JAPAN INTERNATIONAL COOPERATION AGENCY
THE GOVERNMENT OF THE KINGDOM OF MOROCCO

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

FINAL REPORT

VOLUME V

SUPPORTING REPORT (2.B)
FEASIBILITY STUDY

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JOINT VENTURE OF
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Data Book AR:	***Aero-Photo and Ground Survey***
Data Book GC:	***Geology and Construction Materials***
Data Book HY:	***Hydrology***
Data Book SO:	***Soil Survey***
Data Book NE:	***Natural Environment***
Data Book SE:	***Social Environment***
Data Book EA:	***Economic Analysis***

The cost estimate is based on the price level and exchange rate of April 2000. The exchange rate is:
US$ 1.0 = Moroccan Dirham (DH) 10.68 and
Japanese Yen 100.0 = Moroccan Dirham (DH) 9.90

ABBREVIATIONS

Abbreviations	ENGLISH	FRENCH
AEP	Potable Water Supply	**A**pprovisionnement en **E**au **P**otable
APD	Detailed Study	**A**vant **P**rojet **D**étaillé
AUEA	Association of Agricultural Water Users	**A**ssociation des **U**sagers de l'**E**au **A**gricole
BAD	African Bank for Development	**B**anque **A**fricaine de **D**éveloppement
BM	World Bank	**B**anque **M**ondiale
CAM	Agricultural Cooperative of Morocco	**C**oopérative **A**gricole du **M**aroc
CDA	Agricultural DevelopmentCenter	**C**entres de **D**éveloppment **A**gricole
CERED	Center for demographic Research and Studies	**C**entre des études et de **R**echerche **D**émographiques
CLCA	Local Fund for Agricultural Credit	**C**aisse **L**ocale de **C**rédit **A**gricole
CMV	Development Center	**C**entre de **M**ise en **V**aleur
CNCA	National Fund for Agricultural Credit	**C**aisse **N**ationale de **C**rédit **A**gricole
CNE	National Council of Environment	Le **C**onseil **N**ational de l'**E**nvironnement
CSEC	Superior Council for Water and Climate	**C**onseil **S**upérieur de l'**E**au et du **C**limat
DAR	Directorate of Rural Affairs	**D**irection des **A**ffaires **R**urales
DCL	Directorate of Local Collectivities	**D**irection des **C**ollectivités **L**ocales
DCRF	Directorate of Forest Resources Conservation	**D**irection de la **C**onservation des **R**essources **F**orestières
DDF	Directorate of Forest Development	**D**irection de **D**éveloppement **F**orestière
DE	Directorate of Operation	**D**irection des **E**conomiques
DELM	Directorate of Epidemology and Abatement of Disease	**D**irection d'**E**pidemologie et de **L**utte Contre les **M**aladies
DEP	Directorate of Design and Planning	Direction de Planification et des Plans
DEPR	Division of Potable Rural Water Supply	**D**ivision d'Alimentation en **E**au Potable en Milieu **R**ural
DERD	Decentralized Regional Directorate	**D**irection de l'**E**nseignement, de la Recherche et de Développement Rural
DF	Directorate of Finance	Direction des Finances
DGCL	General Directorate of Local Communities	**D**irection **G**énérale des **C**ollectivités **L**ocales
DGH	Directorate General of Hydraulics	**D**irection **G**énérale de l'**H**ydraulique
DH	**D**irham	**D**irham
DIEC	**D**ivision of **I**nformation, **E**ducation and **C**ommunication	**D**ivision d'**I**nformation, **E**ducation et **C**ommunication

DP	Provincial Directorate	**D**irection **P**rovinciale

Abbreviations	**ENGLISH**	**FRENCH**
DPA	Provincial Directorate of Agriculture	**D**irection **P**rovinciale d' **A**griculture
DPA	Provincial Directorate of Animal	**D**irection **P**rovinicials de l' **A**nimale
DPTP	Provincial Directorate of Public Works	**D**irection **P**rovinciale des **T**ravaux Publiques
DPV	Directorate of Vegetable Production	**D**irection de la **P**roduction **V**égétale
DRD	**D**ecentralized **R**egional **D**irectorate	**D**irection **R**égionale **D**écentralisée
DT	Division of Works	**D**ivision du **T**ravail
EIRR	**E**conomic **I**nternal **R**ate of **R**eturn	
EMP	**E**nvironmental Management **P**lan	Plan de Gestion Environnementale
FERTIMA	Moroccan Company of Fertilizers	**S**ociété **M**arocaine de **F**ertilisation
FV	Training Visit	**F**ormation **V**isite
GH	Large Hydraulic	**G**rande **H**ydraulique
GPD	**G**ross **D**omestic **P**roduct	Produit National Brut
HCWC	**H**igh **C**ouncil of Water and **C**limate	Conseil Superieur de l'eau et du Climat
IBRD	**I**nternational **B**ank for **R**econstruction and **D**evelopment	Banque Internationale pour la Reconstruction et le Développement
INH	National Institute of Hygiene	**I**nstitut **N**ationale de l'**H**ygiène
JBIC	**J**apan **B**ank for **I**nternational **C**ooperation	Banque Japon de Coopération Internationale
JICA	**J**apan **I**nternational **C**ooperation **A**gency	Agence Japonaise pour la Coopération Internationale
MADRPM	Ministry of Agriculture, Rural Development and Maritime Fishing	**M**inistère de l'**A**griculture du **D**éveloppement **R**ural et des **P**êches **M**aritimes
MCEF	Ministry In Charge of Water and Forests	**M**inistère **C**hargé des **E**aux et **F**orêts
MI	**M**inistry of **I**nterior	**M**inistère de l'**I**ntérieur
MOA	**M**inistry of **A**griculture, Rural Development and Fishery	Ministère de l'Agriculture du développement Rural et des Pêches maritimes
MOE	**M**inistry of **E**quipment	Ministère de l'Equipement
MOI	**M**inistry of **I**nterior	Ministère de l'Intérieur
MPW	**M**inistry of **P**ublic **W**orks	Ministère des travaux Publics
MSL	**M**ean **S**ea **L**evel	Niveau Moyen de La mer
MSP	Ministry of Public Health	**M**inistère de la **S**anté **P**ublique
NG	**N**atural **G**round	Sol Naturel
NPV	**N**et **P**resent **V**alue	Valeur Nette Actuelle
OECF	**O**verseas **E**conomic **C**ooperation **F**und (now JBIC)	Fond de Coopération Economique Etrangère

OMM	**O**peration, **M**aintenance and **M**anagement	Opérations de gestion et de maintenance
ONE	National Office of Electricity	**O**ffice **N**ational de l'**E**lectricité
ONEP	National Office of Potable Water	**O**ffice **N**ational de l'**E**au **P**otable
Abbreviations	**ENGLISH**	**FRENCH**
ONICL	Inter professional National Office of Cereals and Leguminous	**O**ffice **N**ational Inter professionnel des **C**éréales et **L**égumineuses
ORMVA	Regional Office for Agricultural Development	**O**ffice **R**égional de la **M**ise en **V**aleur **A**gricole
PAGER	Program of Grouped Supply of Rural Water	**P**rogramme d'**A**pprovisionnement **G**roupé des **E**aux **R**urales
PAGI	Program of Large Irrigation Improvement	**P**rogramme d'**A**mélioration de la **G**rande **I**rrigation
PMH	Small and Medium-ScaleHydraulic	**P**etit et **M**oyenne **H**yraulique
PNI	National Program of Irrigation	**P**rogramme **N**ational de l'**I**rrigation
PRV	Extension and Research Project	**P**rojet de **R**echerche et de **V**ulgarisation
PSDA	Agricultural Development and Support Project	**P**rojet de **S**upport et de **D**éveloppement **A**gricole
SE	Water Service at the Provincial Directorate of Public Works	**S**ervice **E**au à la Direction provinciale de l'Equipement
SH	Section of Hydology	**S**ervice d'**H**ydraulogie
SIBE	Site of Biological and Ecological Interest	**S**ite d'**I**ntérêt **B**iologique et **E**cologique
SMN	Service of National Meteorology	**S**ervice de la **M**étéorologie **N**ationale
SONACOS	National Company of Seed Trade	**S**ociété **N**ationale de **C**ommercialisation de **S**emences
UNCAM	National Union of Cooperatives of Morocco	**U**nion **N**ationale de **C**oopératives du **M**aroc
UNDP	**U**nited **N**ations **D**evelopment **P**rogram	Programme des Nations Unies pour le Développement (PNUD)

Conversion Factors

	Metric to Imperial			Imperial to Metric		
Length	1 cm	=	0.394 inch	1 inch	=	2.54 cm
	1 m	=	3.28 feet	1 feet	=	30.48 cm
	1 km	=	0.621 mile	1 mile	=	1.609 km
Area	1 m^2	=	10.76 sq.ft	1 sq.ft	=	0.0929 m^2
	1 ha	=	2.471 acre	1 acre	=	0.4047 ha
	1 km^2	=	0.386 sq.mile	1 sq.mile	=	2.59km^2
Volume	1 lit	=	0.22 gal (imp)	1 gal(imp)	=	4.55 lit
	1 m^3	=	35.3 cu.ft	1 cu.ft	=	28.33 lit
	1 MCM	=	811 acre-ft	1 acre-ft	=	1,233.5 m^3
Weight	1 kg	=	2.20 lb	1 lb	=	0.4536 kg
	1 ton	=	0.984 long ton	1 long ton	=	1.016 ton
Derived	1 m^3/s	=	35.3 cusec	1 cusec	=	0.0283 m^3/s
Measures	1 ton/ha	=	891 lb/acre	1 lb/acre	=	1.12 kg/ha
	1 m^3/s	=	19.0 mgd	1 mgd	=	0.0529 m^3/s
Temperature	°C	=	(^{o}F-32)x5/9	^{o}F	=	1.8x°C+32
Local	1 lit	=	0.22 gantang	1 gantang	=	4.55 lit
Measures	1 kg	=	1.65 kati	1 kati	=	0.606 kg
	1 ton	=	16.5 pikul	1 pikul	=	60.6 kg

Supporting Report XIV Water Supply and Electrification

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SUPPORTING REPORT XIV
WATER SUPPLY AND ELECTRIFICATION

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SUPPORTING REPORT XIV

WATER SUPPLY AND ELECTRIFICATION

XIV1 Water Supply

XIV1.1 Water Supply in Morocco

XIV1.1.1 Related Institutions

In Morocco, several public institutions are participating water supply works.

The Communes are local autonomous bodies subordinate to the Provinces or the Prefectures, and superior to the villages. In the fields of rural water supply, basically the Communes are engaged in planning, construction, and operation and maintenance of the water supply facilities with their own financial and technical resources. Sometimes villagers' associations take responsibility for the operation and maintenance.

The Communes are under control by the Ministry of Interior (MOI). General Directorate of Local Collectivity (DGCL) of this ministry has much experience in the field of water supply.

General Directorate of Hydraulic (DGH) of the Ministry of Equipment (MOE) is in charge of planning, construction and management for major water resources development. This institution also participates execution of Program of Grouped Supply of Rural Water (PAGER).

The Ministry of Agriculture (MOA) also has some influence on rural water supply through its rural agricultural services. The ministry had been directly engaged rural water supply before 1972 when the current administration system on water supply was established. For that, MOA conventionally carried out drinking water supply to villagers in the irrigation areas in part. Even after 1972, MOA has been also concerned in rural water supply scheme related to agricultural development.

The Ministry of Public Health (MPH) conducts disinfections of water supply facilities in rural areas regularly or irregularly.

National Office of Potable Water (ONEP), which is subject to control of MOE, launched its operation in 1972. From that time, ONEP has long and wide experiences in the field of urban water supply. ONEP also participates execution of PAGER by ramification from the main ONEP water conveyance pipes.

There exist 15 state own companies and 2 private companies (Lydec in Casablanca and Redal in Rabat) that operate mainly for the distribution of potable water in large cities.

XIV1.1.2 Production and Consumption

The Government of Morocco has intensively implemented potable water supply projects, especially in urban area. As a result, quality and safe potable water is being supplied to almost all inhabitants in urban area at this moment.

Total production of potable water in urban area was 780 million m^3 per year for 13.7 million inhabitants in 1997. This production volume was secured by ONEP (80% in share, state own companies (12%), a private sector corporation (Elyo, 5%), and urban communes (3%).

Meanwhile its distribution was secured by the state own companies (for large cities, 40% in terms of subscribers number), two private sector corporations (Lydec for Casablanca and Redal for Rabat, 31%), ONEP (for medium and small size cities, 26%) and communes.

Rate of urban population connected to potable water network in home was 83% in 1997, and it is targeted to increase up to 96% in 2010.

XIV1.1.3 Water Supply Facilities

In 1998, there exist 30 water treatment plants owned by ONEP in Morocco, as listed in Table XIV1.1.1. Its total production in 1998 amounted to 410 Mm^3.

XIV1.1.4 Water Demand Forecast

According to the integrated master plan for each river basin, allocation of water resources to cover demand for potable water in Morocco up to 2020 is tabulated as below.

Allocation of Water Resources for Potable Water Demand (Mm^3/year)

No	River Basin	1990	2020
1	Northern Morocco	110	305
2	Moulouya	75	160
3	Sebou	230	663
4	Bouregreg	386	1,270
5	Oum Er Rbia	300	425
6	Tensift	150	355
7	Souss-Massa	50	155
8	Guir, Ziz, Rheriss and Draa	23	55
Total		1,324	3,388

Source: Synthese des Plans Directeurs d'Amenagement Integre des Eaux des Differents Basiins du Royaume

XIV1.1.5 Rural Water Supply

The Government of Morocco launched Program of Group Water Potable Supply to Rural Population (PAGER) in 1995 aiming at increasing access rate to public water supply system in rural area from 14% up to 80% by providing 31,000 adequate water sources for 11 millions rural populations.

The PAGER consists of the following two major components:

(1) Execution by ONEP of ramified pipe networks on the main ONEP water conveyances from which water would be distributed to the surrounding villages through a number of stand pipes.

(2) Development by the General Directorate of Hydraulics (DGH) of water points from various sources such as springs and wells, etc., in the vicinity of villages located in areas where no ONEP main water pipe exists, and provision accordingly the necessary pumping equipments.

Due to intensive execution of the PAGER up to now, access rate of rural population to public water supply system has increased from 14% to 38%. Production and distribution is much secured by communes (96%), meanwhile ONEP intervenes above by 4%.

XIV1.2 Condition of the Study Area

XIV1.2.1 Existing Water Supply Facilities and Future Program

Existing water supply systems at downstream reach of the dams are controlled and managed by the ONEP, communes, villager's associations or individuals.

(1) No.5 N'Fifikh

The beneficiary irrigation area of the N'fifikh dam (upstream) extends within the communes of Ziaida, Mellila, Moualine El Ghaba, Oulad Yahya Louta, and etc. in Ben Slimane province.

The local population in and around the irrigation area exists in dispersed condition, and mainly depends on wells or springs for drinking water supply. There is no plan for intervention by the ONEP in this area at this moment.

Major springs are located in Lakdamra village in Ziaida commune (Sidi Amar) and Ouled Tarfaya village in Moualine El Ghaba commune (Ain Marsid). Public wells are located in Ouled Jialili village in Ziaida commune and Ouled Chaoui village in Mellila commune.

Private wells are constructed not only beside the river, but also on side of hills at both banks. For the latter, however, high salinity and/or scarcity of water quantity during drought seasons are observed in some locations.

Depth of wells is some 10 m at just beside the river course, and it varies between 30 to 60 m at more remote places.

In Mellila center, which is located westward of the dam site around 9km in straight distance, the commune manages a water supply network that serves some 200 recipient households. Water source is a spring (Ain Oum Laknabech) of which discharge is 2 l/s, and there exists three storage tanks ($120m^3$, $30m^3$ and $27m^3$). High salinity is observed. The ONEP is planning to intervene in this center by extending distribution pipe from Fedalate center to which the water is supplied from the Sidi Mohamed Ben Abdallah (SMBA) dam.

Ben Slimane, the municipality that is located northward of the dam, is served by the SMBA dam. Existing water supply capacity is 190 l/s in total (170 l/s from the SMBA dam, 7l/s from one spring and 13l/s from two wells), and this is enough to cover the peak demand in 2020.

(2) No.9 Taskourt

The beneficiary irrigation area of the Taskourt dam extends within the communes of Assif El Mal, Majjat and M'zouda in Chichaoua province.

The local population depends on wells, springs or "Mattfias" (storage tank) for drinking water. As a rule, springs are major sources of water for villages in the mountainous area such as Taskourt, Anebdour, Zilawt, Sidi Bou Otmane, etc. in Assif El Mal commune. Quality of water taken from such springs is comparatively better and accepted by the local population.

Wells do not exist in Taskourt or Anebdour. In Zilawt, there is one public well equipped with motor pump and storage tank ($10m^3$), but serves to the commune office only. In Dar N'Mes in Assif El Mal commune, there also exists one public well equipped with pump, storage tank and standpipes. Private wells are also provided in some villages. However, underground water resource that can be exploited from wells in the beneficiary irrigation area near the foot of mountains is rather scarce compared to the downstream area of the Majjat center.

"Mattfias" is widely used at many villages in flat area, such as Dar Akimakh, Dar Al Jorf, etc. in Assif El Mal commune and Tiguemi Oumrhar, Tamatoust, etc. in M'zouda commune, to store surface water in the river taken through "Seguia" (canal). Quality of water from "Mattfias" is regarded as one of the causes for water-borne disease occurrence.

Quantity of water in these villages becomes insufficient notably during dry seasons. There is no plan for intervention by the ONEP in this area at this moment.

In Majjat center (Souq Al Had Majjat), which is also located within the irrigation area, the commune manages a water supply network that serves some 200 recipient households and 10 standpipes. There exists two wells equipped with two storage tanks ($100m^3$ and $25m^3$), and its daily production is about 120 m^3/day. There is a possibility that the ONEP will intervene with this system in future.

In M'zouda center (Souq As Sebt M'zouda), there also exists water supply facility managed by the commune. The facility consists of two wells equipped with motor pump, storage tanks and standpipes.

Imin Tanout, the municipality that is located westward of the dam around 35km in straight distance, is served by the ONEP's water supply system. Existing water supply capacity is 20 l/s in total, and currently another drilled well of which supply capacity is 15 l/s is constructed to meet with the peak demand as of 2020.

The ONEP also holds its own water supply systems in Chichaoua, Sidi El Moktar in Chichaoua province and Amezmiz in Al Haouz province.

(3) No.10 Timkit

The beneficiary irrigation area of the Project extends within the communes of Aghbalou-N'kerdous, Ferkla El Oulia and Es Soufla in Errachidia province.

At the immediate downstream of the dam (Ifegh village), there exists a water supply system that serves some 400 recipient households under management by a villager's association. There exists one drilled well (168m deep, water surface at some 40m deep) equipped with a pump ($21m^3$/h) and a storage tank ($72m^3$). Monthly production is about 2,500 to 3,000 m^3.

Tinejdad, the municipality that is located at the downstream of the dam, is served by the ONEP's water supply system (Goulmima-Tinejdad) of which main source are three drilled wells. Existing water supply capacity is 96l/s.

Several villages around Tinejdad such as Ait Labzem, Ait Assem, Ait Hamou, etc. in Ferkla El Oulia commune are already connected with the above Goumima-Tinejdad system. The remaining villages in Ferkla El Oulia and Ferkla Es Soufla communes currently depend on "Khettara" (traditional water supply system) or private wells.

However, extension programs of conduits of the Goulmima-Tinejdad system to cover such villages are already committed by the ONEP.

The ONEP also holds its own water supply system of Errachidia-Rissani in Errachidia province. Its water source is the Hassan Ad Dakhil dam, and existing water supply capacity is 320 l/s.

(4) No.17 Azghar

The beneficiary irrigation area of the Azghar dam extends within the communes of Ighazrane and Oulad Mkoudou in Sefrou province.

Ribat El Kheir, the nearest municipality from the dam, is served by the ONEP's water supply system of which source are two wells (Ain Ajri and Ifrah). Existing water supply capacity is 25l/s.

Several villages around Ribat El Kheir such as Ikharouane, Tsaout Ou Araar, Taghza Lamrouj, etc. in Ighazrane commune are already connected with the above Ribat El Kheir system. The remaining villages in the irrigation area currently depend on springs and wells.

