coffer Dam								
	Excavation, gravel	m^3			0		0	0	Estimated in dam foundation excavation
	Plain concrete	m^3	0	191.39	0	355.42	0	0	
	Form work	m^2	0	14.23	0	26.42	0	0	
	Miscellaneous works	L.S	1	0.00	0	0.00	0	0	10% above
	Sub-total				0		0	0	
	Total				1,823		3,384	5,207	

Table XVII3.2.2: Breakdown of Construction Cost for TASKOURT Dam (2/5)

	Work Item	Unit	Quantity	Local Currency Unit Cost (DH)	Local Currency Amount (1,000DH)	Foreign Unit Cost (DH)	Foreign Amount (1,000DH)	Total (1,000DH)	Remarks
2	Foundation Excavation								
	Excavation / hauling, soil & gravel	m^3	102,300	8.59	879	15.95	1,632	2,511	
	- ditto -, rock	m^3	139,800	32.89	4,598	61.13	8,546	13,144	
	Miscellaneous works	L.S	1	547,700.00	548	##########	1,018	1,566	10% above
	Sub-total				6,025		11,196	17,221	
3	Foundation Treatment Works								
	Curtain grouting work	m	6,437	395.85	2,548	735.14	4,732	7,280	
	Consolidation grouting work	m	2,041	262.62	536	487.71	995	1,531	
	Miscellaneous works	L.S	1	308,400.00	308	572,700.00	573	881	10% above
	Sub-total				3,392		6,300	9,692	
4	Dam Embankment								
	Inner concrete	m^3	314,715	115.93	36,485	215.31	67,761	104,246	
	Outer concrete	m^3	99,135	191.39	18,973	355.42	35,235	54,208	
	Reinforced concrete	m^3	1,152	308.77	356	573.43	661	1,017	
	Tie rod	t	39	3,570.00	139	6,630.00	259	398	
	Miscellaneous works	L.S	1	5,595,300	5,595	10,391,600	10,392	15,987	10% above
	Sub-total				61,548		114,308	175,856	
	Total				70,965		131,804	202,769	

Table XVII3.2.2: Breakdown of Construction Cost for TASKOURT Dam (3/5)

	Work Item	Unit	Quantity	Local Currency Unit Cost (DH)	Local Currency Amount (1,000DH)	Foreign Unit Cost (DH)	Foreign Amount (1,000DH)	Total (1,000DH)	Remarks
5	Spillway								
	Reinforced concrete	m^3	1,980	308.77	611	573.43	1,135	1,746	
	Form work	m^2	2,840	14.23	40	26.42	75	115	
	Miscellaneous works	L.S	1	65,100.00	65	121,000.00	121	186	10% above
	Sub-total				716		1,331	2,047	
6	Outlet Works								
6-1	Inlet Structure								
	Reinforced concrete	m^3	1,190	308.77	367	573.43	682	1,049	
	Form work	m^2	1,190	14.23	17	26.42	31	48	
	Miscellaneous works	L.S	1	38,400.00	38	71,300.00	71	109	10% above
	Sub-total				422		784	1,206	
6-2	Plug Works								
	Plain concrete	m^3	0	191.39	0	355.42	0	0	
	Form work	m^2	0	14.23	0	26.42	0	0	
	Miscellaneous works	L.S	1	0.00	0	0.00	0	0	10% above
	Sub-total				0		0	0	
6-3	Outlet Structure								
	Reinforced concrete	m^3	1,170	308.77	361	573.43	671	1,032	
	Form work	m^2	1,484	14.23	21	26.42	39	60	
	Miscellaneous works	L.S	1	38,200.00	38	71,000.00	71	109	10% above
	Sub-total				420		781	1,201	
	Total				1,558		2,896	4,454	

Table XVII3.2.2: Breakdown of Construction Cost for TASKOURT Dam (4/5)

	Work Item	Unit	Quantity	Local Currency Unit Cost (DH)	Local Currency Amount (1,000DH)	Foreign Unit Cost (DH)	Foreign Amount (1,000DH)	Total (1,000DH)	Remarks
7	Gate and Pipe								
7-1	Inlet works								
	W2.5 X H3.0m Slide gate with hoist	pcs	2	175,000	350	325,000	650	1,000	500,000 DH/pcs, incl. installation
	Sub-total				350		650	1,000	
7-2	Outlet works								
	D2000mm Steel pipe	m	73	9,450	690	17,550	1,281	1,971	27,000 DH/m, incl. installation
	D2000mm Jet flow gate with hoist	pcs	1	2,800,000	2,800	5,200,000	5,200	8,000	4,000 DH/mm, -do-
	Flow meter	pcs	1	105,000	105	195,000	195	300	300,000 DH/pcs, -do-
	Sub-total				3,595		6,676	10,271	
7-3	Others	L.S	1	394,500	395	732,600	733	1,127	10%
	Total				4,340		8,059	12,398	
	Total (1-7)				**78,686**		**146,143**	**224,828**	
8	Overhead and Profit of Contractor								
	Overhead	L.S	1	7,434,600	7,435	13,808,400	13,808	21,243	10% total of 1-6
	Profit of Contractor	L.S	1	8,612,050	8,612	15,995,060	15,995	24,607	10% above
	Access road enlargement	m	5,000	328.90	1,645	611.30	3,057	4,702	rock excavation
	Total				17,692		32,860	50,552	
	Total (Direct Construction Cost; 1-8)				**96,378**		**179,003**	**275,380**	
9	Physical Contingency	L.S	1	9,637,750	9,638	17,900,260	17,900	27,538	10% total of 1-8
	Total (1-9)				**106,016**		**196,903**	**302,918**	
10	Price Contingency (3% / year)	L.S	1	24,370,193	24,370	45,262,762	45,263	69,633	23% total of 1-9, 7years
	Total (1-10)				**130,386**		**242,166**	**372,551**	
11	Value Added Tax	L.S	1	18,253,970	18,254	33,903,184	33,903	52,157	14% total of 1-10
	Grand Total				**148,600**		**276,000**	**424,600**	

Table XVII3.2.2: Breakdown of Construction Cost for TASKOURT Dam (5/5)

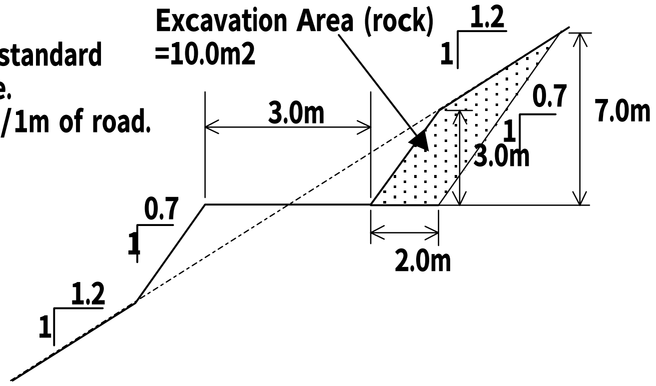
	Work Item	Unit	Quantity	Local Currency Unit Cost (DH)	Local Currency Amount (1,000DH)	Foreign Unit Cost (DH)	Foreign Amount (1,000DH)	Total (1,000DH)	Remarks
B	Irrigation Facilities								
1	Main Canal								
	Main Canal	m	21,600	586.68	12,672	586.68	12,672	25,344	
	Branch Canal	m	15,280	432.17	6,604	432.17	6,604	13,208	
	Sub-total				19,276		19,276	38,552	
2	Structures								
	Headwork	no	1	1,421,185	1,421	1,421,185	1,421	2,842	
	Siphon	no	1	451,380	451	451,380	451	902	
	Drop	m	4,790	1,835	8,790	1,835	8,790	17,580	
	Offtake	no	18	167,810	3,021	167,810	3,021	6,042	
	Spillway	no	6	3,695	22	3,695	22	44	
	Cross Drain	no	102	10,725	1,094	10,725	1,094	2,188	
	Bridge	no	37	8,405	311	8,405	311	622	
	On-farm Facilities	ha	4,500	6,035	27,158	6,035	27,158	54,316	
	Sub-total				42,268		42,268	84,536	
	Total (1-2)				**61,544**		**61,544**	**123,088**	
3	Overhead and Profit of Contractor	L.S	1	4,308,080	4,308	4,308,080	4,308	8,616	7% above
	Total (Direct Construction Cost; 1-3)				**65,852**		**65,852**	**131,704**	
4	Physical Contingency	L.S	1	6,585,200	6,585	6,585,200	6,585	13,170	10% total of 1-3
	Total (1-4)				**72,437**		**72,437**	**144,874**	
5	Price Contingency	L.S	1	16,660,510	16,661	16,660,510	16,661	33,322	23% total of 1-4, 7years
	Total (1-5)				**89,098**		**89,098**	**178,196**	
6	Value Added Tax	L.S	1	12,473,720	12,474	12,473,720	12,474	24,948	14% total of 1-5
	Grand Total				**101,570**		**101,570**	**203,100**	

Table XVII3.2.2 Attachment

Cost Estimate for the Access Road Enlargement (No.9 Taskourt)

The existing road locates at right abutment facing downstream. Its 5km span (from the dam site to a juncture with the major road) shall be enlarged averagely from the width of 3m to 5m.

1 Excavation
According to the condition at site, a standard section is assumed as the right figure.
Therefore, excavation area is 10.0m2/1m of road.



2 Unit cost (DH)/1m of road enlargement

Volume (m3)	Local Currency (DH)		Foreign Currency (DH)		Total (DH)
	Unit Cost	Amount	Unit Cost	Amount	
10	32.89	328.90	61.13	611.30	940.20

Table XVII3.3.1 Daily Rainfall of Timkit

Station: IFFRE (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1991	1		16.2	22.4	4.2		9.0	4.8	14.4	6.2	4.0	4.0	20.0
	2		3.0	5.7	3.0		7.2	4.8	0.0	0.0	0.0	0.0	17.1
	3		0.0	4.2	0.0		0.0	0.0	0.0	0.0	0.0	0.0	9.0
	4		0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	6.6
	5		0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	5.5
	6		0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	3.0
	7		0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	8		0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	9		0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	10		0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	11		0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	12		0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	13		0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	14		0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	15		0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	16		0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	17		0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	18		0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	19		0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	20		0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	21		0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	22		0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	23		0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	24		0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	25		0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	26		0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	27		0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	28		0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	29			0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	30			0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0
	31			0.0				0.0	0.0		0.0		0.0

Table XVII3.3.1 Daily Rainfall of Timkit (2/10)

Station: IFFRE (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1992	1		37.3	5.0		9.0			9.6		7.6	3.8	7.4
	2		20.6	4.3		3.0			6.2		0.0	0.0	7.0
	3		3.5	0.0		0.0			0.0		0.0	0.0	3.7
	4		0.0	0.0		0.0			0.0		0.0	0.0	0.0
	5		0.0	0.0		0.0			0.0		0.0	0.0	0.0
	6		0.0	0.0		0.0			0.0		0.0	0.0	0.0
	7		0.0	0.0		0.0			0.0		0.0	0.0	0.0
	8		0.0	0.0		0.0			0.0		0.0	0.0	0.0
	9		0.0	0.0		0.0			0.0		0.0	0.0	0.0
	10		0.0	0.0		0.0			0.0		0.0	0.0	0.0
	11		0.0	0.0		0.0			0.0		0.0	0.0	0.0
	12		0.0	0.0		0.0			0.0		0.0	0.0	0.0
	13		0.0	0.0		0.0			0.0		0.0	0.0	0.0
	14		0.0	0.0		0.0			0.0		0.0	0.0	0.0
	15		0.0	0.0		0.0			0.0		0.0	0.0	0.0
	16		0.0	0.0		0.0			0.0		0.0	0.0	0.0
	17		0.0	0.0		0.0			0.0		0.0	0.0	0.0
	18		0.0	0.0		0.0			0.0		0.0	0.0	0.0
	19		0.0	0.0		0.0			0.0		0.0	0.0	0.0
	20		0.0	0.0		0.0			0.0		0.0	0.0	0.0
	21		0.0	0.0		0.0			0.0		0.0	0.0	0.0
	22		0.0	0.0		0.0			0.0		0.0	0.0	0.0
	23		0.0	0.0		0.0			0.0		0.0	0.0	0.0
	24		0.0	0.0		0.0			0.0		0.0	0.0	0.0
	25		0.0	0.0		0.0			0.0		0.0	0.0	0.0
	26		0.0	0.0		0.0			0.0		0.0	0.0	0.0
	27		0.0	0.0		0.0			0.0		0.0	0.0	0.0
	28		0.0	0.0		0.0			0.0		0.0	0.0	0.0
	29		0.0	0.0		0.0			0.0		0.0	0.0	0.0
	30			0.0		0.0			0.0		0.0	0.0	0.0
	31			0.0		0.0			0.0		0.0		0.0

Table XVII3.3.1 Daily Rainfall of Timkit

Station: IFFRE (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1993	1	17.2	14.2	10.8							15.2	18.0	3.0
	2	0.0	7.0	0.0							8.6	17.1	0.0
	3	0.0	3.7	0.0							5.4	10.8	0.0
	4	0.0	0.0	0.0							0.0	9.8	0.0
	5	0.0	0.0	0.0							0.0	9.4	0.0
	6	0.0	0.0	0.0							0.0	4.7	0.0
	7	0.0	0.0	0.0							0.0	4.4	0.0
	8	0.0	0.0	0.0							0.0	2.6	0.0
	9	0.0	0.0	0.0							0.0	2.6	0.0
	10	0.0	0.0	0.0							0.0	2.0	0.0
	11	0.0	0.0	0.0							0.0	0.0	0.0
	12	0.0	0.0	0.0							0.0	0.0	0.0
	13	0.0	0.0	0.0							0.0	0.0	0.0
	14	0.0	0.0	0.0							0.0	0.0	0.0
	15	0.0	0.0	0.0							0.0	0.0	0.0
	16	0.0	0.0	0.0							0.0	0.0	0.0
	17	0.0	0.0	0.0							0.0	0.0	0.0
	18	0.0	0.0	0.0							0.0	0.0	0.0
	19	0.0	0.0	0.0							0.0	0.0	0.0
	20	0.0	0.0	0.0							0.0	0.0	0.0
	21	0.0	0.0	0.0							0.0	0.0	0.0
	22	0.0	0.0	0.0							0.0	0.0	0.0
	23	0.0	0.0	0.0							0.0	0.0	0.0
	24	0.0	0.0	0.0							0.0	0.0	0.0
	25	0.0	0.0	0.0							0.0	0.0	0.0
	26	0.0	0.0	0.0							0.0	0.0	0.0
	27	0.0	0.0	0.0							0.0	0.0	0.0
	28	0.0	0.0	0.0							0.0	0.0	0.0
	29	0.0		0.0							0.0	0.0	0.0
	30	0.0		0.0							0.0	0.0	0.0
	31	0.0		0.0							0.0		0.0

Table XVII3.3.1 Daily Rainfall of Timkit (4/10)

Station: IFFRE (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1994	1	11.0									39.2		
	2	0.0									10.6		
	3	0.0									9.3		
	4	0.0									8.8		
	5	0.0									3.6		
	6	0.0									0.0		
	7	0.0									0.0		
	8	0.0									0.0		
	9	0.0									0.0		
	10	0.0									0.0		
	11	0.0									0.0		
	12	0.0									0.0		
	13	0.0									0.0		
	14	0.0									0.0		
	15	0.0									0.0		
	16	0.0									0.0		
	17	0.0									0.0		
	18	0.0									0.0		
	19	0.0									0.0		
	20	0.0									0.0		
	21	0.0									0.0		
	22	0.0									0.0		
	23	0.0									0.0		
	24	0.0									0.0		
	25	0.0									0.0		
	26	0.0									0.0		
	27	0.0									0.0		
	28	0.0									0.0		
	29	0.0									0.0		
	30	0.0									0.0		
	31	0.0									0.0		