At the most downstream irrigation area (Mghila village in Ouled Mkoudou commune), there exists a water supply system that is managed by the commune. Condition of this system is severely bad due to scarcity of water quantity at its source (Ain Jorf spring).

In Ouled M'koudou center (Bouderham), which is located near the Mghila, the ONEP manages a water supply network that serves some 150 recipient households. Its water source is a well (Igli), and existing water supply capacity is 5.5 l/s.

Extension of conduits from Ouled M'koudou to Mghila is undergoing.

Furthermore, extension programs of conduits from Ribat El Kheir to cover villages in and around the irrigation areas, such as Tichout Tamalalet, Nass Said Jbel, Ekarbousse, etc. in Ighazrane commune, are also already committed by the ONEP.

Existing water supply conditions at representative locations in rural and urban areas around the Projects are outlined in Tables XIV1.2.1 and 1.2.2.

XIV1.2.2 Existing Conditions of Water Use

Existing water use conditions at N'Fifikh and Taskourt sites are as below.

(1) No.5 N'Fifikh

Time duration for transportation of water varies from 15 minutes to 2 hours. Manpower transportation is dominantly conducted in case that the water source is located nearby. Meanwhile, in case that the distance to the water source is more than 2 km, mules, donkeys, horses or carts are often used.

Daily water consumption for domestic use (drinking, cooking, washing, bathing and etc.) per one person is 8 to 12 litre/day (9.4 in average). Meanwhile, willingness to pay by local habitants for water supply service varies between 20 and 70 DH per month per one household.

(2) No.9 Taskourt

Time duration for transportation of water varies from 15 minute to 1 hour. Both manpower and animals like mules are used for water transportation almost in half and half. Daily water consumption for domestic use per one person is 14.8 to 16.2 litre/day (15.7 in average). Meanwhile, willingness to pay by local habitants for water supply service varies between 10 and 30 DH per month per one household. Monthly expenditure for water transportation is 5 to 50 DH (21 in average) per month per one household.

XIV1.3 Development Plan

XIV1.3.1 General Concept

Small-scale water supply system is planned, utilizing water from dam conveyed through irrigation canal or river as its source. Result of water quality test is shown in NE2 of Volume VII Data Book. To secure its quality for drinking purpose, water purification by slow sand filter with settling tank and primary filtration (coarse filtration) will be adopted as its concept is shown on Figure XIV1.3.1. Selection of villages is conducted based on the following conditions:

- Serious problem in water quality or quantity is recognized for the existing water source.
- The village is located within or in vicinity of the irrigation area.
- There is no existing or programmed water supply system committed by the ONEP or commune.

(1) No.5 N'Fifikh

It is planned to apply the system to Tlet Ziaida village, as its location is shown on Figure XIV1.3.2, for the reasons of; 1) its relatively near distance from the river (irrigation canal), and 2) existence of public facilities such as market, school, mosque and hospital.

(2) No.9 Taskourt

It is planned to apply the system to some of villages in the irrigation area that utilizes "Mattfia", such as Dar Akimakh, Tamatoust, Tiguemi Oumrhar villages, as their locations are shown on Figure XIV1.3.3, for the reasons of; 1) high dependence on "Mattfia" and 2) rather large population.

(3) No.10 Timkit

No recommendation is done for providing the small-scale water supply system, because the villages in and around the irrigation area are already equipped by adequate water supply facilities or scheduled to be covered by ONEP's conduit extension.

(4) No.17 Azghar

No recommendation is done for providing the small-scale water supply system, because the villages in and around the irrigation area are scheduled to be covered by ONEP's conduit extension.

Meanwhile, as a result of reviewing on current situation of water supply in urban centers around the Projects, which the ONEP is responsible for, it might be said that the existing water resources other than the Projects would cover the immediate water demand. Therefore, this study does not consider provision of ONEP facilities such as water treatment plant and water conveyance system.

However, in Morocco, it is a common practice to provide a discharge pipe in case of possible future use for potable water supply in accordance with request by the ONEP. For the Projects, the ONEP suggested to provide water intake of which capacity is shown as follows.

ONEP's Request for Water Intake

No	Location	Intake Capacity (l/s)
1	No.5 N'Fifikh	100
2	No.9 Taskourt)	70
3	No.10 Timkit)	240
4	No.17 Azghar)	100

According to the suggestion, it is planned to provide independent pipe and valve separately from water conduit for irrigation equipped in the dam. Inlet for such pipe and valve will be provided also, so as to enable independent water taking.

XIV1.3.2 Plan and Cost Estimate

The project features of the proposed water supply systems are outlined in Table XIV1.3.1. Demand in target year of 2020 is obtained by multiplying unit water demand of 20 liter/man/day with projected population with assumption of annual increase rate of 0.7%.

Reservoir capacity is set as 1 day consumption. One stand pipe is assumed be provided for watering place for 300 inhabitants. PVC pipe 40mm is to be laid between reservoir and stand pipes.

Annual economic benefit of the small-scale water supply systems in the N'Fifikh and Taskourt projects are estimated at 0.16 and 0.28 million DH, based on the average willingness to pay of 16.7 DH/m^3.

Meanwhile, financial construction cost of the systems is estimated at 1.8 and 3.0 million DH (local currency portion only), respectively, referring to the past record of the PAGER (unit investment of 1,000 DH/person). Procurement is assumed through the local bidding.

The economic analysis is shown in Supporting Report XVIII.

XIV2 Electrification

XIV2.1 Electrification in Morocco

XIV2.1.1 Related Institutions

In Morocco, the Ministry of Energy and Mining (MEM) is governing the electricity service. National Office of Electricity (ONE), which launched its operation in 1963, is also subject to control of the ministry.

For power generation service, ONE has been long the sole implementation body until 1996. However, from 1997 "Concessionary production" in which the investors produce electricity and sell it to ONE started, as Jorf Lasfer Energy Company (JLEC) commenced its operation.

There are also several private companies such as Maroc-chimie, Maroc-phosphore, etc. that produces electricity but for their own use.

Meanwhile, ONE exclusively carries out power transmission service. Morocco also owns reciprocal linked transmission lines that are connected with Spain and Algeria. These lines enable electricity import/export from/to these two countries.

Power distribution service is performed by ONE and state controlled companies (Regies). There are 11 state controlled companies and they take charge of power distribution in large cities with electricity that is purchased from ONE.

XIV2.1.2 Production and Consumption

In 1998, total electricity supply in Morocco was 12,453GWh.

Production by ONE was 6,757GWh, which consisted of 1,759GWh by hydro power stations and 4,998GWh by thermal power stations. Concessionary production by JLEC reached 4,938GWh, meanwhile sum of import from Spain and Algeria, and private companies' production amounted to 758GWh.

Meanwhile total electricity consumption in 1998 was 10,921GWh.

XIV2.1.3 Power Supply Facilities

As of 1998, there exist 24 hydropower stations in Morocco, as listed in Table XIV2.1.1. Its total installed capacity amounts to 1,175MW. The power stations are mainly located in the basins of Oum Er Rbia, Sebou, Moulouya and Loukkos. It is noted that variation of energy production among each year is very high in every hydropower stations due to effect of drought.

Meanwhile, there exist 19 thermal power stations, including Jorf Lasfar by JLEC. Its total installed capacity amounts to 2,508MW. Besides, there also exist 14 private plants of 23MW in total.

High voltage transmission lines (400, 225, 150 and 60kV) are extended to 15,087km in total. 225kV is mainly used to link large cities such as Casablanca or Mohammedia along the coastal area, meanwhile 60kV is mainly used in rural areas. Medium voltage distribution lines (30, 22 and 20kV) are extended to 23,667km in total. Its standard is now being unified by ONE into 22kV. Progress of installation for transmission and distribution lines in Morocco is as shown on Table XIV2.1.2.

XIV2.1.4 Power Demand Forecast

Rate of annual increase in supply of electricity in 1998 was 5.8%. MEM predicts that the annual increase rate until 2010 would be 6.0%.

XIV2.1.5 Rural Electrification in Morocco

The Government of Morocco instituted Global Rural Electrification Program (PERG) in 1996 to attain rural electrification rate of 90% (150 million houses) in 2010. Rural electrification is basically forwarded by extension of the existing grid to the surrounding villages. However, as it will be very expensive to extend the grid to some of the remote and scattered villages, a special fund under the PERG is also set aside for electrification by photovoltaic.

XIV2.2 Condition of the Study Area

XIV2.2.1 Existing Power Supply System and Future Program

Among the Projects, the Taskourt and Azghar dams are selected for the study of power generation, because of rather ample water resources with respect to annual inflow, storage volume and/or dam height, compared to the other two dams, that is, the N'Fifikh and Timkit dams.

As a result of survey, it is found that there exist concrete programs for rural electrification by the National Office of Electricity (ONE) to extend its 22 kV distribution lines around the sites of the Taskourt and Azghar dams in the framework of PERG, as shown in Table XIV2.2.1.

(1) No.9 Taskourt

Villages in downstream of the dam such as Imin Ouassif, Zilawt, Sidi Bou Otmane and Dar Akimakh in Assif El Mal commune, and in upstream of the reservoir such as Adassil, Mejdid, Quiadat in Adassil commune are already connected to the grid.

ONE is implementing PERG2 (2000-2002) to electrify major villages in irrigation areas such as Taloutint, Tigourar, Dar N'mes etc., in Assif El Mal commune. Villages immediate downstream of the dam such as Taskourt, Anebdour, in Assif El Mal commune and in reservoir area such as Zawyat Hemti, Talat Nemti, Imin Eikha, Kerni, Talborjt, Tiliwa, Assais, etc., in Adassil commune are also to be electrified in PERG 3 (2002-2004).

(2) No.17 Azghar

Villages located around Ribat Al Khayr such as Ifrah and Sidi Bonaza are already electrified. ONE is implementing PERG2 (2000-2002) to electrify villages in irrigation area such as Tsaout Ou Araar, Tichout Tamalalet, Nass Said Jbel, Taghza Lamrouj, Ekarbousse. Villages upstream of the reservoir or outside of the irrigation area are also programmed to be electrified in PERG4 and 5.

XIV2.3 Development Plan

XIV2.3.1 General Concept

Power generation utilizing irrigation water is planned on the basis of the so-called subordinate water use for power generation utilizing the unused head without causing any trouble to irrigation.

The water for irrigation use is discharged from the dam directly into the river in case of the Taskourt dam, or into the irrigation canal in case of the Azghar dam. In both cases, power generation is obtained by connecting a power station to the water outlet pipe for irrigation that is equipped at the downstream of the dam.

The vicinities of the both sites of the Taskourt and Aghar dams are to be electrified by extension of 22kV grid by the ONE in immediate future. Therefore, parallel operation by connecting the power stations to nearby 22kV distribution lines of the ONE is assumed.

Accordingly, electrification by the photovoltaic system or hybrid power generation combined with the photovoltaic system, which is ordinarily applied in case of independent operation, is not considered in this study. The power station is planned to provide a greater annual power generation, not to satisfy the maximum demand.

XIV2.3.2 Plan and Cost Estimate

(1) Energy Calculation

Energy calculation for several alternative plant discharges is carried out with the following conditions:

- Annual energy is estimated as sum of monthly energy that is calculated with monthly water usage and monthly reservoir water level obtained in the water balance study.
- Based on assumed plant discharge and water head, cross-flow water turbine is selected.
- Elevation of turbine center is set at EL. 950m and 847.5m for the Taskourt and Azghar dams, respectively, so as to prevent the runner from being submerged during operation.
- Maximum combined efficiency is assumed at 75%. Relative combined efficiency is considered according to discharge ratio. Variable discharge characteristics are assumed at 15% of the rated discharge. Variable head range is assumed at 70% of the maximum head.

- Loss head is assumed at 8% of the maximum head.

- Discharge for irrigation use during 12 hours a day is assumed to be taken for power generation. Spillout from the dam is not counted.

Calculated energy for each alternative plant discharge is tabulated as follows.

Generated Energy (Taskourt NWL 1020m)

No	Discharge (m^3/s)	Maximum Head (m)	Output (kW)	Energy (GWh)
1	0.50	64.40	237	0.793
2	1.00	64.40	473	1.510
3	1.50	64.40	710	2.057
4	2.00	64.40	947	2.486
5	2.50	64.40	1,183	2.805
6	3.00	64.40	1,420	2.990

Generated Energy (Taskourt NWL 995m)

No	Discharge (m^3/s)	Maximum Head (m)	Output (kW)	Energy (GWh)
1	0.50	41.40	152	0.526
2	1.00	41.40	304	0.937
3	1.50	41.40	456	1.223
4	2.00	41.40	609	1.397
5	2.50	41.40	761	1.487
6	3.00	41.40	913	1.494

Generated Energy (Azghar NWL 854m**)**

No	Discharge (m^3/s)	Maximum Head (m)	Output (kW)	Energy (GWh)
1	0.50	6.00	22	0.052
2	1.00	6.00	44	0.088
3	1.50	6.00	66	0.104
4	2.00	6.00	88	0.113
5	2.50	6.00	110	0.122

(2) Construction Cost

Direct construction cost of the power station including physical contingency for each alternative plant discharge is assumed as below, based on ONE past record.

Construction Cost (Taskourt NWL 1020m)

No	Civil Works	Electro-mechanical	Transmission Line	Total (mil. DH)
1	0.8	4.0	0.1	4.9
2	1.4	6.2	0.1	7.7
3	1.9	8.0	0.1	10.0
4	2.4	9.7	0.1	12.2
5	2.9	11.2	0.1	14.2
6	3.4	12.6	0.1	16.1

Construction Cost (Taskourt NWL 995m)

No	Civil Works	Electro-mechanical	Transmission Line	Total (mil. DH)
1	0.5	3.0	0.1	3.6
2	0.9	4.6	0.1	5.6
3	1.3	6.1	0.1	7.5
4	1.7	7.2	0.1	9.0
5	2.0	8.4	0.1	10.5
6	2.3	9.5	0.1	11.9

Construction Cost (Azghar NWL 854m**)**

No	Civil Works	Electro-mechanical	Transmission Line	Total (mil. DH)
1	0.1	0.8	0.3	1.2
2	0.2	1.2	0.3	1.7
3	0.2	1.5	0.3	2.0
4	0.3	1.9	0.3	2.5
5	0.4	2.2	0.3	2.9

(3) Determination of Facility Scale

Scale of the power station is determined so as to minimize direct construction cost per kWh. As a result, plant discharges of 1.5m^3/s and 1.0m^3/s are adopted for the Taskourt and Azghar power stations, respectively as shown in Figure XIV2.3.1. Relevant outputs are 460kW for Taskourt (NWL 995m) and 50kW for Azghar.

Annual mean energy produced by the Taskourt (NWL 995m) and Azghar power stations are calculated at 1.22 GWh and 0.09 GWh, respectively. Assuming of kWh value of 0.6 DH/kWh, annual economic benefit are estimated at 0.73 and 0.05 million.

Meanwhile, financial construction cost of the power stations is estimated at 10.3 and 2.5 million DH (50% in local currency portion and 50% in foreign currency portion), referring to the past record of the ONE. Procurement is assumed through the international bidding.

The project features of the optimal scale are outlined in Table XIV2.3.1. Unit construction cost per kWh is calculated at 6.2 DH/kWh for Taskourt (NWL 995m) and 19.3 DH/kWh for Azghar, respectively. These values suggest that power generation utilizing irrigation water at the Taskourt and Azghar dams are rather less feasible economically; therefore the plans are discarded.

Feasibility Study on Water Resources Development in the Kingdom of Morocco

Final Report

Volume V Supporting Report (2.B)

Feasibility Study

Supporting Report XIV

Water Supply and Electrification

Rural Area in

Tables

Table XIV1.1.1: Existing Water Treatment Plants in Morocco

Location	Source of Water	Comission	Production (1000 m^3)			
			1995	1996	1997	1998
Souss-Massa-Draa						
Agadir	Barrage Dkhila - Oued Issen	1985	8,267	10,085	11,982	13,565
Tiznit	Barrage Youssef B. Tachfine	1985	1,840	2,135	2,125	2,385
Ouarzazate	Barrage El Mansour Eddahbi	1972	-	-	688	1,917
Marrakech-Tensift-Al Haouz						
Marrakech	Canal Rocade	1983	29,472	32,370	31,504	33,231
Imin Tanoute	Drain	1972	111	99	155	202
El Kelaa des Sraghna	Seguia Yacoubia	1974	784	1,395	1,393	1,338
Doukkala-Abda						
Safi	Retenue de Safi	1974	8,183	6,057	6,857	7,774
El Jadida	Retenue de Daourat	1983	76,562	74,247	73,113	77,878
Azemmour	Sidi Daoui	1984	3,779	3,781	3,485	3,191
Tadla-Azilal						
Beni Mellal	Ain Asserdoun	1977	5,906	7,301	7,995	7,775
Afourer	Barrage Bine El Ouidane	1993	475	426	405	341
Rabat-Sale-Zemmour-Zaer						
Bou Regreg	Barrage Med. B. Abdellah	1968	146,098	144,254	155,826	155,634
Khemisset	Barrage El Kansera	1974	4,820	4,348	4,743	5,277
Tanger-Tetouan						
Tanger	Barrage Ibn Batouta	1968	8,089	22,261	22,409	21,589
Tanger	Barrage 9 Avril 1947	1995	2,826	19,371	18,989	16,920
Dar Chaoui	Barrage 9 Avril 1947	1995	-	25	50	54
M'Diq	Barrage Smir	1992	15,348	12,461	11,139	14,968
Tetouan	Toreta		2,341	11,202	12,762	10,066
Fes-Boulemmane						
Fes	Oued Sebou	1987	16,017	14,653	14,482	15,321
Taza-Al Hoceima-Taounate						
Al Hoceima	Barrage A. El Khattabi	1985	3,874	3,468	3,443	3,513
Targuist	Barrage Joumoua	1993	322	349	370	374
Karia Ba Mohammed	Oued Sebou	1985	320	296	295	287
Ain Ajdah	Oued Inaouen	1987	336	265	282	328
M'Kansa	Oued Sebou	1987	157	135	162	186
Taounate	Barrage Sahla	1994	-	-	8	552
Oriental						
Berkane	Canal Trifa (M. Hammadi)	1979	4,135	4,346	4,831	4,609
Nador	Canal Bouareg (M. Hammadi)	1984	7,624	6,897	6,360	7,731
Zaio nouveau	Canal Bouareg (M. Hammadi)	1984	978	824	835	923
Meknes-Tafilalet						
Khenifra	Oued Oum Rbia	1987	2,801	2,289	1,621	1,535
M'rirt	Oued Oum Rbia	1991	382	342	391	472
		Total	351,847	385,682	398,700	409,936

Source : ONEP

Table XIV1.2.1: Existing Water Supply Conditions in Rural Area (1/5)

N'fifikh Dam

Village: Tlet Ziaida Commune: Ziaida Population: 347 (Lamsaada, 1994), 477 (Ouled Draidi, 1994)	Water source: Public well in Ouled Jialili village or private wells - The village is located on right bank of downstream reach of the dam (around 12km distance). For administration, it belongs to Lamsaada and Ouled Draidi villages. - Drinking water is taken from public well in Ouled Jialili (about 5km distance), meanwhile domestic water for public facilities such as market, schools etc., is taken from surface water in tributary on the opposite bank of the river.
Village: Ouled Wahab Commune: Ziaida Population: 629 (1994)	Water source: Private wells -The village is located on right bank of downstream reach of the dam (around 8km distance). - About 50% of the population in this village own their wells beside the river, meanwhile the remaininig own on side of hills. The latter has salinity problem in general.
Village: Lakdamra Commune: Ziaida Population: 1,529 (1994)	Water source: Spring in Sidi Amar or private wells - The village is located on right bank of downstream reach of the dam (around 4km distance). - There exists public spring in Sidi Amar equipped with standpipes. The population within about 1km from the spring takes water from here, meanwhile the others depend on private wells. The latter has salinity problem, and frequently becomes dry in drought
Village: Haydat Commune: Mellila Population: 526 (1994)	Water source: Public well in Ouled Chaoui village or private wells - The village is located on left bank of downstream reach of the dam (around 4km distance). - About 30% of the population in this village takes water from private wells located beside the river or on side of hills. The latter has salinity problem in general. The remaining 70% of population takes water from well in Ouled Chaoui (around 2km distance).
Village: Moudnienne Commune: Mellila Population: 980 (1994)	Water source: Private wells - The village is located on left bank of downstream reach of the dam (around 8km distance). in general.
Village: Ouled Tarfaya Commune: Moualine El Ghaba Popuation: 1,109 (1994)	Water source: Spring (Ain Marsid) or private wells -The village is located on right bank of downstream reach of the dam (about 18km distance). - One public spring which is equipped with storage tank and standpipe is maintained by the commune. All population depened on this spring, because private wells have salinity problems and become dry in drought. The population in neighbouring villages such as As Swalem or Labiyed also depend on this spring.