Table XVII3.3.1   Daily Rainfall of Timkit

Station: IFFRE (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1995	1			31.5	15.6						37.8	7.2	11.8
	2			7.6	5.6						7.0	0.0	11.6
	3			5.6	0.0						3.4	0.0	0.0
	4			4.0	0.0						0.0	0.0	0.0
	5			3.4	0.0						0.0	0.0	0.0
	6			3.4	0.0						0.0	0.0	0.0
	7			0.0	0.0						0.0	0.0	0.0
	8			0.0	0.0						0.0	0.0	0.0
	9			0.0	0.0						0.0	0.0	0.0
	10			0.0	0.0						0.0	0.0	0.0
	11			0.0	0.0						0.0	0.0	0.0
	12			0.0	0.0						0.0	0.0	0.0
	13			0.0	0.0						0.0	0.0	0.0
	14			0.0	0.0						0.0	0.0	0.0
	15			0.0	0.0						0.0	0.0	0.0
	16			0.0	0.0						0.0	0.0	0.0
	17			0.0	0.0						0.0	0.0	0.0
	18			0.0	0.0						0.0	0.0	0.0
	19			0.0	0.0						0.0	0.0	0.0
	20			0.0	0.0						0.0	0.0	0.0
	21			0.0	0.0						0.0	0.0	0.0
	22			0.0	0.0						0.0	0.0	0.0
	23			0.0	0.0						0.0	0.0	0.0
	24			0.0	0.0						0.0	0.0	0.0
	25			0.0	0.0						0.0	0.0	0.0
	26			0.0	0.0						0.0	0.0	0.0
	27			0.0	0.0						0.0	0.0	0.0
	28			0.0	0.0						0.0	0.0	0.0
	29			0.0	0.0						0.0	0.0	0.0
	30			0.0	0.0						0.0	0.0	0.0
	31			0.0							0.0		0.0

Table XVII3.3.1 Daily Rainfall of Timkit

Station: IFFRE (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1996	1	27.4	22.2	26.6		4.0	11.6	16.0					35.2
	2	13.8	6.0	14.8		0.0	7.8	0.0					17.2
	3	6.0	0.0	11.0		0.0	7.3	0.0					2.6
	4	5.0	0.0	6.0		0.0	6.6	0.0					0.0
	5	4.0	0.0	0.0		0.0	5.0	0.0					0.0
	6	3.0	0.0	0.0		0.0	4.6	0.0					0.0
	7	0.0	0.0	0.0		0.0	4.5	0.0					0.0
	8	0.0	0.0	0.0		0.0	4.2	0.0					0.0
	9	0.0	0.0	0.0		0.0	0.0	0.0					0.0
	10	0.0	0.0	0.0		0.0	0.0	0.0					0.0
	11	0.0	0.0	0.0		0.0	0.0	0.0					0.0
	12	0.0	0.0	0.0		0.0	0.0	0.0					0.0
	13	0.0	0.0	0.0		0.0	0.0	0.0					0.0
	14	0.0	0.0	0.0		0.0	0.0	0.0					0.0
	15	0.0	0.0	0.0		0.0	0.0	0.0					0.0
	16	0.0	0.0	0.0		0.0	0.0	0.0					0.0
	17	0.0	0.0	0.0		0.0	0.0	0.0					0.0
	18	0.0	0.0	0.0		0.0	0.0	0.0					0.0
	19	0.0	0.0	0.0		0.0	0.0	0.0					0.0
	20	0.0	0.0	0.0		0.0	0.0	0.0					0.0
	21	0.0	0.0	0.0		0.0	0.0	0.0					0.0
	22	0.0	0.0	0.0		0.0	0.0	0.0					0.0
	23	0.0	0.0	0.0		0.0	0.0	0.0					0.0
	24	0.0	0.0	0.0		0.0	0.0	0.0					0.0
	25	0.0	0.0	0.0		0.0	0.0	0.0					0.0
	26	0.0	0.0	0.0		0.0	0.0	0.0					0.0
	27	0.0	0.0	0.0		0.0	0.0	0.0					0.0
	28	0.0	0.0	0.0		0.0	0.0	0.0					0.0
	29	0.0	0.0	0.0		0.0	0.0	0.0					0.0
	30	0.0		0.0		0.0	0.0	0.0					0.0
	31	0.0		0.0		0.0		0.0					0.0

Table XVII3.3.1 Daily Rainfall of Timkit

Station: IFFRE

(unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1997	1	8.0	15.0	6.0	5.6				16.5	15.0	3.8		
	2	0.0	0.0	5.5	2.6				8.0	3.6	0.0		
	3	0.0	0.0	0.0	2.4				0.0	0.0	0.0		
	4	0.0	0.0	0.0	0.0				0.0	0.0	0.0		
	5	0.0	0.0	0.0	0.0				0.0	0.0	0.0		
	6	0.0	0.0	0.0	0.0				0.0	0.0	0.0		
	7	0.0	0.0	0.0	0.0				0.0	0.0	0.0		
	8	0.0	0.0	0.0	0.0				0.0	0.0	0.0		
	9	0.0	0.0	0.0	0.0				0.0	0.0	0.0		
	10	0.0	0.0	0.0	0.0				0.0	0.0	0.0		
	11	0.0	0.0	0.0	0.0				0.0	0.0	0.0		
	12	0.0	0.0	0.0	0.0				0.0	0.0	0.0		
	13	0.0	0.0	0.0	0.0				0.0	0.0	0.0		
	14	0.0	0.0	0.0	0.0				0.0	0.0	0.0		
	15	0.0	0.0	0.0	0.0				0.0	0.0	0.0		
	16	0.0	0.0	0.0	0.0				0.0	0.0	0.0		
	17	0.0	0.0	0.0	0.0				0.0	0.0	0.0		
	18	0.0	0.0	0.0	0.0				0.0	0.0	0.0		
	19	0.0	0.0	0.0	0.0				0.0	0.0	0.0		
	20	0.0	0.0	0.0	0.0				0.0	0.0	0.0		
	21	0.0	0.0	0.0	0.0				0.0	0.0	0.0		
	22	0.0	0.0	0.0	0.0				0.0	0.0	0.0		
	23	0.0	0.0	0.0	0.0				0.0	0.0	0.0		
	24	0.0	0.0	0.0	0.0				0.0	0.0	0.0		
	25	0.0	0.0	0.0	0.0				0.0	0.0	0.0		
	26	0.0	0.0	0.0	0.0				0.0	0.0	0.0		
	27	0.0	0.0	0.0	0.0				0.0	0.0	0.0		
	28	0.0	0.0	0.0	0.0				0.0	0.0	0.0		
	29	0.0		0.0	0.0				0.0	0.0	0.0		
	30	0.0		0.0	0.0				0.0	0.0	0.0		
	31	0.0		0.0					0.0		0.0		

Table XVII3.3.1 Daily Rainfall of Timkit

(8/10)

Station: IFFRE (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1998	1	19.7	45.1	36.6			9.6		10.0				2.8
	2	12.6	24.4	16.4			0.0		0.0				0.0
	3	0.0	23.6	0.0			0.0		0.0				0.0
	4	0.0	4.0	0.0			0.0		0.0				0.0
	5	0.0	0.0	0.0			0.0		0.0				0.0
	6	0.0	0.0	0.0			0.0		0.0				0.0
	7	0.0	0.0	0.0			0.0		0.0				0.0
	8	0.0	0.0	0.0			0.0		0.0				0.0
	9	0.0	0.0	0.0			0.0		0.0				0.0
	10	0.0	0.0	0.0			0.0		0.0				0.0
	11	0.0	0.0	0.0			0.0		0.0				0.0
	12	0.0	0.0	0.0			0.0		0.0				0.0
	13	0.0	0.0	0.0			0.0		0.0				0.0
	14	0.0	0.0	0.0			0.0		0.0				0.0
	15	0.0	0.0	0.0			0.0		0.0				0.0
	16	0.0	0.0	0.0			0.0		0.0				0.0
	17	0.0	0.0	0.0			0.0		0.0				0.0
	18	0.0	0.0	0.0			0.0		0.0				0.0
	19	0.0	0.0	0.0			0.0		0.0				0.0
	20	0.0	0.0	0.0			0.0		0.0				0.0
	21	0.0	0.0	0.0			0.0		0.0				0.0
	22	0.0	0.0	0.0			0.0		0.0				0.0
	23	0.0	0.0	0.0			0.0		0.0				0.0
	24	0.0	0.0	0.0			0.0		0.0				0.0
	25	0.0	0.0	0.0			0.0		0.0				0.0
	26	0.0	0.0	0.0			0.0		0.0				0.0
	27	0.0	0.0	0.0			0.0		0.0				0.0
	28	0.0	0.0	0.0			0.0		0.0				0.0
	29	0.0		0.0			0.0		0.0				0.0
	30	0.0		0.0			0.0		0.0				0.0
	31	0.0		0.0					0.0				0.0

Table XVII3.3.1 Daily Rainfall of Timkit

Station: IFFRE (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1999	1	10.0		5.4		2.0		0.0	7.0	2.2	25.2		6.2
	2	6.0		0.0		0.0		0.0	2.6	0.0	23.4		3.8
	3	5.0		0.0		0.0		0.0	0.0	0.0	22.0		3.3
	4	0.0		0.0		0.0		0.0	0.0	0.0	14.8		0.0
	5	0.0		0.0		0.0		0.0	0.0	0.0	13.1		0.0
	6	0.0		0.0		0.0		0.0	0.0	0.0	9.6		0.0
	7	0.0		0.0		0.0		0.0	0.0	0.0	9.2		0.0
	8	0.0		0.0		0.0		0.0	0.0	0.0	6.3		0.0
	9	0.0		0.0		0.0		0.0	0.0	0.0	5.0		0.0
	10	0.0		0.0		0.0		0.0	0.0	0.0	0.0		0.0
	11	0.0		0.0		0.0		0.0	0.0	0.0	0.0		0.0
	12	0.0		0.0		0.0		0.0	0.0	0.0	0.0		0.0
	13	0.0		0.0		0.0		0.0	0.0	0.0	0.0		0.0
	14	0.0		0.0		0.0		0.0	0.0	0.0	0.0		0.0
	15	0.0		0.0		0.0		0.0	0.0	0.0	0.0		0.0
	16	0.0		0.0		0.0		0.0	0.0	0.0	0.0		0.0
	17	0.0		0.0		0.0		0.0	0.0	0.0	0.0		0.0
	18	0.0		0.0		0.0		0.0	0.0	0.0	0.0		0.0
	19	0.0		0.0		0.0		0.0	0.0	0.0	0.0		0.0
	20	0.0		0.0		0.0		0.0	0.0	0.0	0.0		0.0
	21	0.0		0.0		0.0		0.0	0.0	0.0	0.0		0.0
	22	0.0		0.0		0.0		0.0	0.0	0.0	0.0		0.0
	23	0.0		0.0		0.0		0.0	0.0	0.0	0.0		0.0
	24	0.0		0.0		0.0		0.0	0.0	0.0	0.0		0.0
	25	0.0		0.0		0.0		0.0	0.0	0.0	0.0		0.0
	26	0.0		0.0		0.0		0.0	0.0	0.0	0.0		0.0
	27	0.0		0.0		0.0		0.0	0.0	0.0	0.0		0.0
	28	0.0		0.0		0.0		0.0	0.0	0.0	0.0		0.0
	29	0.0		0.0		0.0		0.0	0.0	0.0	0.0		0.0
	30	0.0		0.0		0.0		0.0	0.0	0.0	0.0		0.0
	31	0.0		0.0		0.0		0.0	0.0		0.0		0.0

Table XVII3.3.1 Daily Rainfall of Timkit

Station: IFFRE (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2000	1	0.0	0.0	0.0	5.2	8.2							
	2	0.0	0.0	0.0	0.0	0.0							
	3	0.0	0.0	0.0	0.0	0.0							
	4	0.0	0.0	0.0	0.0	0.0							
	5	0.0	0.0	0.0	0.0	0.0							
	6	0.0	0.0	0.0	0.0	0.0							
	7	0.0	0.0	0.0	0.0	0.0							
	8	0.0	0.0	0.0	0.0	0.0							
	9	0.0	0.0	0.0	0.0	0.0							
	10	0.0	0.0	0.0	0.0	0.0							
	11	0.0	0.0	0.0	0.0	0.0							
	12	0.0	0.0	0.0	0.0	0.0							
	13	0.0	0.0	0.0	0.0	0.0							
	14	0.0	0.0	0.0	0.0	0.0							
	15	0.0	0.0	0.0	0.0	0.0							
	16	0.0	0.0	0.0	0.0	0.0							
	17	0.0	0.0	0.0	0.0	0.0							
	18	0.0	0.0	0.0	0.0	0.0							
	19	0.0	0.0	0.0	0.0	0.0							
	20	0.0	0.0	0.0	0.0	0.0							
	21	0.0	0.0	0.0	0.0	0.0							
	22	0.0	0.0	0.0	0.0	0.0							
	23	0.0	0.0	0.0	0.0	0.0							
	24	0.0	0.0	0.0	0.0	0.0							
	25	0.0	0.0	0.0	0.0	0.0							
	26	0.0	0.0	0.0	0.0	0.0							
	27	0.0	0.0	0.0	0.0	0.0							
	28	0.0	0.0	0.0	0.0	0.0							
	29	0.0	0.0	0.0	0.0	0.0							
	30	0.0		0.0	0.0	0.0							
	31	0.0		0.0		0.0							

Table XVII3.3.2: Breakdown of Construction Cost for TIMKIT Dam (1/5)

	Work Item	Unit	Quantity	Local Currency Unit Cost (DH)	Local Currency Amount (1,000DH)	Foreign Unit Cost (DH)	Foreign Amount (1,000DH)	Total (1,000DH)	Remarks
A	Dam								
1	River Diversion Works								
1-1	Inlet/Outlet Channel								
	Excavation / hauling, soil & gravel	m^3	0	8.59	0	15.95	0	0	
	- ditto -, rock	m^3	0	32.89	0	61.13	0	0	
	Backfill, soil	m^3	0	2.36	0	4.40	0	0	
	Reinforced concrete	m^3	0	308.77	0	573.43	0	0	
	Form work	m^2	0	14.23	0	26.42	0	0	
	Miscellaneous works	L.S	1	0.00	0	0.00	0	0	0% above
	Sub-total				0		0	0	
1-2	Culvert Channel								
	Excavation and hauling, gravel		0	8.59	0	15.95	0	0	
	- ditto -, rock		0	32.89	0	61.13	0	0	
	Reinforced concrete	m^3	2,660	308.77	821	573.43	1,525	2,346	
	Plain concrete (Plugging)	m3	1,615	191.39	309	355.42	574	883	
	Form work	m^2	2,169	14.23	31	26.42	57	88	
	Consolidation grouting	m			0		0	0	foundation treatment
	Curtain grouting	m			0		0	0	work
	Miscellaneous works	L.S	1	0.00	0	0.00	0	0	0% above
	Sub-total				1,161		2,156	3,317	
1-3	Coffer Dam								
	Excavation, gravel	m^3	0		0		0	0	Estimated in dam foundation excavation
	Plain concrete	m^3	0	191.39	0	355.42	0	0	
	Form work	m^2	0	14.23	0	26.42	0	0	
	Miscellaneous works	L.S	1	0.00	0	0.00	0	0	0% above
	Sub-total				0		0	0	
	Total				1,161		2,156	3,317	

Table XVII3.3.2: Breakdown of Construction Cost for TIMKIT Dam (2/5)

	Work Item	Unit	Quantity	Local Currency		Foreign		Total	Remarks
				Unit Cost (DH)	Amount (1,000DH)	Unit Cost (DH)	Amount (1,000DH)	(1,000DH)	
2	Foundation Excavation								
	Excavation / hauling, soil & gravel	m^3	73,400	8.59	631	15.95	1,171	1,802	
	- ditto -, rock	m^3	92,500	32.89	3,042	61.13	5,655	8,697	
	Miscellaneous works	L.S	1	0.00	0	0.00	0	0	0% above
	Sub-total				3,673		6,826	10,499	
3	Foundation Treatment Works								
	Curtain grouting work	m	13,193	411.60	5,430	764.39	10,085	15,515	
	Consolidation grouting work	m	1,649	278.37	459	516.96	852	1,311	
	Miscellaneous works	L.S	1	294,450.00	294	546,850.00	547	841	5% above
	Sub-total				6,183		11,484	17,667	
4	Dam Embankment								
	Inner concrete	m^3	182,725	115.93	21,183	215.31	39,343	60,526	
	Outer concrete	m^3	44,000	191.39	8,421	355.42	15,638	24,059	
	Reinforced concrete	m^3	909	308.77	281	573.43	521	802	
	Tie rod	t	31	3,570.00	111	6,630.00	206	317	
	Miscellaneous works	L.S	1	0.00	0	0.00	0	0	0% above
	Sub-total				29,996		55,708	85,704	
	Total				39,852		74,018	113,870	

Table XVII3.3.2: Breakdown of Construction Cost for TIMKIT Dam (3/5)