Table XIV1.2.1: Existing Water Supply Conditions in Rural Area (2/5)

Taskourt Dam	
Village: Taskourt	Water source: Spring
Commune: Assif El Mal	- The village is located in downstream reach of the dam (about 1km distance).
Population: 424 (1994)	no wells.
Village: Anebdour	Water source: Spring
Commune: Assif El Mal	- The village is located in downstream reach of the dam (about 3km in straight distance).
Popuation: 880 (1994)	- Springs is the major source. There exist some surface water storage tanks, but no wells.
Village: Zilawt	Water source: Spring in river bed or public well
Commune: Assif El Mal	- The village is located on right side of downstream reach of the dam (about 5.5km in str. distance).
Population: 230 (1994)	- One spring exists at river bed. One public well (20m depth) equipped with pump and storage tank ($10m^3$) serves water supply of the communes office.
Village: Sidi Bou Otmane	Water source: Spring
Commune: Assif El Mal	- The village is located on right side of downstream reach of the dam (about 5.5km in str. distance).
Population: 210 (1994)	-The population depend on natural springs in mountain.
Village: Imin Ouassif	Water source: Public wells
Commune: Assif El Mal	- The village is located in left bank of downstream reach of the dam (about 6km in str. distance).
Population: 575 (1994)	- There exists three numbers of public wells and another one is under construction. All are of about 20m depth and not equipped. There exists some surrface water storage tank.
Village: Taloutint	Water source: Spring
Commune: Assif El Mal	- The village is located on right bank of downstream reach of the dam (about 8km in str. distance).
Population: 204 (1994)	- The population depend on springs. A public well is under construction.
Village: Tigourar	Water source: Spring in Taloutint village
Commune: Assif El Mal	- The village is located on right bank of downstream reach of the dam (about 8.5km in str. distance).
Population: 255 (1994)	storage tanks.
Village: N'Mes	Water source: Public well
Commune: Assif El Mal	-The village is located on left bank of downstream reach of the dam (about 8.5km in str. distance).
Population: 691(1994)	- There exists one public well (40m depth, 0.2 l/s) equipped with pump, storage tank and standpipes.
Village: Ajmani	Water source: Private wells
Commune: Assif El Mal	- The village is located on right bank of downstream reach of the dam (about 9km in str. distance).
Population: 110 (1994)	- The population in this village depend on private wells located beside the river. Construction of a public well (not equipped) is programmed.
Village: Tafroukht	Water source: Private wells
Commune: Assif El Mal	- The village is located on right bank of downstream reach of the dam (about 10km in str. distance).
Population: 505 (1994)	- The population depend on private wells located beside the river.
Village: Dar Akimakh	Water source: Surface water storage tanks or wells
Commune: Assif El Mal	- The village is located on right side of downstream reach of the dam (about 13km in str. distance).
Population: 575 (1994)	- There exist some 80 surface water storage tanks of which water source is Segia Tadraouit.
Village: Dar Al Jorf	Water source: Surface water storage tanks
Commune: Assif El Mal	- The vilage is located on right side of downstream reach of the dam (about 14km in str. distance).
Population: 247 (1994)	- There exist surface water storage tanks.
Village: Ait Idbibene	Water source: Surface water storage tanks and public well
Commune: Assif El Mal	- The village is located on right bank of downstream reach of the dam (about 15km in str. distance).
Population:	- There exist private surface water storage tanks and a non-equipped public well.
Village: Ifrane	Water source: Surface water storage tanks
Commune: Assif El Mal	- The village is located on right bank of downstream reach of the dam (about 17km in str. distance).
Population:	- There exist surface water storage tanks.
Village: Souq As Sebt Mzouda	Water source: Public wells
Commune: Mzouda	There exists two public wells equipped with storage tanks ($27m^3$ and $30m^3$) and standpipes (3 numbers) managed by the Commune. Free of charge.
Village: Tiguemi Oumrhar	Water source: Surface water storage tanks
Commune: Mzouda	- The vilage is located on left side of downstream reach of the dam (about 14km in str. distance).
Population: 539 (1994)	- There exists only surface water storage tanks. No wells or springs exist.
Village: Tamatoust	Water source: Surface water storage tanks
Commune: Mzouda	- The vilage is located on left side of downstream reach of the dam (about 13km in str. distance).
Population: 549 (1994)	- There exists only surface water storage tanks. No wells or springs exist.
Village: Dahra	Water source: Surface water storage tanks
Commune: Mzouda	- The vilage is located on left side of downstream reach of the dam (about 12km in str. distance).
Population: 161 (1994)	- There exists only surface water storage tanks. No wells or springs exist.
Village: Souq Al Had Majjat	Water source: Public wells
Commune: Majjat	The commune manages a water supply network which serves 236 recipient households and 10 standpipes. There exists two wells equipped with storage tanks (100m3 and 25m3). Daily production is 120 m3/day. Water rate per 1 m3 is ranked, according to consumption in 3 months, into three ranks, that is, 2.19 Dh (less than 24 m^3), 5.26 Dh (24 to 36 m^3), and 7.5 Dh (more than 36 m^3). Maintenance is carried out in good condition.

Table XIV1.2.1: Existing Water Supply Conditions in Rural Area (3/5)

Timkit Dam

Village: Ifegh Commune: Aghbalou N'kerdous Population: 618 (Izzokal, 1994), 180 (Irbiben, 1994), 475 (Taghia, 1994), 729 (Timkit, 1994)	Water source: Public wells - The village is located just downstream of the dam, within the Ifegh irrigation area. For administration, it consists of Izzokal, Irbiben, Taghia and Timkit. - A villager's association manages a water supply network which serves 448 recipient households. There exists one drilled well (168m depth, water surface at 38m deep) equipped with a pump ($21m^3$/h) and a storage tank ($72m^3$). Water rate per $1m^3$ is ranked, according to consumption in 3 months, into three ranks, that is 1.5-1.6 Dh (less than $20m^3$) and 10 Dh (more than 20 m^3). Monthly production is 2500-3000 m^3. Monthly income of the association due to water tariff is 9,000 Dh, meanwhile expenditure for operation and maintenence is 7,500 Dh in average. - Some inhabitants, who are reluctant to pay tariff of water, use subsurface water of the river for drinking purpose.
Village: Azag Nouchne Commune: Ferkla El Oulia Population: 953 (1994)	Water source: Khettara - The village is located beside Tanguerfa river, around 15km straight distance from the dam. - The population depend on khettara located near Tanguerfa river. There is no program by ONEP to intervene this village.
Village: El Bour Commune: Ferkla El Oulia Population: 1,246 (1994)	Water source: Private wells - The village is located beside (west of) Ait Labzem irrigation area. - The population depend on private wells. There is no program by ONEP to intervene this village.
Village: El Khorbate Commune: Ferkla El Oulia Population:	Water source: Private wells - The village is located at west part of Ait Labzem irrigation area, and near Ferkla river. - The population depend on private wells. Extension of ONEP's water supply system for Tinejdad-Goulmima is undergoing.
Village: Amellal Commune: Ferkla El Oulia Population:	Water source: Private wells - The village is located at west part of Ait Labzem irrigation area, and near Ferkla river. - The population depend on private wells. Extension of ONEP's water supply system for Tinejdad-Goulmima is undergoing.
Village: Tamaroloult Commune: Ferkla El Oulia Population:	Water source: Private wells - The village is located at west part of Ait Labzem irrigation area, and near Ferkla river. - The population depend on private wells. Extension of ONEP's water supply system for Tinejdad-Goulmima is undergoing.
Village: Ait Farah Commune: Ferkla El Oulia Population: 402 (1994)	Water source: ONEP system for Tinejdad-Goulmima - The village is located within Ait Labzem irrigation area, between Tanguerfa and Ferkla rivers. - ONEP's water supply system for Tinejdad-Goulmima is covering this village.
Village: Ait Bouta Khssain Commune: Ferkla El Oulia Population:	Water source: ONEP system for Tinejdad-Goulmima - The village is located within Ait Labzem irrigation area, between Tanguerfa and Ferkla rivers. - ONEP's water supply system for Tinejdad-Goulmima is covering this village.
Village: Ait Bouhadou Commune: Ferkla El Oulia Population: 214 (1994)	Water source: ONEP system for Tinejdad-Goulmima - The village is located within Ait Labzem irrigation area, between Tanguerfa and Ferkla rivers. - ONEP's water supply system for Tinejdad-Goulmima is covering this village.
Village: Ait Hamou Commune: Ferkla El Oulia Population: 717 (1994)	Water source: ONEP system for Tinejdad-Goulmima - The village is located within Ait Labzem irrigation area, between Tanguerfa and Ferkla rivers. - ONEP's water supply system for Tinejdad-Goulmima is covering this village.
Village: Ait Aissa Commune: Ferkla El Oulia Population: 52 (1994)	Water source: ONEP system for Tinejdad-Goulmima - The village is located within Ait Labzem irrigation area, between Tanguerfa and Ferkla rivers. - ONEP's water supply system for Tinejdad-Goulmima is covering this village.
Village: Ait Labzem Commune: Ferkla El Oulia Population: 1,100 (1994)	Water source: ONEP system for Tinejdad-Goulmima - The village is located within Ait Labzem irrigation area, between Tanguerfa and Ferkla rivers. - ONEP's water supply system for Tinejdad-Goulmima is covering this village.
Village: Ait Assem Commune: Ferkla El Oulia Population: 6,930 in total (1994)	Water source: ONEP system for Tinejdad-Goulmima other villages. - ONEP's water supply system for Tinejdad-Goulmima is covering this village.
Village: Taghoucht Commune: Ferkla El Oulia Population: 1,267 in total (1994)	Water source: Khettara - The village is located near Taghia river. It also includes Taghia, Ihandar and Ait M'hammed. - The population depend on Khettara. Extension of ONEP's water supply system for Tinejdad-Goulmima is undergoing.

Table XIV1.2.1: Existing Water Supply Conditions in Rural Area (4/5)

Timkit Dam

Village: Ktaa El Oued Commune: Ferkla Essoufla Population: 2,052 (1994)	Water source: Khettara - The village is located at east part of Ait Labzem irrigation area. - The population depend on Khettara. Extension of ONEP's water supply system for Tinejdad-Goulmima is undergoing.
Village: Ait Maamer Laklim Commune: Ferkla Essoufla Population: 600 (1994)	Water source: Private wells - The village is located at east part of Ait Labzem irrigation area. - The population depend on private wells. Extension of ONEP's water supply system for Tinejdad-Goulmima is undergoing.
Village: Zaouia Commune: Ferkla Essoufla Population: 459 (1994)	Water source: Private wells - The village is located at east part of Ait Labzem irrigation area. - The population depend on private wells. Extension of ONEP's water supply system for Tinejdad-Goulmima is undergoing.
Village: Tighfart Commune: Ferkla Essoufla Population: 1,986 (1994)	Water source: Khettara - The village is located at east part of Ait Labzem irrigation area. - The population depend on Khettara. Extension of ONEP's water supply system for Tinejdad-Goulmima is undergoing.
Village: Talalt Commune: Ferkla Essoufla Population: 456 (1994)	Water source: Private wells or Khettara in Tighfar - The village is located at east part of Ait Labzem irrigation area. - Private wells are frequently dried up, therefore the population also take water from Khettara in Tighfart. Extension of ONEP's water supply system for Tinejdad-Goulmima is undergoing.
Village: Tayarza Commune: Ferkla Essoufla Population: 301 (1994)	Water source: Private wells or Khettara in Tighfar - The village is located at east part of Ait Labzem irrigation area. - Private wells are frequently dried up, therefore the population also take water from Khettara in Tighfart. Extension of ONEP's water supply system for Tinejdad-Goulmima is undergoing.
Village: Tizougachine Commune: Ferkla Essoufla Population: 2,588 (1994)	Water source: Khettara - The village is located beside (north of) Chitam irrigation area, and around middle between Tinejdad and Goulmima. - The population depend on Khettara. Extension of ONEP's water supply system for Tinejdad-Goulmima is undergoing.
Village: Ait Ba Maati Commune: Ferkla Essoufla Population: 446 (1994)	Water source: Khettara - The village is located beside (north of) Chitam irrigation area, and around middle between Tinejdad and Goulmima. - The population depend on Khettara. Extension of ONEP's water supply system for Tinejdad-Goulmima is undergoing.
Village: Ait Moulay Elmamoune Commune: Ferkla Essoufla Population: 506 (1994)	Water source: Khettara - The village is located beside (north of) Chitam irrigation area, and around middle between Tinejdad and Goulmima. - The population depend on Khettara. Extension of ONEP's water supply system for Tinejdad-Goulmima is undergoing.
Village: Dar Oumira Commune: Ferkla Essoufla Population: 521 (1994)	Water source: Khettara - The village is located beside (north of) Ait Labzem irrigation area. - The population depend on Khettara. Extension of ONEP's water supply system for Tinejdad-Goulmima is undergoing.
Village: Laksibat Commune: Ferkla Essoufla Population: 935 (1994)	Water source: Khettara or private wells - The village is located beside (north of) Ait Labzem irrigation area. - Khettara is frequently dried up, therefore the population depend on private wells also. Extension of ONEP's water supply system for Tinejdad-Goulmima is undergoing.
Village: Ait Ben Omar Commune: Ferkla Essoufla Population: 610 (1994)	Water source: Khettara - The village is located beside (north of) Ait Labzem irrigation area. - The population depend on Khettara. Extension of ONEP's water supply system for Tinejdad-Goulmima is undergoing.
Village: Izilf Commune: Ferkla Essoufla Population: 1,193 (1994)	Water source: Khettara - The village is located beside (south of) Chitam irrigation area. - The population depend on Khettara. Extension of ONEP's water supply system for Tinejdad-Goulmima is undergoing.

Table XIV1.2.1: Existing Water Supply Conditions in Rural Area (5/5)

Azghar Dam

Village: Ikharouane	Water source: ONEP system for Ribat Al Khayı
Commune: Ighazrane	- The village is located at border of the irrigation area, around 3km from Ribat Al Khayr.
Population:	- ONEP's water supply system for Ribat Al Khayr is covering this village. Standpipes and house-connection are provided.
Village: Tsaout Ou Araar	Water source: ONEP system for Ribat Al Khayı
Commune: Ighazrane	- The village is located within the irrigation area.
Population:	- ONEP's water supply system for Ribat Al Khayr is covering this village. Standpipes are provided.
Village: Taghza Lamrouj	Water source: ONEP system for Ribat Al Khayı
Commune: Ighazrane	- The village is located within the irrigation area.
Population: 183 (1994)	provided.
Village: Nass Daoud	Water source: ONEP system for Ribat Al Khayı
Commune: Ighazrane	- The village is located outside (north) of the irrigation area, around 2 to 3 km from Ribat Al Khayr.
Population: 840 (1994)	- ONEP's water supply system for Ribat Al Khayr is covering this village. Standpipes and house-connection are provided.
Village: Zaouia Tijania	Water source: ONEP system for Ribat Al Khayı
Commune: Ighazrane	- The village is located outside (north) of the irrigation area, around 2 to 3 km from Ribat Al Khayr.
Population:	- ONEP's water supply system for Ribat Al Khayr is covering this village. Standpipes and house-connection are provided.
Village: Sidi Bouazza	Water source: ONEP system for Ribat Al Khayı
Commune: Ighazrane	- The village is located around 3km north of Ribat Al Khayr.
Population: 151 (1994)	- ONEP's water supply system for Ribat Al Khayr is covering this village. House-connection is
Village: Tissi Ifrah	Water source: ONEP system for Ribat Al Khayı
Commune: Ighazrane	- The village is located around 3km north of Ribat Al Khayr.
Population: 857 (1994)	- ONEP's water supply system for Ribat Al Khayr covers this village. House-connection is provided.
Village: Tahayyant	Water source: ONEP system for Ribat Al Khayı
Commune: Ighazrane	- The village is located around 3km north of Ribat Al Khayr.
Population: 156 (1994)	- ONEP's water supply system for Ribat Al Khayr covers this village. Standpipes and house-connection are provided.
Village: Tichout Tamalalet	Water source: Spring at river bed or private wells
Commune: Ighazrane	- The village is located within the irrigation area.
Population:	- Extension of ONEP's water supply system for Ribat Al Khayr is programmed.
Village: Nass Said Jbel	Water source: Spring at river bed or private wells
Commune: Ighazrane	- The village is located within the irrigation area.
Population: 441(1994)	- Extension of ONEP's water supply system for Ribat Al Khayr is programmed.
Village: Ekarbousse	Water source: Spring at river bed or private wells
Commune: Ighazrane	- The village is located within the irrigation area.
Population: 317 (1994)	- Extension of ONEP's water supply system for Ribat Al Khayr is programmed.
Village: Ansem	Water source: Public well
Commune: Ighazrane	- The village is located within the irrigation area.
Population:	- There exists non-equipped public well in this village.
Village: Mghila	Water source: Spring (Ain Jorf)
Commune: Ouled Mkoudou	- The village is located at the downstream end of the irrigation area.
Population: 1,383 (1994)	- The commune manages a water supply network which was constructed in 1963. Decrepitness of the facilities is severe and water yield from the spring is decreasing. Only 2 standpipes (out of 6 standpipes installed) and about 20 household (out of 110 house-connected) are currently served.
	- Extension of ONEP's water supply system for Ouled Mkoudou is undergoing.

Table XIV1.2.2: Existing Water Supply Conditions in Urban Area (1/2)

N'fifikh Dam

Centre: Ben Slimane Municipality Province: Ben Slimane Population: 36,977 (1994)	Water Supply by: ONEP - The centre is located northward of the dam site, around 25km in straight distance. - Major water source for Ben Slimane is Sidi Mohamed Ben Abdallah (SMBA) dam. The dam is constructed for purpose of drinking and industrial water supply in 1974. It is a fill dam of 99m height and 245Mm^3 suppy capacity per year. - Existing water supply capacity is 190l/s in total (170l/s from SMBA, 7l/s from Daidia spring, and 13l/s from two wells). - Peak demand is estimated at 123l/s in 2000, 150l/s in 2010 and 176l/s in 2020.
Centre: El Gara Municipality Province: Settat Population: 15,822 (1994)	Water Supply by: ONEP - The centre is located southwestward of the dam site, around 21km in straight distance. - Existing water supply capacity is 57l/s in total (five wells).
Centre: Mellila Centre of rural commune Province: Ben Slimane Population: 2000	Water Supply by: Commune - The centre is located westward of the dam site, around 9km in straight distance. - The commune manages a water supply network which serves 176 recipient households. There exists a spring of 2l/s (Oum Ain) as water source, galvanized pipes of 820m long and 2.5 inch dia. and three storage tanks (120, 30, 27m^3). - High salinity is recognized. - ONEP is planning to extend distribution pipe from Fedalate.