	Work Item	Unit	Quantity	Local Currency Unit Cost (DH)	Local Currency Amount (1,000DH)	Foreign Unit Cost (DH)	Foreign Amount (1,000DH)	Total (1,000DH)	Remarks
5	Spillway								
	Reinforced concrete	m^3	1,052	308.77	325	573.43	603	928	
	Form work	m^2	1,522	14.23	22	26.42	40	62	
	Miscellaneous works	L.S	1	0.00	0	0.00	0	0	0% above
	Sub-total				347		643	990	
6	Outlet Works								
6-1	Inlet Structure								
	Reinforced concrete	m^3	344	308.77	106	573.43	197	303	
	Form work	m^2	688	14.23	10	26.42	18	28	
	Miscellaneous works	L.S	1	0.00	0	0.00	0	0	0% above
	Sub-total				116		215	331	
6-2	Plug Works								
	Plain concrete	m^3	0	191.39	0	355.42	0	0	
	Form work	m^2	0	14.23	0	26.42	0	0	
	Miscellaneous works	L.S	1	0.00	0	0.00	0	0	0% above
	Sub-total				0		0	0	
6-3	Outlet Structure								
	Reinforced concrete	m^3	271	308.77	84	573.43	155	239	
	Form work	m^2	593	14.23	8	26.42	16	24	
	Miscellaneous works	L.S	1	0.00	0	0.00	0	0	0% above
	Sub-total				92		171	263	
	Total				555		1,029	1,584	

Table XVII3.3.2: Breakdown of Construction Cost for TIMKIT Dam (4/5)

	Work Item	Unit	Quantity	Local Currency Unit Cost (DH)	Local Currency Amount (1,000DH)	Foreign Unit Cost (DH)	Foreign Amount (1,000DH)	Total (1,000DH)	Remarks
7	Gate and Pipe								
7-1	Inlet works								
	D400mm Slide gate with hoist	pcs	2	280,000	560	520,000	1,040	1,600	2,000 DH/mm, incl. installation
	Sub-total				560		1,040	1,600	
7-2	Outlet works								
	D600mm Steel pipe	m	50	1,225	61	2,275	114	175	3,500 DH/m, incl. installation
	D300mm Jet flow gate with hoist	pcs	1	420,000	420	780,000	780	1,200	4,000 DH/mm, -do-
	Flow meter	pcs	1	52,500	53	97,500	98	151	150,000 DH/pcs, -do-
	Sub-total				534		992	1,526	
7-3	Others	L.S	1	109,400	109	203,200	203	312	10% above
	Total				1,203		2,235	3,438	
8	Sabo Dam								
	Excavation / hauling, soil & gravel	m^3	25,500	8.59	219	15.95	407	626	
	- ditto -, rock	m^3	25,500	32.89	839	61.13	1,559	2,398	
	Sabo dam body	m^3	47,815	115.93	5,543	215.31	10,295	15,838	
	Miscellaneous works	L.S	1	0.00	0	0.00	0	0	0% above
	Total				6,601		12,261	18,862	
	Total (1-8)				**49,372**		**91,699**	**141,071**	
9	Overhead and Profit of Contractor								
	Overhead (general)	L.S	1	4,156,800	4,157	7,720,300	7,720	11,877	10% total of 1-6
	Overhead (sabo)	L.S	1	330,050	330	613,050	613	943	5% total of 8
	Profit of Contractor	L.S	1	2,692,970	2,693	5,001,600	5,002	7,695	5% above
	Road relocation	m	3,500	79	277	147	515	792	
	Total				7,457		13,850	21,307	
	Total (Direct Construction Cost; 1-9)				**56,829**		**105,549**	**162,378**	
10	Physical Contingency	L.S	1	5,682,940	5,683	10,554,900	10,555	16,238	10% total of 1-8
	Total (1-10)				**62,512**		**116,104**	**178,616**	
11	Price Contingency (3% / year)	L.S	1	14,369,967	14,370	26,689,275	26,689	41,059	23% total of 1-9, 7years
	Total (1-11)				**76,882**		**142,793**	**219,675**	
12	Value Added Tax	L.S	1	10,763,536	10,764	19,991,020	19,991	30,755	14% total of 1-10
	Grand Total				**87,600**		**162,700**	**250,300**	

Table XVII3.3.2: Breakdown of Construction Cost for TIMKIT Dam (5/5)

	Work Item	Unit	Quantity	Local Currency		Foreign		Total	Remarks
				Unit Cost (DH)	Amount (1,000DH)	Unit Cost (DH)	Amount (1,000DH)	(1,000DH)	
B	Irrigation Facilities								
1	Canal								
	Flume Canal	m	3,600	60.00	216	60.00	216	432	
	Masonry Canal	m	34,900	221.50	7,730	221.50	7,730	15,460	
	Sub-total				7,946		7,946	15,892	
2	Structures								
	Diversion	no	12	290,995	3,492	290,995	3,492	6,984	
	On-farm Facilities	ha	3,060	11,115	34,012	11,115	34,012	68,024	
	Well	no	37	173,820	6,431	173,820	6,431	12,862	
	River channel	m	5,000	120	600	120	600	1,200	
	Sub-total				44,535		44,535	89,070	
	Total (1-2)				**52,481**		**52,481**	**104,962**	
3	Overhead and Profit of Contractor	L.S	1	3,673,670	3,674	3,673,670	3,674	7,348	7% above
	Total (Direct Construction Cost; 1-3)				**56,155**		**56,155**	**112,310**	
4	Physical Contingency	L.S	1	5,615,500	5,616	5,615,500	5,616	11,232	10% total of 1-3
	Total (1-4)				**61,771**		**61,771**	**123,542**	
5	Price Contingency	L.S	1	14,207,330	14,207	14,207,330	14,207	28,414	23% total of 1-4, 7years
	Total (1-5)				**75,978**		**75,978**	**151,956**	
6	Value Added Tax	L.S	1	10,636,920	10,637	10,636,920	10,637	21,274	14% total of 1-5
	Grand Total				**86,610**		**86,610**	**173,200**	

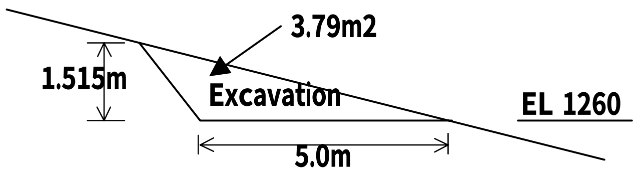
Table XVII3.3.2 Attachment

I. Cost Estimate for the Road Relocation

The left bank road should be relocated as it would be inundated after dam construction.
The length of relocation is about 3.5km.

1 Excavation

Area (m2);	3.79
Soil : Rock=	1 : 1
Soil exc.	1.9 m2/m
Rock exc.	1.9 m2/m



2 Gravel Pavement

Area (m2);	1.5 m2/m

3 Unit cost (DH)/1m of road relocation

*Total value is rounded.

Item	Volume (m3)	Local Currency (DH) Unit Cost	Local Currency (DH) Amount	Foreign Currency (DH) Unit Cost	Foreign Currency (DH) Amount	Total (DH)
Soil exc.	1.9	8.59	16.32	15.95	30.31	46.63
Rock exc.	1.9	32.89	62.49	61.13	116.15	178.64
Gravel pav	1.5	0.27	0.41	0.51	0.77	1.17
Total			79.00		147.00	226.00

II. Volume of Sabo Dam

The main dam has a pocket of 20 years sediment volume only.
Therefore, remaining 30 years sediment volume (6M m3) shall be stored at a sabo dam.
The location of sabo dam is about 20km upstream from the dam site.

1 Features

Basin Area	330 km2		
1/100 Flood	557 m3/s		
Crest EL	1372.27	=>	1372.5 m
Dam Height	42.5 m		

2 Volume

Dam Volume	956,300
Excavation	102,000 *soil : rock = 1: 1

Table XVII3.4.1 Daily Rainfall of Azghar

(1/10)

Station: DAR HAMRA (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1991	1	4.1	21.3	25.4	18.3	9.8	5.7	5.0	9.0	16.0	14.5	10.7	17.0
	2	3.2	16.4	23.0	13.2	3.0	2.4	2.0	6.5	15.3	7.2	8.5	8.8
	3	2.3	16.1	22.1	6.3	1.0	0.9	1.6	4.9	7.5	6.0	6.3	3.0
	4	2.1	12.0	20.7	3.6	0.4	0.5	0.3	1.7	6.2	5.7	0.9	2.5
	5	0.7	11.2	18.3	1.8	0.4	0.0	0.0	1.0	3.4	2.5	0.0	1.4
	6	0.0	9.0	15.5	1.7	0.0	0.0	0.0	0.0	1.6	2.2	0.0	1.3
	7	0.0	8.5	14.7	1.7	0.0	0.0	0.0	0.0	1.5	1.2	0.0	1.1
	8	0.0	7.6	9.7	1.2	0.0	0.0	0.0	0.0	0.5	0.3	0.0	1.0
	9	0.0	1.1	3.6	1.1	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.3
	10	0.0	1.1	2.6	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	11	0.0	1.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	12	0.0	0.2	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	13	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	29	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	30	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	31	0.0		0.0		0.0		0.0	0.0		0.0		0.0

Table XVII3.4.1 Daily Rainfall of Azghar

Station: DAR HAMRA (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1992	1	4.3	12.5	28.8	9.2	39.1	36.6	0.6	8.0	8.4	15.1	8.6	11.9
	2	0.0	12.3	18.3	8.0	20.5	24.4	0.0	4.4	3.6	12.4	4.2	6.2
	3	0.0	4.1	14.8	7.9	7.7	3.3	0.0	2.0	0.4	4.1	0.4	0.7
	4	0.0	2.5	8.5	7.0	4.1	3.1	0.0	0.9	0.4	3.8	0.0	0.7
	5	0.0	1.9	4.5	6.9	3.3	1.1	0.0	0.8	0.0	3.4	0.0	0.5
	6	0.0	1.2	3.5	6.5	1.5	1.0	0.0	0.7	0.0	1.2	0.0	0.3
	7	0.0	0.0	2.8	6.3	0.9	0.0	0.0	0.3	0.0	0.3	0.0	0.0
	8	0.0	0.0	2.0	6.3	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	9	0.0	0.0	1.8	4.3	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	10	0.0	0.0	0.2	3.8	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	29	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	30	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	31	0.0		0.0		0.0		0.0	0.0		0.0		0.0

Table XVII3.4.1 Daily Rainfall of Azghar

(3/10)

Station: DAR HAMRA (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1993	1	14.7	18.5	41.5	11.2	11.5	4.3	0.0	2.3	4.4	5.8	27.6	11.0
	2	2.8	9.9	10.8	7.6	10.9	3.3	0.0	0.3	1.0	4.9	18.6	10.2
	3	0.5	8.1	8.2	7.4	0.3	1.4	0.0	0.0	0.8	3.8	10.0	1.4
	4	0.0	3.6	8.0	4.4	0.2	0.0	0.0	0.0	0.0	0.4	8.3	0.5
	5	0.0	3.5	6.6	3.6	0.2	0.0	0.0	0.0	0.0	0.3	4.9	0.3
	6	0.0	2.7	6.3	2.5	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0
	7	0.0	1.6	5.6	0.9	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0
	8	0.0	1.2	3.7	0.8	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0
	9	0.0	0.5	2.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.0
	10	0.0	0.0	0.7	0.2	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.0
	11	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0
	12	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0
	13	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0
	14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0
	15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0
	16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0
	17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0
	18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0
	19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0
	20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	29	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	30	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	31	0.0		0.0		0.0		0.0	0.0		0.0		0.0

Table XVII3.4.1 Daily Rainfall of Azghar

Station: DAR HAMRA (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1994	1	17.8	32.2	21.0	11.7	17.5	0.5	0.0	1.0	13.9	7.1	6.5	1.3
	2	16.1	29.0	20.1	3.7	6.3	0.0	0.0	0.0	7.5	6.9	2.4	1.1
	3	8.3	18.0	14.5	1.7	0.6	0.0	0.0	0.0	7.4	4.9	0.5	0.0
	4	6.6	15.5	6.9	1.4	0.0	0.0	0.0	0.0	6.2	2.2	0.0	0.0
	5	2.5	11.0	6.8	0.3	0.0	0.0	0.0	0.0	0.6	0.7	0.0	0.0
	6	2.0	6.5	5.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	7	1.1	4.3	5.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	8	0.6	2.5	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	9	0.0	1.6	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	10	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	11	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	29	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	30	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	31	0.0		0.0		0.0		0.0	0.0		0.0		0.0

Table XVII3.4.1 Daily Rainfall of Azghar

Station: DAR HAMRA (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1995	1	2.9	58.2	18.7	28.7	3.8	19.4	0.1	4.9	6.2	8.6	10.1	48.9
	2	2.0	12.1	12.7	11.1	1.9	1.8	0.0	3.8	4.6	4.4	8.4	13.6
	3	1.3	6.0	10.6	5.3	1.5	1.3	0.0	0.0	3.4	0.1	4.9	13.0
	4	1.2	1.3	9.4	3.2	0.5	1.2	0.0	0.0	0.0	0.1	3.7	13.0
	5	0.0	0.3	8.3	1.9	0.4	0.6	0.0	0.0	0.0	0.0	0.6	10.8
	6	0.0	0.2	7.5	1.7	0.3	0.4	0.0	0.0	0.0	0.0	0.1	4.9
	7	0.0	0.0	5.8	1.7	0.0	0.2	0.0	0.0	0.0	0.0	0.0	3.4
	8	0.0	0.0	1.6	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5
	9	0.0	0.0	0.2	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
	10	0.0	0.0	0.2	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
	11	0.0	0.0	0.2	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
	12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
	13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	29	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	30	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	31	0.0		0.0		0.0		0.0	0.0		0.0		0.0

Table XVII3.4.1 Daily Rainfall of Azghar

Station: DAR HAMRA (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1996	1	38.9	13.5	18.4	28.0	13.6	25.2	1.3	1.5	23.6	14.4	10.4	27.0
	2	34.5	13.0	15.2	12.3	10.0	5.6	0.0	0.4	15.0	2.2	2.4	25.9
	3	15.0	9.6	15.1	11.4	9.6	2.0	0.0	0.0	1.5	1.9	1.4	24.8
	4	14.2	4.6	9.7	10.7	8.9	0.9	0.0	0.0	1.1	0.0	1.0	9.7
	5	14.1	3.9	6.7	7.9	7.7	0.5	0.0	0.0	0.6	0.0	0.0	9.6
	6	13.1	3.8	5.5	4.0	3.7	0.4	0.0	0.0	0.4	0.0	0.0	6.6
	7	8.7	3.7	3.1	3.2	2.8	0.4	0.0	0.0	0.1	0.0	0.0	6.3
	8	8.5	2.4	1.7	2.9	2.3	0.2	0.0	0.0	0.0	0.0	0.0	6.2
	9	6.6	1.7	1.2	1.4	2.2	0.2	0.0	0.0	0.0	0.0	0.0	6.1
	10	5.7	1.7	0.9	1.1	1.8	0.0	0.0	0.0	0.0	0.0	0.0	5.7
	11	4.9	1.2	0.8	0.5	1.1	0.0	0.0	0.0	0.0	0.0	0.0	4.7
	12	4.7	1.0	0.4	0.3	0.4	0.0	0.0	0.0	0.0	0.0	0.0	4.5
	13	4.1	0.9	0.3	0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	3.7
	14	2.9	0.9	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.7
	15	2.5	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6
	16	2.4	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3
	17	1.6	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7
	18	1.4	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
	19	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
	20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
	21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	29	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	30	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	31	0.0		0.0		0.0		0.0	0.0		0.0		0.0

Table XVII3.4.1 Daily Rainfall of Azghar

Station: DAR HAMRA (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1997	1	45.7		8.4	22.5	26.0	6.6	0.0	2.0	27.6	10.6	28.7	30.3
	2	19.7		5.2	18.0	4.9	4.8	0.0	1.3	23.1	7.3	14.1	17.5
	3	19.2		4.4	8.2	3.4	0.2	0.0	0.6	14.7	1.0	10.9	13.8
	4	6.3		0.4	7.4	3.4	0.0	0.0	0.0	12.6	0.0	5.1	10.2
	5	4.9		0.0	6.2	1.9	0.0	0.0	0.0	6.2	0.0	3.6	7.7
	6	4.8		0.0	4.6	0.3	0.0	0.0	0.0	4.8	0.0	2.9	3.3
	7	4.6		0.0	3.4	0.0	0.0	0.0	0.0	3.8	0.0	1.7	3.0
	8	2.7		0.0	3.2	0.0	0.0	0.0	0.0	1.3	0.0	1.4	1.6
	9	1.9		0.0	2.4	0.0	0.0	0.0	0.0	1.1	0.0	1.2	0.6
	10	1.9		0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.3
	11	1.0		0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0
	12	1.0		0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0
	13	0.5		0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0
	14	0.3		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0
	15	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	16	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	17	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	18	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	19	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	20	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	21	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	22	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	23	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	24	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	25	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	26	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	27	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	28	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	29	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	30	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	31	0.0		0.0		0.0		0.0	0.0		0.0		0.0