Taskourt Dam

Centre: Imin Tanout Municipality Province: Chichaoua Population: 12,592 (1994)	Water Supply by: ONEP - The centre is located westward of the dam site, around 35km in straight distance. - Existing water supply capacity is 20l/s (15l/s from well and 5l/s from spring). Currently a drilled well of which capacity is 10-15l/s is under construction. Two water storage tank of 1000m^3 and 300m^3 are equipped. - Peak demand is estimated at 20l/s in 2000, 22l/s in 2003 and 26l/s in 2010.
Centre: Chichaoua Municipality Province: Chichaoua Population: 9,738 (1994)	Water Supply by: ONEP - The centre is located northwestward of the dam site, around 45km in straight distance. - Existing water supply capacity is 23l/s from drilled well. Two water storage tank of 300m^3 and 500m^3 are equipped. - Peak demand is estimated at 17l/s in 2000, 18l/s in 2003 and 22l/s in 2010.
Centre: Sidi Moktar Centre of rural commune Province: Chichaoua Population: 9,495 (1994)	Water Supply by: ONEP - The centre is located westward of Chichaoua, around 25km in straight distance. - Existing water supply capacity is 25l/s from drilled well. One water storage tank of 600m^3 is - Peak demand is estimated at 7.6l/s in 2000, 11l/s in 2003 and 12l/s in 2010.
Centre: Amezmiz Centre of rural commune Province: Al Haouz Population: 8,985 (1994)	Water Supply by: ONEP - The centre is located eastward of the dam site, around 23km instraight distance. - Existing water supply capacity is 35l/s. One water storage tank of 1000m3 is equipped. - Peak demand is estimated at 18l/s in 2000, 20l/s in 2003 and 21l/s in 2010.

Table XIV1.2.2: Existing Water Supply Conditions in Urban Area (2/2)

Timkit Dam

Centre: Tinejdad- Goulmima Municipality Province: Errachidia Population: 5,755 (Tinejdad, 1944), 14,026 (Goulmima, 1944)	Water Supply by: ONEP - Tinejdad is located southeastward of the dam site, around 32km in straight distance. - Goulmima is located eastward of the dam site, around 35km in straight distance. Distance between Tinejdad and Goulmima is about 22km, - Existing water supply capacity is 96l/s in total (drilled wells of 50, 30 and 10l/s, and four wells of 6l/s). - Peak demand is estimated at 65l/s in 2000, 91l/s in 2010 and 112l/s in 2020. - One drilled well of 50l/s is located in Dar Oumira village of Ferkla Essoufla commune, meanwhile the other two are located near water tank of ONEP about 4km far from Goulmima. From here, the water is conveyed through 250mm dia pipes to Thinejdad and Goulmima. - One water storage tank of 1000m^3 exists in Tinejdad, meanwhile another one of 1000m3 is also under construction. In Goulmima, there exists two water tanks of 1000 and 300m^3. There is also another water tank of 120m^3 is under construction between Goulmima and Tinejdad. - One drilled well of 10l/s and 4 wells are currently not used for problem of water quality. Moreover, another drilled well of 30l/s sometimes faces trouble of entrainment of sands. For these reasons, ONEP is excuting trial digging of drilled wells to see another source nearby.
Centre: Errachidia-Rissani Municiplity Province: Errachidia Population: 62,542 (Errachidia, 1944), 12,946 (Aoufous, 1944), 18,563 (Erfoud, 1994), 4,673 (Rissani, 1994)	Water Supply by: ONEP - Errachidia is located eastward of the dam site, around 90km in straight distance. - The supply system stretches over some 100km, includes the centers of Errachidia, Aoufous, Erfoud, Rissani and villages located along the Ziz valley and in the Tafialet plain. - Existing water supply capacity is 320l/s in total (four drilled wells located at immediate downstream of the Hassan Ad Dakhil dam), which corresponds to water demand in 2008. Deficit to meet with demand in long term future might be covered by another exploitation of - One water storage tank of 5000m^3 exists at immediate downstream of the Hassan Ad Dakhil dam, meanwhile another one of 5000 m^3 exits in Erfoud.
Centre: Tinghir Municipality Province: Ouarzazate Population: 30,471 (1944)	Water Supply by: ONEP - The centre is located westward of the dam site, around 25km in straight distance. - Existing water supply capacity is 70l/s in total (two wells of 30 and 10l/s, and one drilled well of 30l/s). - Peak demand is estimated at 70l/s in 2010 and 90l/s in 2020. Deficit of 20l/s to meet with demand in 2020, might be covered by another exploitation of ground water.

Azghar Dam

Centre: Ribat Al Khayr Municipality Province: Sefrou Population: 8,373 (1944)	Water Supply by: ONEP - The centre is located westward of the dam site, around 7km in straight distance. - Existing water supply capacity is 25l/s in total (two wells of Ain Ajri and Ifrah). - Peak demand is estimated at 23l/s in 2000, 24l/s in 2010 and 28l/s in 2020. - Ain Ajri is located westward of Ribat Al Khayr, about 5km distance. The well has 2m diameter, 13.2m depth and capacity of 15l/s. From the well, pipes of 200mm diameter are - Ifrah is located northwestward of Ribat Al Khayr, about 4km distance. The well has 1.6m diameter, 33.5m depth and capcity of 10l/s. 150mm diameter pipes are extended to the centre. - There exists two water storage tanks of 500m^3 and 200m^3. - Water rate per 1m3 is ranked, according to consumption in 3 months, into three ranks, that is 2.30Dh (less than 24m^3), 6.42 Dh (24 to 60m^3) and 9.54 Dh (more than 60m^3)
Centre: El Menzel Municipality Province: Sefrou Population: 10,785 (1944)	Water Supply by: Commune - The centre is located westward of Ribat Al Khayr, around 13km in straight distance. - Existing water supply capacity is 32 l/s (from spring Ain Lakbir). - Peak demand, including centre of Ouled M'koudou is estimated at 42.4 l/s in 2015. - ONEP is studying to intervene with sources of both new drilled well (40l/s) and Igli well (5l/s).
Centre: Ouled M'koudou Centre of rural commune Province: Sefrou Population: 1000	Water Supply by: Commune - The centre is located westward of Ribat Al Khayr, around 13km in straight distance. - Existing water supply capacity is 5l/s (from well Igli). - There exists one water storage tank of 70m^3.
Centre: El Aderj Centre of rural commune Province: Sefrou Population: 1000	Water Supply by: ONEP - The centre is located southward of the dam site, around 23km in straight distance. - Existing water supply capacity is 3l/s (from spring Ain Saba). - Peak demand is estimated at 4.8l/s in 2000, 4.8l/s in 2005 and 6.8l/s in 2010. - There exists one water storage tank of 75m^3. - ONEP is committing developing another drilled well of 5l/s.

Table XIV1.3.1: Preliminary Project Features of Small-scale Water Supply System

Item	Unit	N'fifikh	Taskourt		
Village		Tlet Ziaida	Dar Akimakh	Tamatoust	Tiguemi Oumrhar
Commune		Ziaida	Assif El Mal	Mzouda	Mzouda
Population	person				
1994		824	575	549	539
2000		1120	760	(292)	552
2020		1300	900	700	700
Consumption					
Daily	m3/d	26	18	14	14
Annual	m3/y	9,490	6,570	5,110	5,110
Water Source		Oued N'fifikh	Seguia Tadraouit	Seguia Tamatoust	Seguia Taourdast
Reservoir Volume	m3	26	18	14	14
Number of Stand Pipes	nos	4	3	3	3
Project Cost	mil DH	1.8	1.2	0.9	0.9

Table XIV2.1.1: Existing Hydropower Stations in Morocco

Power Station	Province	River	Start of Operation	Installed Capacity (MW)	Energy (GWh)				
					1994	1995	1996	1997	1998
Al Wahda	Sidi Kacem	Ouergha	1997	247.5	-	-	-	132.8	486.7
Allal El Fassi	Sefrou	Mamata	1994	240	16.3	66.3	302.5	196.3	102.7
Oued El Makhazine	Larache	Loukkos	1979	36	12.7	9.5	90.0	93.9	70.9
Idriss 1er	Taounate	Inaouene	1978	40.6	11.5	-0.2	71.3	136.6	48.2
El Kansera	Sidi Slimane	Beht	1935	14.4	10.3	5.1	39.2	33.7	28.3
Fes, Meknes, Taza, Sefrou		Boukhrareb	1934	4.92	2.3	0.3	4.2	4.0	2.2
Lau, Taurart	Chefchaouen	Lau Talambot	1934	16.1	36.6	11.6	58.3	17.8	21.6
Hassan 1er	Azilal	Lakhdar	1991	67	71.0	52.3	158.7	126.7	98.2
Lala Takerkoust	Marrakech	N'fis	1984	12	19.2	9.1	43.8	30.3	20.6
Al Massira	Settat	Oum Erbia	1980	128	54.7	-0.5	138.6	244.8	142.4
Moulay Youssef	El Kelaa Des Sraghna	Tassaout	1974	24	47.5	21.8	61.4	49.9	40.4
Afourer	Azilal	Abid	1955	93.6	315.3	261.7	446.0	455.6	382.4
Bine El Ouidane	Azilal	Al Abed	1953	135	116.0	81.0	256.9	204.7	162.8
Daourat	Settat	Oum Erbia	1950	17	4.0	2.8	25.5	60.5	17.3
Imfout	Settat	Oum Erbia	1947	31.2	13.1	10.3	46.6	102.6	35.3
Kasba Zidania		Oum Erbia	1935	7.1	6.2	1.4	15.7	13.5	7.8
Sidi Said	El Jadida	Oum Erbia	1929	20.8	-0.3	-0.4	17.8	43.5	9.7
Mansour	Ouarzazate	Draa	1987	10	23.9	31.3	46.7	27.9	29.7
Bou Areg	Nador	Moulouya	1969	6.4	14.2	7.1	19.5	15.6	9.0
Mohammed El Khamis	Oujda	Moulouya	1967	23.2	65.0	34.5	94.9	71.2	42.9
		Total		1,175	840	605	1,938	2,062	1,759

Source: ONE

Table XIV2.1.2: Length of Transmission and Distribution Lines in Morocco

(Unit : km)

	1994	1995	1996	1997	1998
High Voltage	12,942	13,609	13,775	15,046	15,087
400 kV	-	-	-	500	500
225 kV	4,106	4,629	4,652	5,028	5,028
150 kV	762	763	763	763	763
60 kV	8,074	8,217	8,360	8,755	8,796
Medium Voltage	16,867	17,085	19,826	20,058	23,667
30 kV	3	3	3	3	3
22 kV	16,782	17,000	19,741	19,973	23,582
20 kV	82	82	82	82	82
Low Voltage					
380/220 V				30,355	36,426

Source : ONE

Table XIV2.2.1: Program of Electrification for Villages around the Project

Taskourt Dam

Status	Year	Commune : Assif El Mal	
		Village	Location
Electrified		Imin Ouassif	between dam and irrigation area
		Sidi Bou	
		Dar Akimah	witin irrigation
PERG2	2000 - 2002	Ait Abaid	within irrigation area
		Ifrane	
		Jorf	
		Taloutint	
		Ajmani	
		Tigourar	
		Dar N'mes	
PERG3	2002 - 2004	Taskourt	between dam and irrigation area
		Anebdour	
		Bonou	within irrigation area
		Tafroukht	
PERG4	2004 - 2006	Imin Ighzer	between dam and irrigation area
PERG5	2006 - 2008	Taddart	near irrigation area

Status	Year	Commune : Adassil	
		Vilage	Location
Electrified		Adassil Centre	upstream of reservoir
		Majdid	
		Quaidat	
PERG2	2000 - 2002	Tignarine	upstream of reservoir
PERG3	2002 - 2004	Azmou	within reservoir
		Tiderguine	
		Assais	
		Kerni	
		Tiliwa	
		Talborjt	
		Imin Eikha	
		Talat Nemti	
		Zawyat Hemti	
		Ighermane	
		Tikht	
		Tighoula	near reservoir
		Tagadirt	
		Agaolir	
		Aoammer	
		Zwalil	
		Iberdatene	
PERG4	2004 - 2006	Tawtirt	upstream of
		Ighzer	within reservoir

Azghar Dam

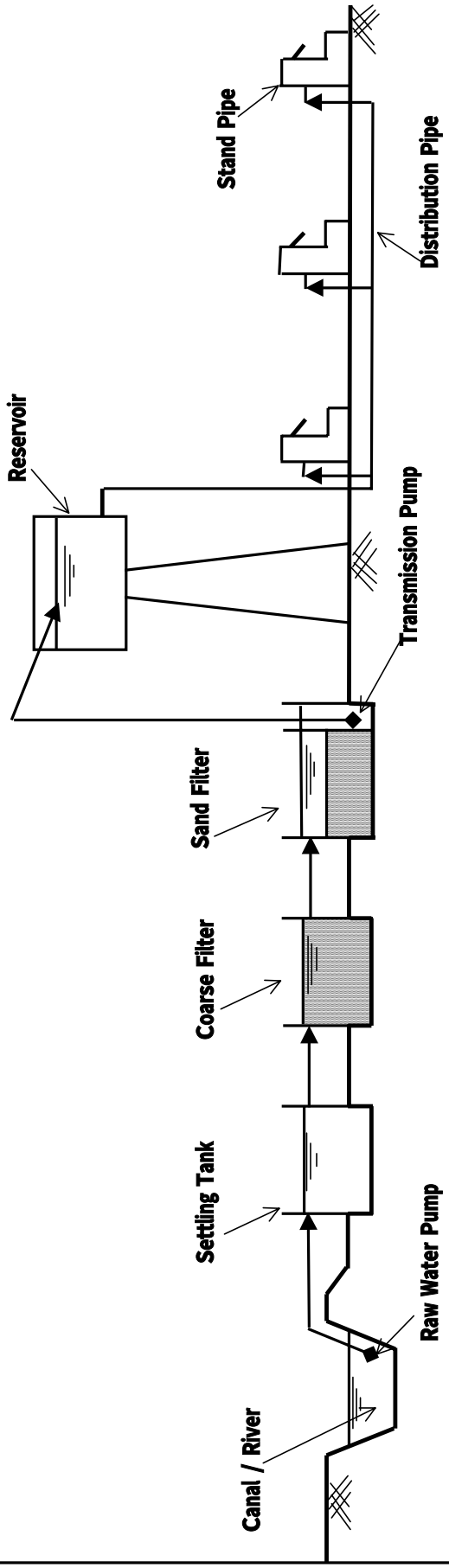
Status	Year	Commune : Ighazrane	
		Village	Location
Electrified		Ifrah	north of Ribat El Kheir
		Sidi Bonaza	
PERG2	2000 - 2002	Tsaout Ou Araar	within irrigation area
		Tichout	
		Nass Said Jbel	
		Taghza Lamrouj	
		Ekarbousse	
		Ouled Nacer	near irrigation
		Tahiyante	north of Ribat
PERG3	2002 - 2004	(none)	
PERG4	2004 - 2006	Batha	upstream of reservoir
		Beni Souhane	
		Od Mimoune	
		Sidi Yahia	near irrigation
		Tirbitinr	(other location)
		Taounte Ouaarar	
PERG5	2006 - 2008	Ansem	within irrigation area
		Ihanoune	upstream of reservoir
		El Mesreh	
		Beni Abbad	
		Matine	
		Ahmmar	
		Faj Azrar	
		Ain Mediouna 1	(other location)
		Ain Mediouna 2	
		Nasdaoud	
		Ait Mhamed	
		Igli	

Table XIV2.3.1: Preliminary Project Features of Mini-hydro Power Station

Item	Unit	Taskourt		Azghar
		NWL 1020m	NWL 995m	
Specifications				
Installed capacity	kW	710	460	50
Maximum discharge	m3/s	1.5	1.5	1.0
Reservoir water level	m	1020	995	854
Turbine center level	m	950	950	847.5
Gross head	m	70.0	45.0	6.5
Maximum effective head	m	64.4	41.4	6.0
Generated energy	GWh	2.06	1.22	0.09
Powerhouse building				
Type		Open	Open	Open
Turbine				
Type		Cross-flow	Cross-flow	Cross-flow
Transmission line				
Line voltage	V	22,000	22,000	22,000
Wire length	km	1.0	1.0	2.5
Project Cost				
Powerhouse building	mil. DH	2.6	1.9	0.3
Generating equipment	mil. DH	11.0	8.3	1.8
Transmission line	mil. DH	0.1	0.1	0.4
Total	mil. DH	13.7	10.3	2.5
Unit Construction Cost				
per kWh	DH/kWh	4.9	6.2	19.3

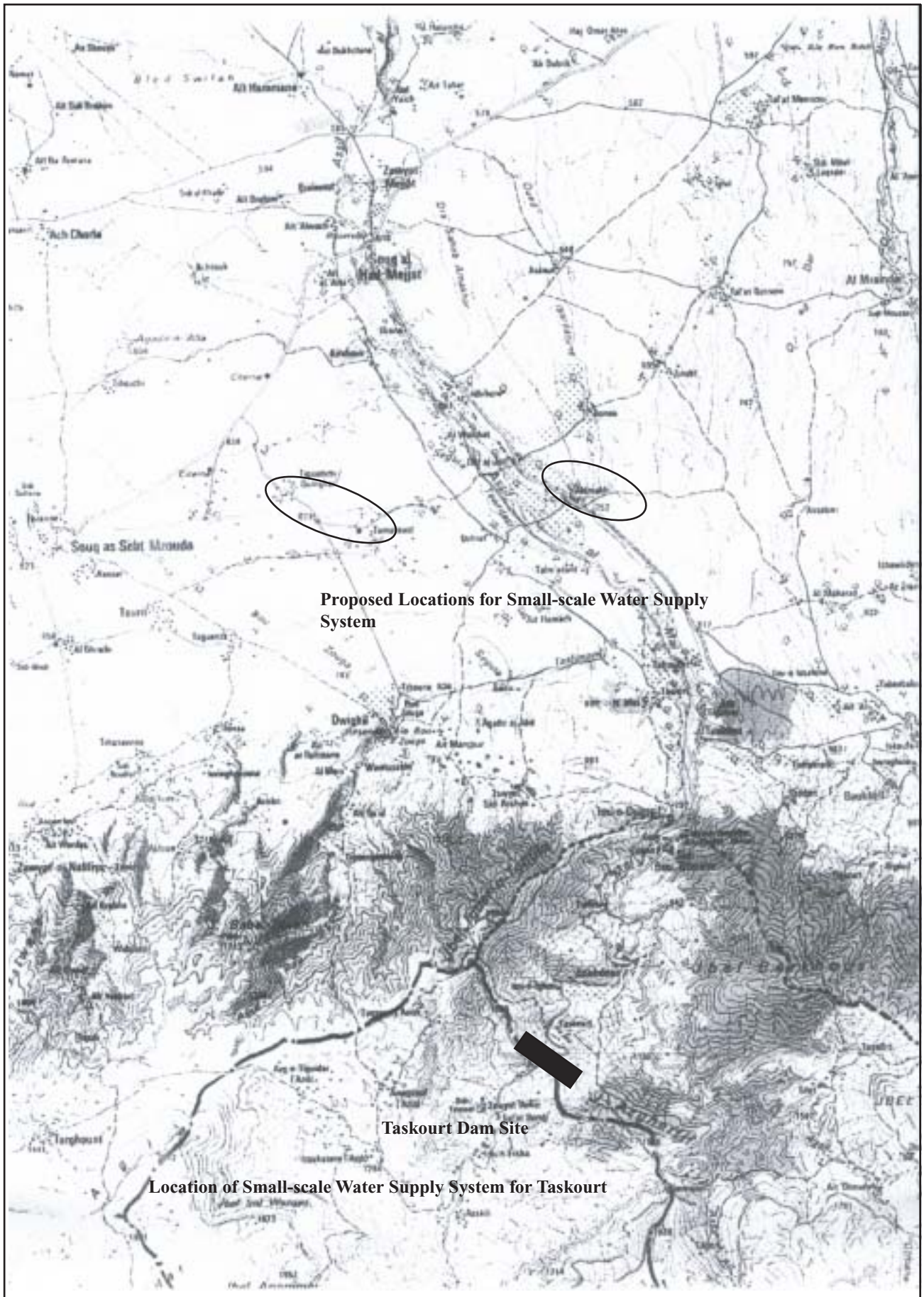
Note Unit construcion cost per kWh is calculated by cost that covers actual work, overhead and profit of the contractor, and physical contingency only.

Figures



FEASIBILITY STUDY ON WATER RESOURCES DEVELOPMENT IN RURAL AREA JAPAN INTERNATIONAL COOPERATION AGENCY	**Figure XIV1.3.1** **Water Conveyance, Purification and Distribution Methods for Small-scale Water**

FEASIBILITY STUDY ON WATER RESOURCES DEVELOPMENT IN RURAL AREA JAPAN INTERNATIONAL COOPERATION AGENCY	**Figure XIV1.3.2** **Location of Small-scale Water Supply System for N'Fifikh**

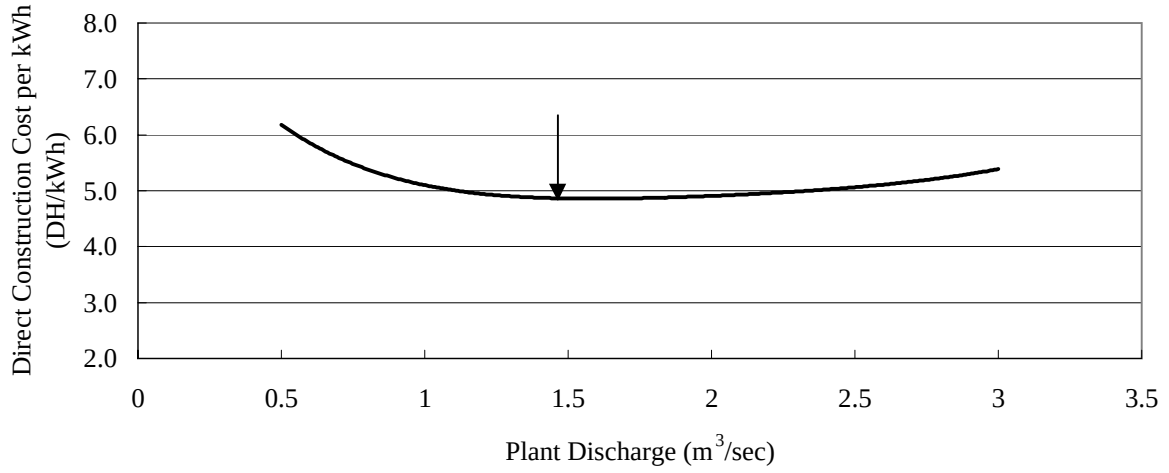


FEASIBILITY STUDY ON
WATER RESOURCES DEVELOPMENT
IN RURAL AREA

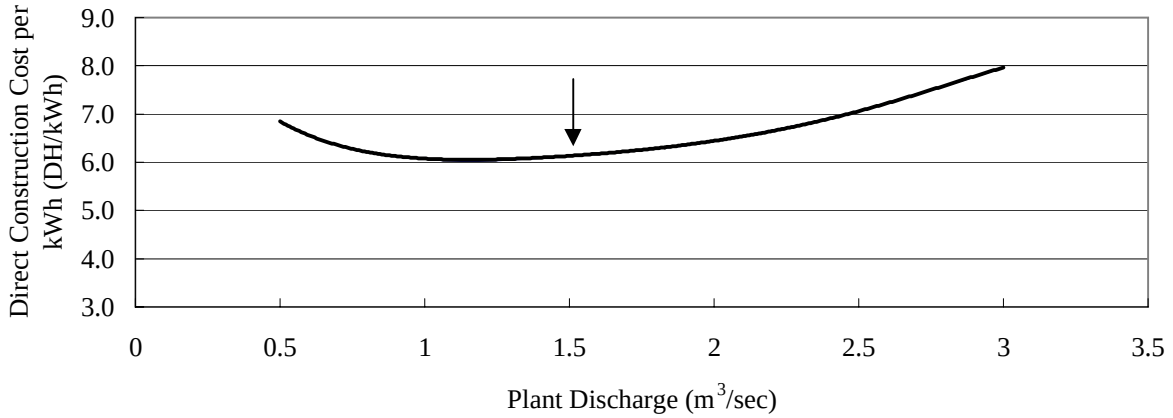
JAPAN INTERNATIONAL COOPERATION AGENCY

Figure XIV1.3.3
Location of Small-scale Water Supply System for Taskourt

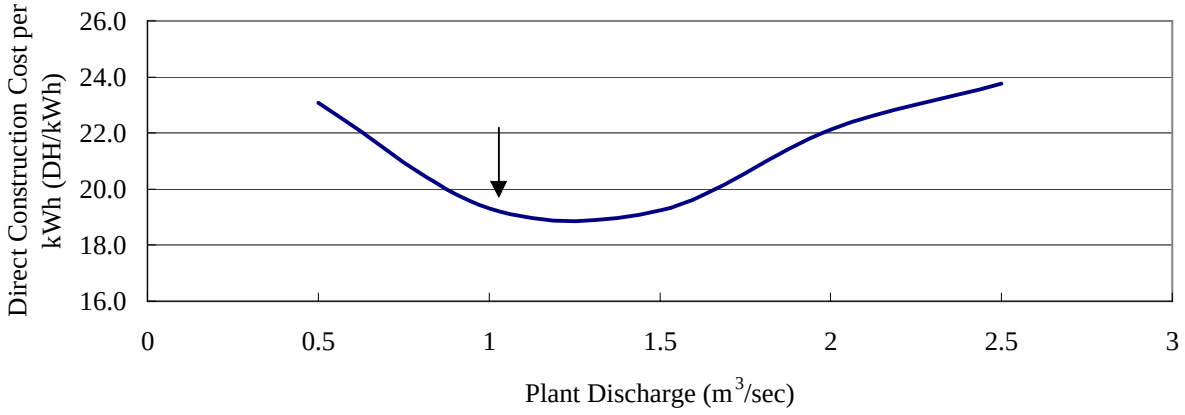
Taskourt (NWL 1020m)



Taskourt (NWL 995m)



Azghar



FEASIBILITY STUDY ON WATER RESOURCES DEVELOPMENT IN RURAL AREA	**Figure XIV2.3.1** **Scale Optimization for Power Stations**
JAPAN INTERNATIONAL COOPERATION AGENCY	

Supporting Report XV Determination of the Project Scale and Ground Water Recharging

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 XV
DETERMINATION OF THE PROJECT SCALE
AND
GROUND WATER RECHARGING

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REPORT XV

DETERMINATION OF THE PROJECT SCALE AND GROUND WATER RECHARGING

XV1 Water Balance Study

XV1.1 Calculation Method

Reservoir operation calculation in monthly basis by computer simulation model is carried out in order to estimate the annual regulated volume from each dam, based on the following equation:

$$\Delta V = VE - VS - EN \times S$$

where,

ΔV : Increase of stored water volume in the reservoir

VE : Inflow volume to the reservoir

VS : Outflow volume from the reservoir (water use and spill-out)

EN : Net evaporation (evaporation - rainfall) per reservoir area

S : Reservoir area

XV1.2 Basic Data

XV1.2.1 Inflow

Annual inflow to the reservoir is estimated as follows.

Inflow to Reservoir

No	Dam	Period of Data	Annual Inflow (Mm^3/yr)
1	N'Fifikh (upstream)	1939/40-1996/97	13.32
2	N'Fifikh (downstream)	1939/40-1996/97	11.40
3	Taskourt	1935/36-1996/97	44.65
4	Timkit	1961/62-1996/97	11.71
5	Azghar	1955/56-1998/99	53.21

The above estimation of inflow is principally obtained by the records at the reference gauging stations adjusted by ratio of catchment area. For the N'Fifikh (downstream) dam, residual catchment area excluding the one for the N'Fifikh (upstream) dam is considered and such derived inflow is reduced to 70% for a margin against overestimation.

Monthly inflow to the reservoir is as tabulated in Table XV1.1 to XV1.5.

XV1.2.2 Sedimentation

Annual reservoir sedimentation is estimated as follows.

Sedimentation

No	Dam	Annual Sedimentation (Mm^3/yr)
1	N'Fifikh (upstream)	0.03
2	N'Fifikh (downstream)	0.04
3	Taskourt	0.12
4	Timkit	0.20
5	Azghar	0.13

XV1.2.3 Precipitation

Annual precipitation on reservoir surface is estimated as follows.

Precipitation

No	Dam	Annual Precipitation (mm/yr)
1	N'Fifikh (upstream)	323.4
2	N'Fifikh (downstream)	323.4
3	Taskourt	366.0
4	Timkit	186.4
5	Azghar	446.8

Monthly distribution of the precipitation is tabulated on Table XV1.6.

XV1.2.4 Evaporation

Annual evaporation from reservoir surface is estimated as follows.

Evaporation

No	Dam	Annual Evaporation (mm/yr)
1	N'Fifikh (upstream)	1,545
2	N'Fifikh (downstream)	1,545
3	Taskourt	1,412
4	Timkit	2,115
5	Azghar	1,484

The above estimation of evaporation is obtained using the pan data records collected at the nearest and most similarly situated existing dams with adjustment by coefficient of 0.8.

Monthly distribution of the evaporation is tabulated on Table XV1.7.

XV1.2.5 Water Demand

Water demand is considered for the irrigation purpose only. Requirement based on drought rainfall with 5-year probability is adopted. Applied annual water demand per unit irrigation area is as follows.

Water Demand

No	Dam	Annual Water Demand (m^3/ha/yr)
1	N'Fifikh (upstream)	8,247
2	N'Fifikh (downstream)	5,712
3	Taskourt	9,641
4	Timkit	11,212
5	Azghar	7,304

Water demand for the small-scale water supply systems is negligibly small; therefore deemed to be included in the irrigation water demand. Water demand for mini-hydro power generation is not considered because subordinate water use to the irrigation is assumed.

Monthly distribution of the water demand per unit irrigation area is tabulated on Figure XV1.8.

XV1.2.6 H-Q/A Curve

Based on 1:5,000 scale topography maps, correlation between elevation and reservoir area/volume are obtained as shown on Figure XV1.1 and Table XV1.9 to Table XV1.13.

XV1.2.7 Maintenance Flow

No maintenance flow to the downstream reach of the dam is considered in this reservoir operation calculation.

XV1.3 Calculation Criteria

Duration of simultaneous calculation is taken as long as possible, in so far as the monthly inflow data is available.

50-year sedimentation volume is taken as dead storage volume for the N'Fifikh, Taskourt and Azghar dams.

Meanwhile 20-year sedimentation volume is applied for the Timkit dam to avoid water loss due to excessive evaporation from reservoir surface.

Criteria for supply guarantee for irrigation are set as follows, according to the common practice in Morocco:

- Deficit year is defined as years of which annual deficit overpass 15%.
- Admissible frequency for occurrence of the deficit year is 20 %.
- Admissible maximum annual deficit is 50 %.

For operation of the reservoir, the followings are assumed:

- 100% of water requirement is taken in case that the reservoir water level is between the normal water level and the minimum operation water level-1.
- 68% of water requirement is taken in case that the reservoir water level is between the minimum operation water level-1 and -2.
- 50% of water requirement is taken in case that the reservoir water level is between the minimum operation water level-2 and the minimum water level (same as the dead storage water level).
- No water is taken in case that the reservoir water level is below the minimum water level.

The minimum operation water level-2 is set as the one that corresponds to 50% of the effective volume for the minimum operation water level-1.

The minimum operation water level-1 is set by trial and error so as to realize the most satisfaction of the aforementioned criteria for water supply guarantee.

Initial reservoir water level is set as the one that corresponds to 70% of the effective volume of the reservoir.

XV1.4 Result

As a result of the calculation, regulated volumes at respective dam scales are obtained as shown on Table XV1.14. Correlation curves between the regulated volume and the normal water level are shown on Figure XV3.1 to Figure XV3.5.

Correlation curves between the normal water level and annual average volumes for water use for irrigation, evaporation and spill-out are also obtained and shown on Figure XV1.2.

Figure XV1.3 indicates evaporation and regulated volumes in case that 50 to 20-year sedimentation volumes are considered as the dead storage volume in the Timkit reservoir. It is found that evaporation volume becomes substantially too large in case of other than the 20-year case.

XV2 Groundwater Recharging at the Timkit Dam

XV2.1 Water Intake at Weirs in Downstream of the Timkit Dam

For the Timkit dam, there are three weirs, that is, Ait Labzem (maximum intake capacity of 16 m^3/s), Bour (13.5 m^3/s) and Chitam (11 m^3/s) weirs which are aimed to take flood water in the Tanguerfa and Todrah rivers. Volume of water intake and spill-out, excluding due to discharge from the Timkit dam, at each weir is estimated in the following method:

(1) Based on the monthly, daily and peak discharge data at the Merroutcha gauging station, a dimensionless hydrograph in monthly basis is established.

(2) Inflows to each weir are estimated on the monthly basis based on the Tadighoust gauging station by ratio of catchment area. Assumed catchment area for each weir is as follows:

Catchment Area for Weir

No	Weir	Catchment Area (km^2)
1	Ait Labzem	382
2	Bour	1,254
3	Chitam	191

(3) Based on the established dimensionless hydrograph, water volume which exceeds the maximum intake capacity (spill-out) is calculated at each weir. Monthly intake volume is obtained as differential between the monthly inflow volume and the monthly spill-out volume.

Firstly, the above calculation is done to the Chitam weir location with total intake capacity of the three weirs in order to estimate total intake volume. Subsequently, intake volumes at the Ait Labzem and Bour weirs are calculated respectively. Intake volume at the Chitam weir is obtained as differential between the total intake volume, and intake volumes at the Ait Labzem and Bour weirs.

Consequently, monthly intake volumes at the Ait Labzem, Bour and Chitam weirs are calculated as shown in Table XV2.1 to Table XV2.3. Annual mean water intake volumes are summarized as follows.

Annual Mean Water Intake Volume at Weir

No	Weir	Intake Volumes (Mm^3/yr)
1	Ait Labzem	3.75
2	Bour	7.87
3	Chitam	3.75

Accordingly, annual mean volume of 15.37Mm^3 in total is adopted as inflow to the command area of the project. This amount does not include the released volume from the Timkit dam.

XV2.2 Simulation of Groundwater Recharge and Pumping

XV2.2.1 Basic Data and Calculation Criteria

Based on the obtained hydrogeological parameters and findings by the calibrations, the recharge and pumping method is simulated by the manner to catch floods, to transport it through canals to the command area, and to infiltrate to the underground at the irrigation fields.

The simulation is made with the following conditions:

(1) Groundwater recharge by flood water in the Tanguerfa and Todrha rivers are considered, but released water from the Timkit dam is not counted.

(2) 37.5% of water intake at the Ait Labzem weir is assumed to be discharged into the Timkit basin, meanwhile remaining water intake at the Ait Labzem, Bour and Chitam weirs is assumed to be discharged into the Todrah basin.

(3) Ground water level in the outside of the irrigation area is set at 8.5 m in the Timkit basin and 17.6 m in the Todrah basin at the year of project completion based on the past actual average.

(4) The 3 scenarios for fluctuation of the ground water level in the outside of the irrigation area are analysed with condition of; A) the ground water level based on the 1973-2000 records, B) 50% reduction of the groundwater exploitation as of the year 2000, and C) 100% cut of the groundwater exploitation. For each scenario above, several pumping plan in the irrigation area are studied so as to prevent excessive lowering of the ground water level in the irrigation area.

Simulation result for each scenario/case is as shown in Figure XV2.1 and Table XV2.4 to Table XV2.5.

XV2.2.2 Recommended Plan

For the Timkit basin, it is recommended that 1.12 Mm^3 (80% of annual mean inflow to the basin) is to be exploited annually in the irrigation area by 7 wells of 30 l/s capacity with 4 hours operation a day in average. It is allowed to maintain water exploitation at current level in the outside of the irrigation area.

Meanwhile, for the Todrah basin, it is recommended to restrict groundwater exploitation in the outside of the irrigation area to 50% of the year 2000 level. In the irrigation area, 11.17 Mm^3 (80% of annual mean inflow to the basin) is to be exploited annually by 30 wells of 30 l/s capacity with 9 hours operation a day in average. In case of drought with 5-year probability, however, the water take from the wells in the irrigation areas are to be reduced to 5.58 Mm^3 (50% of 11.17 Mm^3).

XV3 Determination of Project Scale

XV3.1 Applied Criteria

In order to decide development scale for dam and irrigation area, following criteria is applied without consideration of other project components such as rural water supply and mini-hydro power generation:

(1) For each alternative dam scale, regulated volume and direct construction cost of both dam and irrigation facilities are calculated. For estimation of irrigation facilities cost, scale of irrigation facilities is assumed as 126% (100% for the Timkit) of regulated volume divided by water requirement per hectare based on drought rainfall with 5-year probability. Then total direct construction cost of both dam and irrigation facilities is divided by the regulated volume. Optimum scale for the dam is obtained as the dam scale that brings minimum direct construction cost per unit regulated volume. The corresponding scale of the dam is determined as the final development scale of the dam.

(2) Final development scale of the irrigation facility area (net irrigation area) is determined as follows:

- For the N'fifikh and Taskourt dams, final scale of irrigation facility area is set at 126 % of irrigation area that corresponds to the regulated volume from the final development scale of the dam.

- For the Timkit dam, the MOA (ORMVA) has already committed to develop the net irrigation area of 3,060 ha (3,825 ha in gross area). Therefore, this whole area is considered as the development scale.

- For the Azghar dam, the development scale of the irrigation facility area is set considering that the irrigable area is limited to 2,000 ha in net area (2,350 ha in gross area) at maximum due to its topographic condition.

(3) For benefit calculation, annual average irrigable area is calculated as follows:

- For the N'fifikh and Taskourt dams, actual irrigation water requirement for each year is assumed using annual rainfall for each year. Then, actual possible irrigation area for each year is estimated as the annual regulated volume by dam with the final development scale being divided by the actual irrigation water requirement for each year. Annual average of such actual possible irrigation area is used for benefit calculation of the project.

- For the Timkit dam, irrigable area for benefit calculation is obtained by water requirement based on drought rainfall with 5-year probability, because difference between drought rainfall and abundant rainfall is negligibly small.

- For the Azghar dam, irrigable area for benefit calculation is set considering that the irrigable area is limited to 2,000 ha at maximum.

XV3.2 Determination of the Project Scale

Based on the above criteria, development scale for dam and irrigation area are determined for each project as below:

(1) No.5 N'fifikh (upstream)

For the N'fifikh (upstream), correlations between the normal water level in the reservoir and the direct construction cost of dam and irrigation facilities, and the regulated volume are shown on Figure XV3.1. The direct construction cost per unit regulated volume touches its bottom in case that the normal water level is around EL. 240 to 245m. Therefore, the normal water level is set at EL. 245m as the final development scale of the dam. Annual regulated volume corresponding to this dam scale is 6.4 Mm^3.

Net irrigation area that corresponds to the water requirement (Alternative NU1) based on drought rainfall with 5-year probability is 780 ha.

Accordingly, development scale of the irrigation facility area is set at 1,000 ha. Annual average irrigation area is calculated at 853 ha, as shown on Table XV3.1.

With the same dam scale, another four alternative schemes on cropping pattern or irrigation method are studied as follows:

- Cropping pattern is made as the identical with the existing condition (Alternative NU2).
- Cropping pattern that enhances vegetable cultivation is applied (Alternative NU3).
- Mechanical irrigation is introduced with the same cropping pattern for NU1 (Alternative NU4).
- Irrigation area is located on the high hills of the left bank (Alternative NU5).

Development scale of irrigation facility area and annual average irrigable area are as follows:

Alternative Schemes for N'Fifikh (upstream)

Alternative	Net Irrigation Area with 80% Probability (ha)	Annual Average Irrigation Area (ha)	Net Irrigation Facility Area (ha)
NU1	780	853	1,000
NU2	810	886	1,030
NU3	590	645	1,000
NU4	900	984	1,170
NU5	780	853	1,000

According to economic evaluation, Alternative NU3 brings the highest economic internal rate of return, accordingly suggested as the definitive plan. With cropping pattern that enhances vegetable cultivation, net irrigation area is calculated at 590 ha, and annual average irrigable area is 645 ha. Development scale of the irrigation facility is set as the same as the Alternative NU1.

(2) No.5 N'Fifikh (downstream)

For the N'Fifikh (downstream), two alternative options are conceivable; that is, 1) with intake weir that has no regulating capacity (Alternative ND1), and 2) with small dam that provides regulated volume (Alternative ND2).

The former option exploits base flow of drought discharge with 5-year probability and groundwater.

For the latter, correlations between the normal water level in the reservoir and the direct construction cost of dam and irrigation facilities, and the regulated volume are shown on Figure XV3.2. The normal water level in the reservoir is set at EL. 15 m as the most economical option. Annual regulated volume corresponding to this dam scale is 2.7 Mm^3.