Table XVII3.4.1 Daily Rainfall of Azghar

Station: DAR HAMRA (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1998	1	9.2		9.0	4.7	12.5	2.6	0.0	17.3	12.0	0.8	3.3	28.2
	2	1.9		0.0	3.3	10.2	2.5	0.0	6.1	2.4	0.0	0.0	6.0
	3	0.6		0.0	1.4	8.6	0.5	0.0	1.7	1.6	0.0	0.0	5.3
	4	0.0		0.0	0.9	7.0	0.4	0.0	0.9	0.0	0.0	0.0	2.9
	5	0.0		0.0	0.8	4.4	0.2	0.0	0.2	0.0	0.0	0.0	2.6
	6	0.0		0.0	0.5	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.9
	7	0.0		0.0	0.5	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	8	0.0		0.0	0.4	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	9	0.0		0.0	0.2	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	10	0.0		0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	11	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	12	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	13	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	14	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	15	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	16	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	17	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	18	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	19	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	20	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	21	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	22	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	23	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	24	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	25	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	26	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	27	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	28	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	29	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	30	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	31	0.0		0.0		0.0		0.0	0.0		0.0		0.0

Table XVII3.4.1 Daily Rainfall of Azghar

Station: DAR HAMRA (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1999	1	27.7	25.6	25.7	3.5	15.3	2.8		2.0	8.0	7.3		
	2	9.0	15.3	13.2	0.3	14.9	2.5		0.4	3.3	6.3		
	3	8.8	4.5	12.4	0.0	1.0	0.2		0.0	1.4	2.1		
	4	7.5	3.2	10.5	0.0	0.4	0.0		0.0	1.4	0.7		
	5	5.9	2.5	5.4	0.0	0.3	0.0		0.0	0.0	0.0		
	6	5.6	0.4	5.2	0.0	0.3	0.0		0.0	0.0	0.0		
	7	4.9	0.3	2.8	0.0	0.0	0.0		0.0	0.0	0.0		
	8	2.9	0.0	1.4	0.0	0.0	0.0		0.0	0.0	0.0		
	9	2.5	0.0	1.0	0.0	0.0	0.0		0.0	0.0	0.0		
	10	0.3	0.0	0.8	0.0	0.0	0.0		0.0	0.0	0.0		
	11	0.0	0.0	0.7	0.0	0.0	0.0		0.0	0.0	0.0		
	12	0.0	0.0	0.5	0.0	0.0	0.0		0.0	0.0	0.0		
	13	0.0	0.0	0.4	0.0	0.0	0.0		0.0	0.0	0.0		
	14	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0		
	15	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0		
	16	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0		
	17	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0		
	18	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0		
	19	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0		
	20	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0		
	21	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0		
	22	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0		
	23	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0		
	24	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0		
	25	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0		
	26	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0		
	27	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0		
	28	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0		
	29	0.0		0.0	0.0	0.0	0.0		0.0	0.0	0.0		
	30	0.0		0.0	0.0	0.0	0.0		0.0	0.0	0.0		
	31	0.0		0.0		0.0			0.0		0.0		

Table XVII3.4.1 Daily Rainfall of Azghar

Station: DAR HAMRA (unit: mm/day)

Year	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2000	1		0.0	0.0	12.6								
	2		0.0	0.0	6.6								
	3		0.0	0.0	4.5								
	4		0.0	0.0	3.7								
	5		0.0	0.0	1.8								
	6		0.0	0.0	1.7								
	7		0.0	0.0	1.3								
	8		0.0	0.0	1.2								
	9		0.0	0.0	0.5								
	10		0.0	0.0	0.4								
	11		0.0	0.0	0.0								
	12		0.0	0.0	0.0								
	13		0.0	0.0	0.0								
	14		0.0	0.0	0.0								
	15		0.0	0.0	0.0								
	16		0.0	0.0	0.0								
	17		0.0	0.0	0.0								
	18		0.0	0.0	0.0								
	19		0.0	0.0	0.0								
	20		0.0	0.0	0.0								
	21		0.0	0.0	0.0								
	22		0.0	0.0	0.0								
	23		0.0	0.0	0.0								
	24		0.0	0.0	0.0								
	25		0.0	0.0	0.0								
	26		0.0	0.0	0.0								
	27		0.0	0.0	0.0								
	28		0.0	0.0	0.0								
	29		0.0	0.0	0.0								
	30			0.0	0.0								
	31			0.0									

Table XVII3.4.2: Breakdown of Construction Cost for AZGHAR Dam (1/5)

	Work Item	Unit	Quantity	Local Currency Unit Cost (DH)	Local Currency Amount (1,000DH)	Foreign Unit Cost (DH)	Foreign Amount (1,000DH)	Total (1,000DH)	Remarks
A	Dam								
1	River Diversion Works								
1-1	Inlet/Outlet Channel								
	Excavation / hauling, soil & gravel	m^3	53,400	8.59	459	15.95	852	1,311	
	- ditto -, rock	m^3	0	32.89	0	61.13	0	0	
	Backfill, soil	m^3	0	2.36	0	4.40	0	0	
	Reinforced concrete	m^3	437	308.77	135	573.43	251	386	
	Form work	m^2	180	14.23	3	26.42	5	8	
	Miscellaneous works	L.S	1	0.00	0	0.00	0	0	0% above
	Sub-total				597		1,108	1,705	
1-2	Culvert Channel								
	Excavation and hauling, gravel		0	8.59	0	15.95	0	0	
	- ditto -, rock		22,900	32.89	753	61.13	1,400	2,153	
	Reinforced concrete	m^3	13,320	308.77	4,113	573.43	7,638	11,751	
	Plain concrete (Plugging)	m^3	6,000	191.39	1,148	355.42	2,133	3,281	
	Form work	m^2	6,000	14.23	85	26.42	159	244	
	Consolidation grouting	m			0		0	0	Estimated in foundation
	Curtain grouting	m			0		0	0	treatment work
	Miscellaneous works	L.S	1	0.00	0	0.00	0	0	0% above
	Sub-total				6,099		11,330	17,429	
1-3	Coffer Dam						8,490		
	Excavation, gravel	m^3			0		0	0	Estimated in dam foundation excavation
	Embankment, soil	m^3	34,100	2.36	80	4.40	150	230	
	Miscellaneous works	L.S	1	0.00	0	0.00	0	0	0% above
	Sub-total				80		150	230	
	Total				6,776		12,588	19,364	

Table XVII3.4.2: Breakdown of Construction Cost for AZGHAR Dam (2/5)

	Work Item	Unit	Quantity	Local Currency		Foreign		Total	Remarks
				Unit Cost (DH)	Amount (1,000DH)	Unit Cost (DH)	Amount (1,000DH)	(1,000DH)	
2	Foundation Excavation								
	Excavation / hauling, soil & gravel	m^3	211,100	8.59	1,813	15.95	3,367	5,180	
	- ditto -, rock	m^3	46,900	32.89	1,543	61.13	2,867	4,410	
	Miscellaneous works	L.S	1	0.00	0	0.00	0	0	0% above
	Sub-total				3,356		6,234	9,590	
3	Foundation Treatment Works								
	Curtain grouting work	m	4,791	395.85	1,897	735.14	3,522	5,419	
	Miscellaneous works	L.S	1	0.00	0	0.00	0	0	0% above
	Sub-total				1,897		3,522	5,419	
4	Dam Embankment								
	Impervious zone	m^3	130,900	5.44	712	10.10	1,322	2,034	in-situ material
	Filter and Transition zone	m^3	314,600	2.36	742	4.40	1,384	2,126	in-situ material
	Filter and Transition zone	m^3	301,200	12.53	3,774	23.30	7,018	10,792	quarry
	Rip-rap	m^3	23,100	16.35	378	30.35	701	1,079	
	Miscellaneous works	L.S	1	0.00	0	0.00	0	0	0% above
	Sub-total				5,606		10,425	16,031	
	Total				10,859		20,181	31,040	

Table XVII3.4.2: Breakdown of Construction Cost for AZGHAR Dam (2/5)