Development scale of irrigation facility area and annual average irrigable area for the above options are as follows:

Alternative Schemes for N'Fifikh (downstream)

Alternative	Net Irrigation Area with 80% Probability (ha)	Annual Average Irrigation Area (ha)	Net Irrigation Facility Area (ha)
ND1	210	228	260
ND2	470	510	590

Calculation of annual average irrigation area for Alternative ND1 is as shown on Table XV3.2.

According to economic evaluation, Alternative ND1 brings the higher economic internal rate of return. Nevertheless, as there is still uncertainty in available water at site, both alternatives are not suggested as the definitive plan.

(3) No.9 Taskourt

Correlations between the normal water level in the reservoir and the direct construction cost of dam and irrigation facilities, and the regulated volume are shown on Figure XV3.3.

Irrigation area of the Taskourt dam consists of perennial, seasonal and flood irrigation areas. Benefit increase with the Project is considerably larger in the seasonal and flood irrigation areas compared to the perennial area, accordingly benefit with unit regulated volume becomes larger in case that the regulated volume increases. Therefore, the regulated volume is adjusted so that unit volume's worth becomes equivalent.

Coefficient for adjusting the regulated volume is calculated as shown in Table XV3.3.

The direct construction cost of dam and irrigation facilities per unit adjusted regulated volume touches its bottom in case that the normal water level is around EL. 995 to 1020 m. The normal water level at EL. 1020 m (Alternative TA1) brings annual regulated volume of 34 Mm^3.

Net irrigation area that corresponds to water requirement based on drought rainfall with 5-year probability is 3,530 ha. Accordingly, development scale of the irrigation facility area is set at 4,500 ha. Annual average irrigable area is calculated at 3,831 ha as shown on Table XV3.4.

As the alternative dam scale, the normal water level in the reservoir at EL. 995 m is considered (Alternative TA3). Annual regulated volume corresponding to this dam scale is 24 Mm^3.

Moreover, another alternatives in case of introducing mechanical irrigation are also considered for the above two dam scales respectively (Alternative TA2 and TA4).

Development scales of irrigation facility area and annual average irrigable area for each alternative are as follows:

Alternative Schemes for Taskourt

Alternative	Net Irrigation Area with 80% Probability (ha)	Annual Average Irrigation Area (ha)	Net Irrigation Facility Area (ha)
TA1	3,530	3,831	4,500
TA2	4,060	4,406	5,100
TA3	2,500	2,713	4,500
TA4	2,880	3,126	4,500

According to economic evaluation, both Alternative TA1 and TA3 bring the highest economic internal rate of return. Considering DGH's policy to implement the Taskourt dam as a medium-scale dam, and vantage to mitigate negative impact due to inundation, Alternative TA3 is suggested as the definitive plan.

(4) No.10 Timkit

Because of inflow characteristics and high evaporation rate, the Timkit dam is not economically feasible if only considering the benefit due to regulated volume from the dam.

In order to minimize water loss due to evaporation, reservoir area of the dam is minimized in so far as the water requirement at Ifegh is satisfied.

Accordingly, the normal water level is determined at EL. 1,245m. Annual regulated volume corresponding to this dam scale is 2.7 Mm^3. Net irrigation area that corresponds to water requirement based on drought rainfall with 5-year probability at Ifegh is 240 ha. For irrigation purpose at the Ait Labzem and Chitam area, flood water is assumed to be stored temporarily in the reservoir above EL. 1,245m, and such water is to be released in regulated condition so as to be taken at the Ait Labzem and Chitam weirs.

Correlation between the storage capacity under the surcharge water level and the annual average volume released from the dam in regulated condition is calculated on Table XV3.5 with assumption that frequency of major flood is two times a year, that is, one between October and December, and the other between January and September.

Correlation between the surcharge water level and direct construction cost per annual average volume released from the dam in regulated condition is shown on Figure XV3.4. As the most economical scale, the surcharge water level of 1,255.8 m (corresponding to storage volume of 20 Mm^3 above NWL 1,245 m) is selected. The corresponding dam scale brings a released water volume for Ait Labzem and Chitam of 6.14Mm^3 in annual average.

With assumption of 20% water loss, discharged water from the dam of 4.91Mm^3 in annual average is assumed be taken at the Ait Labzem and Chitam weirs. Moreover, 15.37 Mm3 water volume in annual average, which originates from floods both in the Tanguerfa and Todrah rivers, is assumed to come into the irrigation area.

For irrigation method of the Timkit, there are two conceivable options as follows:

- Flood water from both the Tanguerfa and Todrah rivers are assumed to infiltrate to the underground at the irrigation fields. Meanwhile, the water from the Timkit dam is assumed to be released according to irrigation requirement on time and used as surface water (Alternative TI1).

- Not only the flood water from the Todrah and Tanguerfa rivers, but also the released water from the Timit dam infiltrate to the underground for groundwater recharging (Alternative TI2).

Development scales of irrigation facility area and annual average irrigable area including Ifegh for each alternative are as follows:

Alternative Schemes for Timkit

Alternative	Net Irrigation Area with 80% Probability (ha)	Annual Average Irrigation Area (ha)	Net Irrigation Facility Area (ha)
TI1	1,350	1,690	3,060
TI2	1,700	1,570	3,060

According to economic evaluation, Alternative TI1 brings the higher economic internal rate of return, therefore suggested as the definitive plan.

(5) No.17 Azghar

Correlations between the normal water level in the reservoir and the direct construction cost of dam and irrigation facilities, and the regulated volume are shown on Figure XV3.5.

Development scale of the irrigation facility area is set at 2,000 ha, that is the maximum limit from the topographic condition. Required regulated volume that corresponds to this irrigation area is calculated at 14.6 Mm^3, with water requirement based on drought rainfall of 5-year probability. The normal water level in the reservoir is set at EL. 854 m so as to bring this regulated volume.

According to economic evaluation, this project scale brings high economic viability even if the negative impact on existing dams in downstream is also considered. Therefore, this scale is suggested as the definitive plan.

Feasibility Study on Water Resources Development in the Rural Area in the Kingdom of Morocco

Final Report

Volume V Supporting Report (2.B)

Feasibility Study

Supporting Report XV

Determination of the Project Scale And Ground Water Recharging

Tables

Table XV1.1: Monthly Inflow to N'Fifikh Reservoir (upstream)

Unit : Mm^3

Year	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Total
39	0.36	0.36	1.55	1.55	6.33	6.33	3.21	3.21	1.11	1.11	0.36	0.36	25.83
40	0.38	0.38	1.62	1.62	6.60	6.60	3.34	3.34	1.15	1.16	0.38	0.38	26.93
41	0.26	0.27	0.69	1.35	1.84	2.71	2.08	1.74	0.90	0.47	0.27	0.27	12.83
42	0.43	0.43	1.11	2.17	2.95	4.35	3.33	2.79	1.47	0.76	0.43	0.43	20.66
43	0.17	0.17	0.17	0.17	0.48	0.14	0.14	0.14	0.14	0.14	0.02	0.02	1.92
44	0.33	0.33	0.33	0.33	0.51	0.29	0.32	0.31	0.32	0.91	0.24	0.24	4.46
45	0.25	0.25	0.66	1.28	1.75	2.58	1.97	1.65	0.86	0.45	0.25	0.25	12.18
46	0.89	0.91	0.89	0.91	2.52	0.74	0.74	0.73	0.74	0.73	0.10	0.10	10.01
47	0.27	0.27	0.70	1.38	1.88	2.76	2.11	1.77	0.93	0.48	0.27	0.27	13.10
48	0.26	0.25	0.67	1.30	1.77	2.62	2.00	1.68	0.87	0.46	0.25	0.25	12.38
49	0.42	0.43	0.42	0.43	0.79	0.37	0.40	0.39	0.40	0.39	0.26	0.26	4.96
50	0.32	0.32	0.84	1.63	2.23	3.28	2.52	2.11	1.11	0.57	0.32	0.32	15.59
51	0.91	0.92	0.91	0.92	2.55	0.75	0.75	0.74	0.75	0.74	0.10	0.10	10.14
52	0.98	0.98	0.98	0.98	2.74	0.80	0.80	0.81	0.80	0.81	0.10	0.10	10.88
53	0.41	0.40	1.04	2.03	2.76	4.06	3.12	2.61	1.37	0.72	0.40	0.40	19.33
54	0.37	0.38	0.97	1.89	2.56	3.78	2.89	2.42	1.27	0.66	0.38	0.38	17.93
55	0.55	0.11	2.36	2.36	9.64	9.64	4.88	4.88	1.69	1.69	0.55	0.55	38.87
56	0.46	0.47	0.46	0.47	0.88	0.40	0.42	0.42	0.42	0.42	0.26	0.26	5.34
57	0.27	0.27	0.72	1.40	1.92	2.83	2.16	1.82	0.96	0.49	0.27	0.27	13.39
58	1.00	1.01	1.00	1.01	2.82	0.83	0.82	0.83	0.82	0.83	0.11	0.11	11.18
59	0.32	0.32	0.82	1.61	2.20	3.23	2.47	2.07	1.09	0.56	0.32	0.32	15.36
60	0.26	0.25	0.66	1.29	1.77	2.61	1.99	1.67	0.87	0.46	0.25	0.25	12.35
61	0.45	0.45	1.15	2.24	3.06	4.50	3.44	2.89	1.52	0.79	0.45	0.45	21.38
62	0.38	0.39	1.66	1.66	6.78	6.77	3.43	3.43	1.19	1.19	0.39	0.33	27.58
63	0.49	0.50	1.28	2.50	3.40	5.00	3.83	3.21	1.69	0.88	0.50	0.50	23.76
64	0.86	0.85	0.86	0.85	2.39	0.70	0.71	0.70	0.71	0.70	0.09	0.09	9.52
65	0.89	0.90	0.89	0.90	2.50	0.74	0.73	0.73	0.73	0.73	0.10	0.10	9.94
66	0.61	0.63	0.61	0.63	1.75	0.50	0.49	0.51	0.49	0.51	0.07	0.07	6.86
67	0.40	0.41	1.05	2.05	2.79	4.10	3.14	2.63	1.39	0.72	0.41	0.41	19.50
68	0.40	0.39	1.71	1.70	6.97	6.97	3.52	3.53	1.22	1.22	0.39	0.39	28.42
69	0.32	0.33	0.85	1.64	2.24	3.29	2.52	2.12	1.11	0.57	0.33	0.33	15.63
70	0.49	0.49	2.09	2.09	8.55	8.55	4.33	4.33	1.50	1.50	0.49	0.49	34.89
71	0.42	0.43	1.11	0.25	2.94	4.30	3.30	2.77	1.45	0.76	0.43	0.43	18.58
72	0.48	0.50	0.48	0.50	1.25	0.23	0.25	0.24	0.25	0.24	0.00	0.00	4.42
73	0.49	0.50	1.28	2.50	3.40	5.00	3.83	3.21	1.69	0.88	0.50	0.50	23.78
74	0.46	0.47	0.46	0.47	0.88	0.40	0.42	0.42	0.42	0.42	0.26	0.26	5.34
75	0.04	0.06	0.09	0.22	0.11	0.50	1.20	1.38	0.54	0.08	0.04	0.02	4.29
76	0.03	1.31	0.10	2.18	4.44	5.01	0.42	0.19	0.15	0.16	0.10	0.09	14.18
77	0.05	0.14	0.23	0.60	2.55	8.69	0.17	0.57	0.29	0.06	0.02	0.01	13.38
78	0.11	0.26	0.20	3.96	10.17	20.81	2.86	1.02	0.69	0.62	0.54	0.34	41.57
79	0.25	1.81	0.46	0.39	1.22	0.42	5.28	0.47	0.37	0.14	0.04	0.00	10.87
80	0.12	0.23	1.00	0.19	0.17	0.10	0.49	0.13	0.10	0.05	0.04	0.04	2.66
81	0.04	0.05	0.05	0.42	1.07	0.84	0.25	1.84	0.08	0.05	0.05	0.04	4.79
82	0.04	0.06	0.22	0.27	0.11	1.01	0.19	0.15	0.13	0.08	0.08	0.06	2.40
83	0.04	0.06	0.59	0.78	0.08	0.05	0.83	0.57	1.12	0.06	0.02	0.02	4.21
84	0.02	0.02	3.40	0.24	1.26	0.26	0.06	0.03	0.08	0.02	0.02	0.02	5.45
85	0.06	0.02	0.96	0.20	0.70	3.20	0.27	0.44	0.03	0.01	0.00	0.00	5.89
86	0.00	0.01	3.65	0.07	0.35	2.52	0.07	0.05	0.01	0.00	0.00	0.00	6.72
87	0.03	0.21	0.84	2.14	2.11	4.22	0.85	0.09	0.08	0.06	0.02	0.01	10.65
88	0.02	0.07	0.51	0.06	0.48	0.63	1.32	1.84	0.02	0.01	0.01	0.00	4.97
89	0.00	0.03	1.96	3.70	1.68	0.08	0.27	0.07	0.04	0.02	0.01	0.00	7.86
90	0.00	0.11	0.18	1.72	0.11	2.02	2.92	2.08	0.13	0.08	0.05	0.04	9.44
91	0.29	0.55	0.12	0.30	0.11	0.22	0.23	1.77	0.29	0.23	0.02	0.02	4.16
92	0.02	0.22	0.21	0.12	0.11	0.03	0.69	0.10	0.03	0.03	0.03	0.03	1.63
93	0.04	0.06	0.09	0.22	0.11	0.50	1.20	1.38	0.54	0.08	0.04	0.02	4.29
94	0.01	0.01	0.10	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.15
95	0.01	0.02	0.91	1.97	11.42	2.47	5.49	0.23	0.34	0.11	0.03	0.01	23.01
96	0.02	0.03	0.11	12.16	10.63	0.39	0.31	1.00	0.12	0.07	0.04	0.03	24.92
												Ave.	**13.32**

Table XV1.2: Monthly Inflow to N'Fifikh Reservoir (downstream)

Unit : Mm^3

Year	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Total
39	0.31	0.31	1.33	1.32	5.42	5.42	2.74	2.74	0.95	0.95	0.31	0.31	22.11
40	0.32	0.32	1.38	1.38	5.65	5.65	2.86	2.86	0.99	0.99	0.32	0.32	23.05
41	0.22	0.23	0.59	1.16	1.57	2.32	1.78	1.49	0.77	0.40	0.23	0.23	10.99
42	0.37	0.37	0.95	1.86	2.53	3.72	2.85	2.39	1.25	0.65	0.37	0.37	17.69
43	0.15	0.15	0.15	0.15	0.41	0.12	0.12	0.12	0.12	0.12	0.02	0.02	1.64
44	0.28	0.28	0.28	0.28	0.44	0.25	0.27	0.26	0.27	0.78	0.21	0.21	3.82
45	0.22	0.21	0.56	1.09	1.49	2.21	1.68	1.41	0.74	0.39	0.21	0.21	10.43
46	0.77	0.78	0.77	0.78	2.16	0.64	0.63	0.63	0.63	0.63	0.09	0.09	8.57
47	0.23	0.23	0.60	1.18	1.61	2.36	1.81	1.52	0.80	0.41	0.23	0.23	11.21
48	0.22	0.22	0.57	1.11	1.52	2.24	1.71	1.44	0.75	0.39	0.22	0.22	10.60
49	0.36	0.37	0.36	0.37	0.67	0.32	0.34	0.34	0.34	0.34	0.22	0.22	4.25
50	0.28	0.28	0.72	1.40	1.91	2.81	2.15	1.81	0.95	0.49	0.28	0.28	13.35
51	0.78	0.79	0.78	0.79	2.19	0.64	0.64	0.63	0.64	0.63	0.09	0.09	8.68
52	0.84	0.84	0.84	0.84	2.34	0.68	0.69	0.69	0.69	0.69	0.08	0.08	9.32
53	0.35	0.34	0.89	1.74	2.37	3.48	2.67	2.23	1.18	0.61	0.34	0.34	16.55
54	0.32	0.32	0.83	1.61	2.19	3.23	2.48	2.07	1.09	0.56	0.32	0.32	15.35
55	0.47	0.09	2.02	2.02	8.25	8.25	4.17	4.17	1.45	1.45	0.47	0.47	33.28
56	0.39	0.40	0.39	0.40	0.75	0.34	0.36	0.36	0.36	0.36	0.22	0.22	4.57
57	0.23	0.23	0.62	1.20	1.65	2.42	1.85	1.55	0.82	0.42	0.23	0.23	11.46
58	0.86	0.86	0.86	0.86	2.41	0.71	0.70	0.71	0.70	0.71	0.09	0.09	9.57
59	0.28	0.28	0.71	1.38	1.89	2.76	2.12	1.77	0.93	0.48	0.28	0.28	13.15
60	0.22	0.21	0.57	1.11	1.51	2.24	1.71	1.43	0.75	0.39	0.21	0.21	10.57
61	0.38	0.38	0.99	1.92	2.62	3.85	2.94	2.47	1.30	0.68	0.38	0.38	18.30
62	0.33	0.33	1.42	1.42	5.80	5.80	2.93	2.93	1.02	1.02	0.33	0.28	23.61
63	0.42	0.43	1.10	2.14	2.91	4.28	3.28	2.75	1.44	0.75	0.43	0.43	20.34
64	0.73	0.73	0.73	0.73	2.05	0.60	0.61	0.60	0.61	0.60	0.08	0.08	8.15
65	0.76	0.77	0.76	0.77	2.14	0.63	0.63	0.62	0.63	0.62	0.09	0.09	8.51
66	0.52	0.54	0.52	0.54	1.50	0.43	0.42	0.43	0.42	0.43	0.06	0.06	5.87
67	0.34	0.35	0.90	1.75	2.39	3.51	2.69	2.25	1.19	0.62	0.35	0.35	16.69
68	0.34	0.34	1.46	1.46	5.96	5.97	3.02	3.02	1.05	1.05	0.34	0.34	24.33
69	0.28	0.28	0.72	1.40	1.92	2.81	2.16	1.81	0.95	0.49	0.28	0.28	13.38
70	0.42	0.42	1.79	1.79	7.32	7.32	3.71	3.70	1.28	1.28	0.42	0.42	29.87
71	0.36	0.37	0.95	0.21	2.51	3.69	2.82	2.37	1.24	0.65	0.37	0.37	15.90
72	0.41	0.43	0.41	0.43	1.07	0.19	0.21	0.21	0.21	0.21	0.00	0.00	3.78
73	0.42	0.43	1.10	2.14	2.91	4.28	3.28	2.75	1.45	0.75	0.43	0.43	20.36
74	0.39	0.40	0.39	0.40	0.75	0.34	0.36	0.36	0.36	0.36	0.22	0.22	4.57
75	0.04	0.05	0.07	0.19	0.10	0.43	1.03	1.18	0.47	0.07	0.04	0.02	3.67
76	0.03	1.12	0.08	1.86	3.80	4.29	0.36	0.16	0.13	0.14	0.09	0.07	12.13
77	0.04	0.12	0.20	0.52	2.19	7.44	0.14	0.49	0.25	0.05	0.01	0.01	11.46
78	0.09	0.22	0.17	3.39	8.71	17.82	2.45	0.87	0.59	0.53	0.46	0.29	35.59
79	0.21	1.55	0.39	0.34	1.04	0.36	4.52	0.41	0.32	0.12	0.04	0.00	9.30
80	0.10	0.20	0.86	0.16	0.15	0.09	0.42	0.11	0.08	0.04	0.03	0.03	2.28
81	0.04	0.05	0.04	0.36	0.91	0.72	0.21	1.58	0.07	0.04	0.04	0.03	4.10
82	0.04	0.05	0.19	0.23	0.09	0.87	0.17	0.13	0.11	0.07	0.06	0.05	2.05
83	0.04	0.05	0.50	0.66	0.07	0.04	0.71	0.49	0.95	0.05	0.02	0.02	3.60
84	0.02	0.02	2.91	0.21	1.08	0.22	0.05	0.03	0.07	0.02	0.02	0.02	4.66
85	0.05	0.02	0.82	0.17	0.60	2.74	0.23	0.38	0.02	0.01	0.00	0.00	5.04
86	0.00	0.01	3.12	0.06	0.30	2.16	0.06	0.04	0.01	0.00	0.00	0.00	5.76
87	0.03	0.18	0.72	1.83	1.80	3.61	0.73	0.08	0.07	0.05	0.02	0.00	9.12
88	0.01	0.06	0.44	0.05	0.41	0.54	1.13	1.57	0.02	0.01	0.00	0.00	4.25
89	0.00	0.02	1.68	3.16	1.44	0.07	0.23	0.06	0.04	0.02	0.00	0.00	6.73
90	0.00	0.09	0.15	1.47	0.10	1.73	2.50	1.78	0.11	0.07	0.04	0.04	8.08
91	0.25	0.47	0.10	0.26	0.10	0.19	0.19	1.52	0.25	0.19	0.02	0.02	3.56
92	0.02	0.19	0.18	0.11	0.09	0.03	0.59	0.09	0.03	0.03	0.03	0.03	1.39
93	0.04	0.05	0.07	0.19	0.10	0.43	1.03	1.18	0.47	0.07	0.04	0.02	3.67
94	0.01	0.01	0.09	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.13
95	0.00	0.01	0.78	1.69	9.78	2.12	4.70	0.20	0.29	0.09	0.03	0.01	19.70
96	0.01	0.03	0.09	10.41	9.10	0.33	0.27	0.86	0.10	0.06	0.04	0.02	21.33
												Ave.	**11.40**