Work Item	Unit	Quantity	Local Currency		Foreign		Total	Remarks
			Unit Cost (DH)	Amount (1,000DH)	Unit Cost (DH)	Amount (1,000DH)	(1,000DH)	

Table XVII3.4.2: Breakdown of Construction Cost for AZGHAR Dam (3/5)

	Work Item	Unit	Quantity	Local Currency Unit Cost (DH)	Local Currency Amount (1,000DH)	Foreign Unit Cost (DH)	Foreign Amount (1,000DH)	Total (1,000DH)	Remarks
5	Spillway								
	Excavation / hauling, soil & gravel	m^3	156,000	8.59	1,340	15.95	2,488	3,828	
	- ditto -, rock	m^3	39,000	32.89	1,283	61.13	2,384	3,667	
	Backfill, soil	m^3	26,600	12.53	333	23.30	620	953	
	Reinforced concrete	m^3	29,390	308.77	9,075	573.43	16,853	25,928	
	Form work	m^2	22,565	14.23	321	26.42	596	917	
	Miscellaneous works	L.S	1	0.00	0	0.00	0	0	0% above
	Sub-total				12,352		22,941	35,293	
6	Outlet Works								
6-1	Inlet Structure								
	Reinforced concrete	m^3	849	308.77	262	573.43	487	749	
	Form work	m^2	680	14.23	10	26.42	18	28	
	Miscellaneous works	L.S	1	0.00	0	0.00	0	0	0% above
	Sub-total				272		505	777	
6-2	Plug Works								
	Plain concrete	m^3	324	191.39	62	355.42	115	177	
	Miscellaneous works	L.S	1	0.00	0	0.00	0	0	0% above
	Sub-total				62		115	177	
6-3	Outlet Structure								
	Reinforced concrete	m^3	250	308.77	77	573.43	143	220	
	Form work	m^2	750	14.23	11	26.42	20	31	
	Miscellaneous works	L.S	1	0.00	0	0.00	0	0	0% above
	Sub-total				88		163	251	
	Total				12,774		23,724	36,498	

Table XVII3.4.2: Breakdown of Construction Cost for AZGHAR Dam (4/5)

	Work Item	Unit	Quantity	Local Currency Unit Cost (DH)	Local Currency Amount (1,000DH)	Foreign Unit Cost (DH)	Foreign Amount (1,000DH)	Total (1,000DH)	Remarks
7	Gate and Pipe								
7-1	Inlet works								
	D100mm Slide gate	pcs	2	70,000	140	130,000	260	400	2,000 DH/mm, incl. installation
	W3.5 X H10m Roller gate	pcs	1	700,000	700	1,300,000	1,300	2,000	2,000,000 DH/pcs, -do-
	Sub-total				840		1,560	2,400	
7-2	Outlet works								
	D1000mm Steel pipe	m	260	2,380	619	4,420	1,149	1,768	6,800 DH/m, incl. installation
	D1000mm Jet flow gate with hoist	pcs	1	1,400,000	1,400	2,600,000	2,600	4,000	4,000 DH/mm, -do-
	D1000mm Sleeve valve with hoist	pcs	1	1,400,000	1,400	2,600,000	2,600	4,000	4,000 DH/mm, -do-
	Flow meter	pcs	1	87,500	88	162,500	163	251	250,000 DH/pcs, -do-
	Sub-total				3,507		6,512	10,019	
7-3	Others	L.S	1	0	0	0	0	0	0% above
	Total				4,347		8,072	12,419	
	Total (1-7)				**34,756**		**64,565**	**99,321**	
8	Overhead and Profit of Contractor								
	Overhead	L.S	1	2,736,810	2,737	5,084,370	5,084	7,821	9% total of 1-6
	Profit of Contractor	L.S	1	1,874,650	1,875	3,482,450	3,482	5,357	5% above
	Total				4,612		8,566	13,178	
	Total (Direct Construction Cost; 1-8)				**39,368**		**73,131**	**112,499**	
9	Physical Contingency	L.S	1	3,936,800	3,937	7,313,100	7,313	11,250	10% total of 1-8
	Total (1-9)				**43,305**		**80,444**	**123,749**	
10	Price Contingency (3% / year)	L.S	1	9,954,688	9,955	18,491,973	18,492	28,447	23% total of 1-9, 7years
	Total (1-10)				**53,260**		**98,936**	**152,196**	
11	Value Added Tax	L.S	1	7,456,400	7,456	13,851,040	13,851	21,307	14% total of 1-10
	Grand Total				**60,700**		**112,700**	**173,400**	

Table XVII3.4.2: Breakdown of Construction Cost for AZGHAR Dam (5/5)

	Work Item	Unit	Quantity	Local Currency Unit Cost (DH)	Local Currency Amount (1,000DH)	Foreign Unit Cost (DH)	Foreign Amount (1,000DH)	Total (1,000DH)	Remarks
B	Irrigation Facilities								
1	Main Canal								
	Main Canal	m	13,545	233.83	3,167	233.83	3,167	6,334	
	Branch Canal 1	m	2,580	228.09	588	228.09	588	1,176	
	Branch Canal 2	m	5,515	299.20	1,650	299.20	1,650	3,300	
	Branch Canal 3	m	2,670	264.46	706	264.46	706	1,412	
	Sub-total				6,111		6,111	12,222	
2	Structures								
	Siphon	no	20	160,150	3,203	160,150	3,203	6,406	
	Drop	m	875	495	433	495	433	866	
	Offtake	no	50	167,810	8,391	167,810	8,391	16,782	
	Spill way	no	7	2,570	18	2,570	18	36	
	Check	no	13	113,100	1,470	113,100	1,470	2,940	
	Cross Drain	no	60	10,725	644	10,725	644	1,288	
	Bridge	no	26	8,405	219	8,405	219	438	
	Box Culvert	m	65	2,010	131	2,010	131	262	
	On-farm facilities	ha	2,000	6,825	13,650	6,825	13,650	27,300	
	Sub-total				28,159		28,159	56,318	
	Total (1-2)				**34,270**		**34,270**	**68,540**	
3	Overhead and Profit of Contractor	L.S	1	2,398,900	2,399	2,398,900	2,399	4,798	7% above
	Total (Direct Construction Cost; 1-3)				**36,669**		**36,669**	**73,338**	
4	Physical Contingency	L.S	1	3,666,900	3,667	3,666,900	3,667	7,334	10% total of 1-3
	Total (1-4)				**40,336**		**40,336**	**80,672**	
5	Price Contingency	L.S	1	9,277,280	9,277	9,277,280	9,277	18,554	23% total of 1-4, 7years
	Total (1-5)				**49,613**		**49,613**	**99,226**	
6	Value Added Tax	L.S	1	6,945,820	6,946	6,945,820	6,946	13,892	14% total of 1-5
	Grand Total				**56,550**		**56,550**	**113,100**	

Table XVII3.4.2 Attachment

Cost Estimate for Diversion Tunnel (No.17 Azghar)

The cost of the diversion tunnel at No.17 Azghar was estimated basing on the similar case in Japan. A tunnel type is NATM (New Austrian Tunneling Method).

1 Miike Head Race

Type: Horseshoe shape 2r

Radius:	5.4	m
Excavation Area:	27.1	m2
Length:	1895	m
Watertight Work L:	13.8	m

2 Breakdown of Miike Head Race

Item	Unit	Unit Cost (DH/unit)
Excavation	m3	1,370
Shotcrete	m3	1,410
Steel Support	pcs	10,000
Rock Bolt	pcs	640
Cover Concrete	m3	2,870
Watertight Work	m2	211

3 Azghar Diversion Tunnel

Type: Horseshoe shape 2r

Radius:	5	m
Excavation Area:	28	m2
Length:	350	m
Watertight Work L:	12.7	m
Area of Shotcrete:	4.1	m2
Area of Concrete:	3.4	m2

4 Breakdown of Azghar

Item	Unit	Unit Cost (DH/unit)	Volume	Amount (DH)	
Excavation	m3	1,370	9,800	13,426,000	
Shotcrete	m3	1,410	1,435	2,023,350	
Steel Support	pcs	10,000	4	40,000	
Rock Bolt	pcs	640	3,033	1,941,333	
Cover Concrete	m3	2,870	1,190	3,415,300	
Watertight Work	m2	211	4,445	937,895	
				21,783,878	/350m
			=	62,240	/m

*Local Currency : Foreign Currency = 0.35:0.65