Table XV1.3: Monthly Inflow to Taskourt Reservoir

Unit : Mm^3

Year	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Total
35	0.03	2.35	0.34	0.17	0.34	3.70	8.60	2.81	1.37	0.53	0.21	0.07	20.53
36	0.02	0.24	2.21	2.38	0.68	0.26	0.10	0.04	3.15	0.46	0.18	0.06	9.77
37	0.01	13.07	3.34	3.28	1.37	0.59	0.29	8.50	2.10	0.83	0.33	0.13	33.84
38	0.04	1.93	0.35	17.14	6.82	11.13	4.14	4.32	1.23	0.50	0.20	0.08	47.87
39	0.02	1.49	2.39	3.28	7.46	11.23	6.62	2.51	1.05	0.41	0.17	0.07	36.69
40	0.50	4.82	2.90	1.15	9.22	4.83	5.37	6.84	1.77	0.70	0.27	0.11	38.48
41	0.36	0.60	8.92	2.84	5.68	10.22	7.17	2.83	1.13	0.45	0.18	0.07	40.45
42	0.61	4.82	18.80	11.07	4.71	1.99	9.81	10.92	8.91	2.58	1.03	0.41	75.67
43	0.22	0.10	0.11	2.99	0.61	4.49	1.29	0.50	0.19	1.35	0.17	0.05	12.09
44	7.01	0.96	4.07	1.95	4.71	1.37	0.54	0.21	0.08	0.02	0.01	0.00	20.92
45	0.00	0.07	0.60	0.21	3.21	0.80	1.46	3.17	0.86	0.33	0.13	0.05	10.90
46	2.43	0.24	4.09	3.56	9.07	10.71	5.55	2.06	4.67	0.89	0.35	0.14	43.75
47	0.04	0.02	2.45	0.52	2.77	3.32	6.71	17.50	11.51	3.75	1.50	0.60	50.69
48	0.24	0.16	0.06	2.11	3.37	6.32	16.46	36.20	16.55	6.75	2.68	1.07	91.97
49	0.42	0.17	1.84	14.72	10.30	3.80	1.52	0.61	0.74	0.19	0.07	0.05	34.44
50	2.56	6.36	1.30	6.29	7.92	6.88	6.73	2.15	0.99	0.39	0.16	0.05	41.78
51	0.90	0.22	6.13	5.28	8.67	2.78	1.19	0.98	0.33	0.13	0.04	0.01	26.66
52	5.17	1.30	0.59	1.01	6.71	4.71	10.52	3.51	1.39	0.55	0.21	0.07	35.75
53	0.01	6.67	3.17	8.89	9.77	6.20	14.72	19.02	6.16	2.45	0.98	0.39	78.43
54	0.16	0.06	5.66	6.38	5.63	7.85	6.54	5.24	1.58	0.63	0.25	0.09	40.08
55	0.04	5.66	1.44	8.36	19.06	26.24	25.09	13.52	8.87	2.94	1.17	0.47	112.84
56	0.18	0.06	0.15	0.14	1.30	0.35	0.42	3.53	2.08	0.54	0.21	0.07	9.04
57	0.02	9.95	8.39	26.63	14.63	8.09	3.23	3.34	2.95	1.66	0.42	0.16	79.47
58	0.05	0.32	2.47	1.82	0.90	2.92	6.21	2.24	2.95	0.68	0.27	0.09	20.92
59	1.37	0.18	3.28	1.30	11.79	3.42	4.47	4.49	1.23	2.00	0.37	0.14	34.05
60	0.05	1.25	0.99	7.61	2.03	0.81	0.90	0.34	0.19	0.07	0.03	0.00	14.27
61	0.03	0.00	0.99	2.97	8.82	2.72	18.11	14.80	9.29	3.09	1.23	0.47	62.53
62	1.72	5.44	12.35	10.52	17.80	30.81	13.49	8.88	10.89	2.79	1.11	0.44	116.24
63	0.17	0.06	0.18	20.57	15.71	7.19	3.72	14.84	3.81	1.52	0.61	0.24	68.63
64	0.09	0.03	0.39	13.71	14.70	21.86	10.41	9.41	2.93	1.16	0.46	0.17	75.33
65	0.05	11.60	20.95	13.09	5.24	2.11	3.43	0.82	0.38	0.15	0.06	0.02	57.90
66	0.04	0.27	13.31	3.54	1.57	8.19	6.80	6.84	2.62	1.00	0.40	0.15	44.72
67	0.08	5.24	39.40	22.89	11.05	9.84	16.59	13.22	4.38	1.75	0.68	0.26	125.37
68	0.09	0.03	7.26	9.81	6.40	17.83	9.00	15.14	5.68	2.24	0.87	0.34	74.70
69	0.13	1.27	11.63	4.53	17.58	8.09	8.08	3.79	1.40	0.56	0.22	0.09	57.36
70	0.02	3.06	1.95	16.77	18.77	10.97	16.17	21.30	14.46	5.00	1.99	0.79	111.25
71	0.30	0.26	11.35	3.43	3.28	15.22	9.22	4.28	1.96	0.78	0.31	0.12	50.52
72	0.53	0.46	4.32	2.66	1.00	0.81	2.42	2.75	0.67	0.26	0.10	0.04	16.02
73	0.01	0.09	3.07	13.58	4.38	10.16	20.00	22.15	8.30	3.36	1.34	0.53	86.97
74	0.20	0.07	0.02	0.02	0.99	0.37	0.22	10.65	4.93	1.58	0.63	0.24	19.92
75	0.08	0.03	0.03	0.68	0.27	4.09	5.00	10.78	11.38	3.07	1.22	0.49	37.09
76	1.11	3.23	0.51	2.66	8.76	3.86	1.70	0.67	0.26	0.10	0.04	0.02	22.91
77	1.72	3.15	5.52	9.02	18.81	9.16	3.89	6.26	1.84	0.75	0.30	0.11	60.52
78	0.03	1.01	0.14	5.00	14.61	8.25	3.21	1.28	0.50	0.19	0.07	0.03	34.33
79	0.00	9.70	1.91	0.76	1.03	7.71	15.54	6.79	2.66	1.06	0.42	0.16	47.75
80	0.07	0.03	6.41	1.32	0.68	2.03	1.69	0.51	0.20	0.07	0.03	0.01	13.04
81	0.00	0.25	0.07	0.10	10.14	4.07	2.86	13.16	11.84	3.34	1.32	0.53	47.68
82	0.21	0.08	2.60	0.94	0.37	3.62	1.05	0.46	0.21	0.08	0.03	0.01	9.65
83	0.00	0.00	6.26	1.42	0.56	0.22	3.87	2.02	0.89	0.35	0.14	0.06	15.80
84	0.01	0.00	0.17	0.04	3.75	3.88	3.53	5.50	5.55	1.34	0.11	0.05	23.92
85	0.05	0.06	0.05	0.10	0.44	0.32	3.38	5.30	5.17	0.63	0.05	0.04	15.60
86	0.04	0.42	0.09	0.03	1.10	2.14	0.68	0.49	0.34	1.03	0.02	0.02	6.41
87	0.04	4.86	6.87	14.49	3.60	11.98	17.25	8.61	5.78	2.49	0.33	0.05	76.36
88	0.04	2.42	31.24	8.70	5.09	4.38	6.10	9.82	6.22	2.09	0.83	0.50	77.44
89	0.14	8.16	6.19	3.30	2.76	1.07	6.88	4.52	5.09	1.59	1.12	0.21	41.02
90	0.04	0.05	0.32	0.39	0.15	1.00	3.48	2.34	1.41	0.23	0.16	2.45	12.00
91	0.41	0.37	0.29	9.55	1.81	3.37	4.41	8.57	6.26	1.49	0.53	0.33	37.39
92	0.51	0.74	0.74	2.34	1.47	3.05	2.11	3.87	1.53	0.74	0.04	0.02	17.17
93	0.02	0.55	2.28	1.95	2.70	2.71	13.20	12.76	3.90	0.90	0.05	0.04	41.07
94	0.05	0.79	0.28	0.11	0.03	0.04	0.10	3.81	1.87	0.50	0.08	0.44	8.09
95	0.16	0.45	0.70	3.31	6.34	5.60	11.16	14.06	6.75	5.58	0.90	0.52	55.54
96	0.22	0.18	1.35	1.68	2.98	3.17	3.02	11.58	9.60	2.13	2.29	0.46	38.66
												Ave.	**44.65**

Table XV1.4: Monthly Inflow to Timkit Reservoir

Unit : Mm^3

Year	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Total
61	0.23	0.16	1.99	0.16	0.13	0.13	0.13	0.33	0.55	0.13	0.13	0.13	4.21
62	2.07	1.41	0.41	0.27	0.21	0.17	0.18	0.30	10.26	1.34	0.13	0.13	16.89
63	0.73	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.17	0.13	0.13	2.23
64	3.08	0.13	0.13	0.13	0.13	4.94	0.48	0.72	0.28	0.53	0.40	0.99	11.96
65	1.58	12.42	45.53	13.21	2.93	1.71	2.60	2.48	2.07	1.83	1.10	0.81	88.26
66	1.30	0.87	0.98	0.79	0.70	0.85	0.92	0.68	0.82	0.16	0.14	0.14	8.34
67	0.42	1.33	7.60	1.33	1.13	1.11	1.19	1.67	0.89	0.79	0.70	0.60	18.75
68	0.65	0.68	0.58	0.71	0.53	0.50	0.33	0.27	0.24	0.25	0.39	3.73	8.85
69	0.95	0.30	0.58	0.16	0.20	0.17	0.17	0.17	0.66	0.44	0.17	0.18	4.17
70	0.23	0.18	0.42	0.17	0.17	0.16	0.17	1.03	0.15	0.14	0.14	0.14	3.11
71	0.19	0.63	0.23	0.13	0.13	0.13	0.13	2.16	0.18	0.19	0.18	0.18	4.46
72	0.18	0.19	5.98	0.52	0.44	0.40	0.37	0.38	0.29	0.50	0.46	0.29	10.00
73	0.29	0.29	0.76	0.36	0.25	0.19	0.18	0.34	0.23	0.23	0.25	0.20	3.58
74	0.83	0.18	0.14	0.14	0.14	0.13	0.14	2.14	2.03	0.25	0.16	0.19	6.46
75	0.19	0.20	0.24	0.37	0.30	0.19	0.17	0.27	1.34	0.68	0.55	0.22	4.71
76	1.70	0.65	0.47	0.56	0.81	0.27	0.18	0.19	0.19	0.18	0.16	0.15	5.51
77	0.44	0.25	0.16	0.98	0.18	0.14	0.14	0.14	0.14	0.14	0.14	0.13	2.95
78	0.13	0.30	0.13	0.13	0.68	0.13	0.13	0.13	0.57	0.14	0.13	0.13	2.75
79	0.90	5.03	0.13	0.13	0.25	0.93	2.75	1.64	0.67	0.43	0.46	0.35	13.68
80	0.52	0.61	0.43	0.57	0.37	0.44	0.23	0.19	0.28	0.27	0.27	0.25	4.44
81	0.16	0.16	0.25	0.25	0.23	0.13	0.13	0.22	0.92	0.51	0.13	0.13	3.21
82	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.14	0.43	0.13	0.13	0.28	2.04
83	0.23	0.24	0.14	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	1.82
84	0.13	0.13	0.39	0.13	0.13	0.13	0.13	0.14	0.54	0.13	0.13	0.13	2.27
85	0.99	1.09	4.04	1.99	0.13	0.13	0.13	0.13	0.13	1.24	0.13	0.88	11.04
86	1.66	5.09	0.13	0.13	0.13	0.13	0.76	0.13	0.74	0.13	0.13	0.13	9.32
87	0.65	1.55	1.36	1.65	0.13	0.13	0.13	0.13	0.33	0.13	0.13	0.13	6.47
88	0.14	4.43	1.06	0.13	0.13	2.14	1.79	0.23	0.15	2.65	0.74	2.24	15.82
89	1.05	1.44	9.08	12.26	4.07	2.89	2.07	1.58	7.20	1.51	1.43	1.56	46.14
90	3.17	0.95	0.61	1.14	1.42	1.35	0.67	0.53	0.72	6.90	1.93	2.04	21.42
91	1.34	0.59	0.32	1.03	0.40	0.41	0.33	0.17	0.17	0.46	0.14	0.13	5.49
92	1.72	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	3.18
93	0.25	0.37	16.42	0.42	1.15	1.17	1.28	1.46	1.47	1.21	1.10	0.49	26.79
94	0.48	2.93	0.67	0.47	0.37	0.39	0.70	5.23	0.48	0.56	0.35	0.34	12.97
95	0.33	15.09	1.93	0.37	0.35	0.83	1.39	0.53	0.52	0.49	0.48	0.46	22.78
96	0.44	0.43	0.41	0.40	0.39	0.35	0.36	0.33	0.32	0.29	0.28	1.39	5.38
												Ave.	**11.71**

Table XV1.5: Monthly Inflow to Azghar Reservoir

Unit : Mm^3

Year	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Total
55	0.31	0.96	1.20	7.54	4.64	14.48	25.36	30.23	18.93	8.56	4.50	2.44	119.14
56	1.41	1.95	1.54	2.06	3.97	1.76	5.91	10.41	9.62	2.81	1.17	0.99	43.60
57	0.14	1.81	5.17	6.51	13.09	11.92	6.69	7.77	5.88	2.81	0.89	0.15	62.83
58	0.00	0.00	0.69	8.78	8.49	5.15	11.00	6.37	5.49	3.26	1.35	0.36	50.93
59	0.14	0.29	0.62	17.97	28.23	16.17	17.90	10.92	6.55	7.94	3.05	1.45	111.23
60	0.72	1.28	1.89	12.52	14.75	12.97	9.77	9.69	4.11	2.98	1.03	0.18	71.89
61	0.11	0.39	3.02	2.34	1.91	1.41	15.14	12.33	4.99	3.02	1.03	0.25	45.94
62	0.00	0.75	6.85	5.73	19.32	25.69	14.65	8.29	22.96	13.56	4.74	3.43	125.96
63	2.33	2.06	1.72	10.54	4.78	4.09	7.61	17.80	5.59	3.19	1.88	1.31	62.90
64	1.34	0.96	2.37	2.59	10.93	10.51	15.78	15.06	6.62	4.21	2.98	1.84	75.19
65	1.96	1.98	1.68	1.31	1.77	1.25	1.74	1.96	1.17	0.24	0.00	0.00	15.06
66	0.07	10.26	2.91	0.99	0.04	0.36	0.99	2.78	2.66	1.54	0.00	0.00	22.61
67	0.00	0.64	1.03	2.55	3.86	9.30	22.71	15.89	12.17	5.17	2.44	1.35	77.11
68	0.65	0.29	3.80	10.26	14.89	20.00	17.48	14.79	9.77	6.82	3.54	1.74	104.03
69	1.34	1.56	3.08	5.80	27.34	7.96	8.81	8.32	4.43	2.61	1.10	0.57	72.92
70	0.55	0.46	0.24	0.50	6.62	7.00	10.90	21.02	21.30	11.26	5.20	3.01	88.07
71	2.06	1.77	4.15	4.14	7.18	12.62	23.77	17.08	12.88	7.05	3.68	1.95	98.34
72	1.99	3.51	2.09	2.30	4.07	8.66	15.39	14.35	7.79	3.73	1.77	1.31	66.96
73	0.31	0.50	0.48	0.99	1.45	2.75	10.01	16.60	13.62	5.65	2.98	1.35	56.71
74	1.00	1.17	0.65	0.22	0.07	2.69	8.28	15.92	11.53	6.03	2.48	1.35	51.39
75	0.62	0.46	0.52	1.03	0.71	4.96	7.43	13.46	20.98	6.68	3.65	1.53	62.01
76	1.20	2.44	2.91	7.25	17.12	18.08	12.45	9.11	4.74	2.78	1.31	0.46	79.88
77	0.76	1.42	0.89	2.73	3.19	9.04	7.96	9.69	6.69	3.29	1.42	0.75	47.83
78	0.04	0.00	0.00	0.53	2.02	13.55	15.46	9.72	5.10	2.71	1.21	0.25	50.59
79	4.04	5.03	7.23	4.35	3.33	3.23	8.14	5.21	6.19	1.72	0.36	0.00	48.82
80	0.00	0.71	2.23	1.21	1.63	2.53	3.97	6.64	5.03	1.85	0.53	0.00	26.33
81	0.00	0.71	0.00	0.00	0.78	2.30	4.28	8.36	6.30	2.40	0.61	0.00	25.74
82	0.00	4.99	2.47	3.97	3.40	3.13	4.00	3.19	1.17	0.04	0.00	0.00	26.36
83	0.00	0.00	0.76	1.31	0.75	0.00	1.67	3.63	5.27	2.37	0.00	0.07	15.83
84	0.08	0.09	2.31	1.03	3.30	1.42	1.95	0.98	4.43	0.58	0.15	0.07	16.37
85	0.06	0.15	0.58	0.81	5.62	18.41	18.29	7.67	1.35	3.73	0.20	0.09	56.97
86	0.18	0.57	1.19	0.39	3.96	20.01	3.21	0.81	0.39	0.27	0.42	0.17	31.58
87	3.20	3.97	3.28	1.03	6.50	5.19	10.03	1.23	2.33	0.42	0.13	0.09	37.39
88	0.07	0.08	0.43	0.34	0.12	1.16	3.52	12.56	1.54	0.75	0.13	0.27	20.98
89	1.52	3.06	2.89	11.80	9.05	1.12	0.50	4.02	0.91	0.10	0.73	0.24	35.94
90	1.04	0.12	1.44	6.40	0.75	5.67	27.64	8.70	1.92	0.66	0.55	0.35	55.23
91	1.44	0.69	0.54	0.45	0.53	0.67	2.42	8.81	1.21	3.09	0.57	0.44	20.85
92	0.18	0.43	0.35	1.40	0.37	0.42	3.66	3.08	4.30	0.26	0.08	0.05	14.58
93	0.03	0.26	5.70	1.08	4.29	12.98	5.03	1.11	0.54	0.14	0.04	0.02	31.23
94	0.44	0.32	0.56	0.13	0.13	0.10	4.28	2.22	0.48	0.26	0.07	0.07	9.06
95	0.12	0.17	0.26	4.56	29.09	13.57	16.74	13.47	7.39	2.24	0.59	0.12	88.32
96	2.73	1.94	0.59	20.61	28.00	4.42	2.13	5.10	1.98	0.56	0.17	0.09	68.32
97	1.99	3.67	5.69	7.31	4.31	7.33	1.49	1.34	1.42	0.58	0.43	0.59	36.17
98	0.63	0.62	0.59	0.69	3.32	1.82	2.66	0.49	0.69	0.31	0.10	0.06	11.97
												Ave.	**53.21**

Table XV1.6: Monthly Precipitation on Reservoir

Unit : mm

No.	Dam	Precipitation												
		Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Total
1	N'fifikh (upstream)	4.6	28.0	43.3	60.8	55.3	46.5	38.2	31.6	11.1	3.4	0.4	0.2	323.4
2	N'fifikh (dowstream)	4.6	28.0	43.3	60.8	55.3	46.5	38.2	31.6	11.1	3.4	0.4	0.2	323.4
3	Taskourt	14.5	47.8	28.2	47.8	37.4	55.4	57.3	44.9	13.0	13.1	3.9	2.8	366.0
4	Timkit	14.3	23.4	30.5	18.9	18.4	24.1	17.4	12.0	13.0	5.4	2.5	6.5	186.4
5	Azghar	26.4	22.2	48.7	56.0	56.0	58.3	65.5	46.1	38.6	15.7	6.4	6.9	446.8

Table XV1.7: Monthly Evaporation from Reservoir

Unit : mm

No.	Dam	Evaporation												
		Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Total
1	N'fifikh (upstream)	171	127	89	67	62	58	87	104	145	187	230	219	1,545
2	N'fifikh (dowstream)	171	127	89	67	62	58	87	104	145	187	230	219	1,545
3	Taskourt	153	111	70	51	48	53	87	108	143	171	214	203	1,412
4	Timkit	218	148	98	70	65	83	132	168	228	277	324	304	2,115
5	Azghar	172	110	64	43	41	51	79	103	143	200	252	227	1,484

Table XV1.8: Monthly Water Demand

Unit : m^3/ha

No.	Dam	Water Demand												
		Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Total
1	N'fifikh (upstream)	273	225	321	229	821	1,442	2,025	1,152	644	375	402	338	8,247
2	N'fifikh (dowstream)	189	152	192	149	517	906	1,254	850	505	455	279	264	5,712
3	Taskourt	415	238	294	400	581	1,261	1,844	1,196	788	935	1,006	683	9,641
4	Timkit	586	655	600	597	988	1,305	1,940	1,453	931	819	729	609	11,212
5	Azghar	269	158	96	0	204	635	1,665	1,660	950	500	652	515	7,304

Table XV1.9: Elevation-Reservoir Area & Storage of N'Fifikh Dam (upstream)

Elevation H(m)	Difference D(m)	Area $A(m^2)$	Ave. Area $A(m^2)$	Volume $V(m^3)$	Accu. Volume $\Sigma V (m^3)$
215	0	0	0	0	0
216	1	21,240	10,620	10,620	10,620
217	1	42,480	31,860	31,860	42,480
218	1	63,720	53,100	53,100	95,580
219	1	84,960	74,340	74,340	169,920
220	1	106,200	95,580	95,580	265,500
221	1	141,880	124,040	124,040	389,540
222	1	177,560	159,720	159,720	549,260
223	1	213,240	195,400	195,400	744,660
224	1	248,920	231,080	231,080	975,740
225	1	284,600	266,760	266,760	1,242,500
226	1	328,880	306,740	306,740	1,549,240
227	1	373,160	351,020	351,020	1,900,260
228	1	417,440	395,300	395,300	2,295,560
229	1	461,720	439,580	439,580	2,735,140
230	1	506,000	483,860	483,860	3,219,000
231	1	567,240	536,620	536,620	3,755,620
232	1	628,480	597,860	597,860	4,353,480
233	1	689,720	659,100	659,100	5,012,580
234	1	750,960	720,340	720,340	5,732,920
235	1	812,200	781,580	781,580	6,514,500
236	1	902,160	857,180	857,180	7,371,680
237	1	992,120	947,140	947,140	8,318,820
238	1	1,082,080	1,037,100	1,037,100	9,355,920
239	1	1,172,040	1,127,060	1,127,060	10,482,980
240	1	1,262,000	1,217,020	1,217,020	11,700,000
241	1	1,356,720	1,309,360	1,309,360	13,009,360
242	1	1,451,440	1,404,080	1,404,080	14,413,440
243	1	1,546,160	1,498,800	1,498,800	15,912,240
244	1	1,640,880	1,593,520	1,593,520	17,505,760
245	1	1,735,600	1,688,240	1,688,240	19,194,000
246	1	1,826,400	1,781,000	1,781,000	20,975,000
247	1	1,917,200	1,871,800	1,871,800	22,846,800
248	1	2,008,000	1,962,600	1,962,600	24,809,400
249	1	2,098,800	2,053,400	2,053,400	26,862,800
250	1	2,189,600	2,144,200	2,144,200	29,007,000

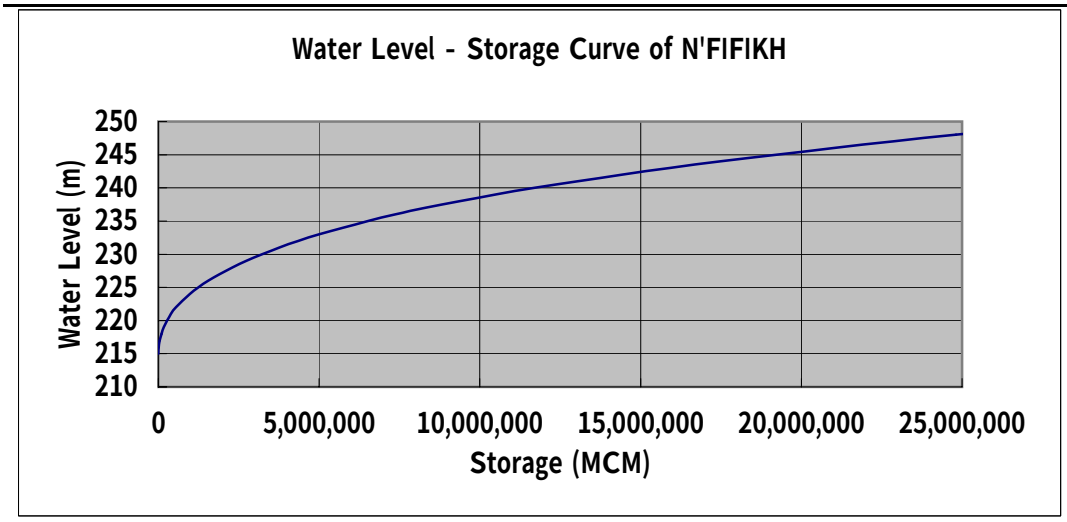


Table XV1.10: Elevation-Reservoir Area & Storage of N'Fifikh Dam (downstream)

Elevation H(m)	Difference D(m)	Area $A(m^2)$	Ave. Area $A(m^2)$	Volume $V(m^3)$	Accu. Volume $\Sigma V (m^3)$
6	0	0	0	0	0
7	1	177,270	88,635	88,635	88,635
8	1	354,540	265,905	265,905	354,540
9	1	531,810	443,175	443,175	797,715
10	1	709,080	620,445	620,445	1,418,160
11	1	769,858	739,469	739,469	2,157,629
12	1	830,636	800,247	800,247	2,957,876
13	1	891,414	861,025	861,025	3,818,901
14	1	952,192	921,803	921,803	4,740,704
15	1	1,012,970	982,581	982,581	5,723,285
16	1	1,108,336	1,060,653	1,060,653	6,783,938
17	1	1,203,702	1,156,019	1,156,019	7,939,957
18	1	1,299,068	1,251,385	1,251,385	9,191,342
19	1	1,394,434	1,346,751	1,346,751	10,538,093
20	1	1,489,800	1,442,117	1,442,117	11,980,210
21	1	1,585,166	1,537,483	1,537,483	13,517,693
22	1	1,680,532	1,632,849	1,632,849	15,150,542
23	1	1,775,898	1,728,215	1,728,215	16,878,757
24	1	1,871,264	1,823,581	1,823,581	18,702,338
25	1	1,966,630	1,918,947	1,918,947	20,621,285
26	1	2,034,178	2,000,404	2,000,404	22,621,689
27	1	2,101,726	2,067,952	2,067,952	24,689,641
28	1	2,169,274	2,135,500	2,135,500	26,825,141
29	1	2,236,822	2,203,048	2,203,048	29,028,189
30	1	2,304,370	2,270,596	2,270,596	31,298,785
31	1	2,371,918	2,338,144	2,338,144	33,636,929
32	1	2,439,466	2,405,692	2,405,692	36,042,621
33	1	2,507,014	2,473,240	2,473,240	38,515,861
34	1	2,574,562	2,540,788	2,540,788	41,056,649
35	1	2,642,110	2,608,336	2,608,336	43,664,985

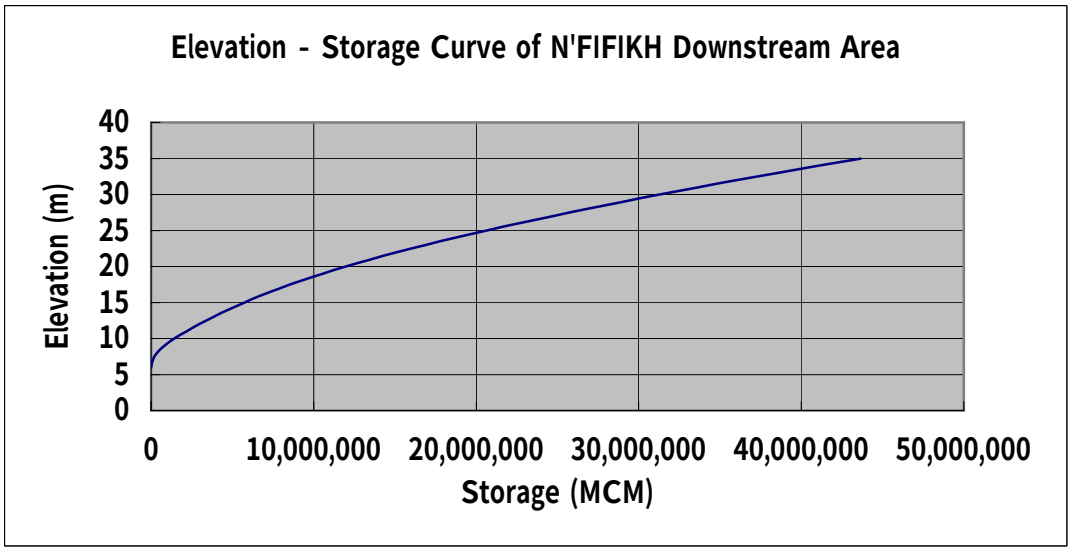


Table XV1.11: Elevation-Reservoir Area & Storage of Taskourt Dam

Elevation H(m)	Difference D(m)	Area $A(m^2)$	Ave. Area $A(m^2)$	Volume $V(m^3)$	Accu. Volume $\Sigma V (m^3)$
944	0	0	0	0	0
946	2	12,733	6,367	12,733	12,733
948	2	25,467	19,100	38,200	50,933
950	2	38,200	31,833	63,667	114,600
952	2	68,480	53,340	106,680	221,280
954	2	98,760	83,620	167,240	388,520
956	2	129,040	113,900	227,800	616,320
958	2	159,320	144,180	288,360	904,680
960	2	189,600	174,460	348,920	1,253,600
962	2	235,720	212,660	425,320	1,678,920
964	2	281,840	258,780	517,560	2,196,480
966	2	327,960	304,900	609,800	2,806,280
968	2	374,080	351,020	702,040	3,508,320
970	2	420,200	397,140	794,280	4,302,600
972	2	732,400	576,300	1,152,600	5,455,200
974	2	545,080	638,740	1,277,480	6,732,680
976	2	607,520	576,300	1,152,600	7,885,280
978	2	669,960	638,740	1,277,480	9,162,760
980	2	732,400	701,180	1,402,360	10,565,120
982	2	791,520	761,960	1,523,920	12,089,040
984	2	850,640	821,080	1,642,160	13,731,200
986	2	909,760	880,200	1,760,400	15,491,600
988	2	968,880	939,320	1,878,640	17,370,240
990	2	1,028,000	998,440	1,996,880	19,367,120
992	2	1,115,720	1,071,860	2,143,720	21,510,840
994	2	1,203,440	1,159,580	2,319,160	23,830,000
996	2	1,291,160	1,247,300	2,494,600	26,324,600
998	2	1,378,880	1,335,020	2,670,040	28,994,640
1,000	2	1,466,600	1,422,740	2,845,480	31,840,120
1,002	2	1,562,600	1,514,600	3,029,200	34,869,320
1,004	2	1,658,600	1,610,600	3,221,200	38,090,520
1,006	2	1,754,600	1,706,600	3,413,200	41,503,720
1,008	2	1,850,600	1,802,600	3,605,200	45,108,920
1,010	2	1,946,600	1,898,600	3,797,200	48,906,120
1,012	2	2,078,360	2,012,480	4,024,960	52,931,080
1,014	2	2,210,120	2,144,240	4,288,480	57,219,560
1,016	2	2,341,880	2,276,000	4,552,000	61,771,560
1,018	2	2,473,640	2,407,760	4,815,520	66,587,080
1,020	2	2,605,400	2,539,520	5,079,040	71,666,120
1,022	2	2,738,240	2,671,820	5,343,640	77,009,760
1,024	2	2,871,080	2,804,660	5,609,320	82,619,080
1,026	2	3,003,920	2,937,500	5,875,000	88,494,080
1,028	2	3,136,760	3,070,340	6,140,680	94,634,760
1,030	2	3,269,600	3,203,180	6,406,360	101,041,120
1,032	2	3,400,720	3,335,160	6,670,320	107,711,440
1,034	2	3,531,840	3,466,280	6,932,560	114,644,000
1,036	2	3,662,960	3,597,400	7,194,800	121,838,800
1,038	2	3,794,080	3,728,520	7,457,040	129,295,840
1,040	2	3,925,200	3,859,640	7,719,280	137,015,120

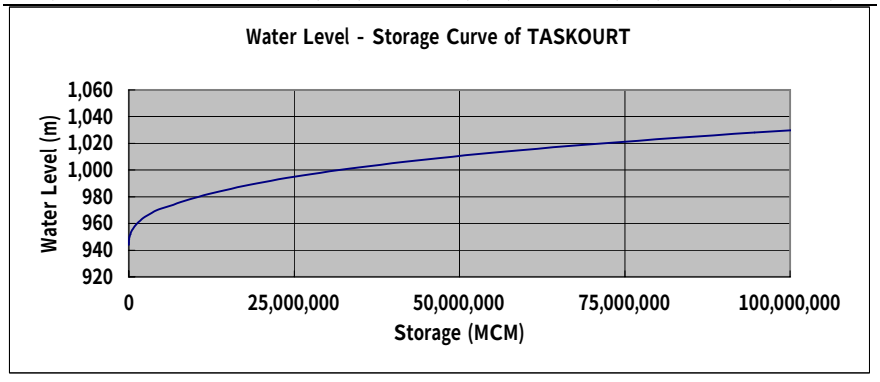


Table XV1.12: Elevation-Reservoir Area & Storage of Timkit Dam

Elevation H(m)	Difference D(m)	Area $A(m^2)$	Ave. Area $A(m^2)$	Volume $V(m^3)$	Accu. Volume $\Sigma V (m^3)$
1,211	0	0	0	0	0
1,212	1	5,000	2,500	2,500	2,500
1,213	1	10,000	7,500	7,500	10,000
1,214	1	15,000	12,500	12,500	22,500
1,215	1	20,000	17,500	17,500	40,000
1,216	1	23,560	21,780	21,780	61,780
1,217	1	27,120	25,340	25,340	87,120
1,218	1	30,680	28,900	28,900	116,020
1,219	1	34,240	32,460	32,460	148,480
1,220	1	37,800	36,020	36,020	184,500
1,221	1	45,600	41,700	41,700	226,200
1,222	1	53,400	49,500	49,500	275,700
1,223	1	61,200	57,300	57,300	333,000
1,224	1	69,000	65,100	65,100	398,100
1,225	1	76,800	72,900	72,900	471,000
1,226	1	88,560	82,680	82,680	553,680
1,227	1	100,320	94,440	94,440	648,120
1,228	1	112,080	106,200	106,200	754,320
1,229	1	123,840	117,960	117,960	872,280
1,230	1	135,600	129,720	129,720	1,002,000
1,231	1	156,520	146,060	146,060	1,148,060
1,232	1	177,440	166,980	166,980	1,315,040
1,233	1	198,360	187,900	187,900	1,502,940
1,234	1	219,280	208,820	208,820	1,711,760
1,235	1	240,200	229,740	229,740	1,941,500
1,236	1	295,560	267,880	267,880	2,209,380
1,237	1	350,920	323,240	323,240	2,532,620
1,238	1	406,280	378,600	378,600	2,911,220
1,239	1	461,640	433,960	433,960	3,345,180
1,240	1	517,000	489,320	489,320	3,834,500
1,241	1	604,440	560,720	560,720	4,395,220
1,242	1	691,880	648,160	648,160	5,043,380
1,243	1	779,320	735,600	735,600	5,778,980
1,244	1	866,760	823,040	823,040	6,602,020
1,245	1	954,200	910,480	910,480	7,512,500
1,246	1	1,083,000	1,018,600	1,018,600	8,531,100
1,247	1	1,211,800	1,147,400	1,147,400	9,678,500
1,248	1	1,340,600	1,276,200	1,276,200	10,954,700
1,249	1	1,469,400	1,405,000	1,405,000	12,359,700
1,250	1	1,598,200	1,533,800	1,533,800	13,893,500
1,251	1	1,850,920	1,724,560	1,724,560	15,618,060
1,252	1	2,103,640	1,977,280	1,977,280	17,595,340
1,253	1	2,356,360	2,230,000	2,230,000	19,825,340
1,254	1	2,609,080	2,482,720	2,482,720	22,308,060
1,255	1	2,861,800	2,735,440	2,735,440	25,043,500
1,256	1	3,220,280	3,041,040	3,041,040	28,084,540
1,257	1	3,578,760	3,399,520	3,399,520	31,484,060
1,258	1	3,937,240	3,758,000	3,758,000	35,242,060
1,259	1	4,295,720	4,116,480	4,116,480	39,358,540
1,260	1	4,654,200	4,474,960	4,474,960	43,833,500

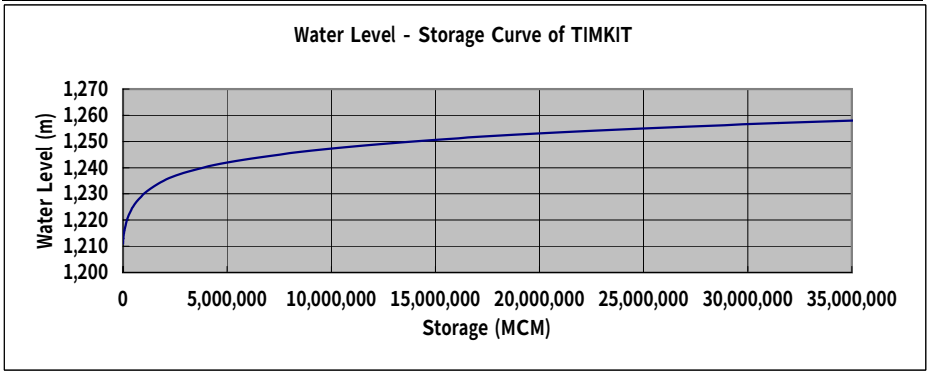


Table XV1.13 : Elevation-Reservoir Area & Storage of Azghar Dam

Elevation H(m)	Difference D(m)	Area $A(m^2)$	Ave. Area $A(m^2)$	Volume $V(m^3)$	Accu. Volume $\Sigma V\ (m^3)$
823	0	0	0	0	0
824	1	400	200	200	200
825	1	800	600	600	800
826	1	14,620	7,710	7,710	8,510
827	1	28,440	21,530	21,530	30,040
828	1	42,260	35,350	35,350	65,390
829	1	56,080	49,170	49,170	114,560
830	1	69,900	62,990	62,990	177,550
831	1	90,620	80,260	80,260	257,810
832	1	111,340	100,980	100,980	358,790
833	1	132,060	121,700	121,700	480,490
834	1	152,780	142,420	142,420	622,910
835	1	173,500	163,140	163,140	786,050
836	1	202,040	187,770	187,770	973,820
837	1	230,580	216,310	216,310	1,190,130
838	1	259,120	244,850	244,850	1,434,980
839	1	287,660	273,390	273,390	1,708,370
840	1	316,200	301,930	301,930	2,010,300
841	1	361,080	338,640	338,640	2,348,940
842	1	405,960	383,520	383,520	2,732,460
843	1	450,840	428,400	428,400	3,160,860
844	1	495,720	473,280	473,280	3,634,140
845	1	540,600	518,160	518,160	4,152,300
846	1	603,320	571,960	571,960	4,724,260
847	1	666,040	634,680	634,680	5,358,940
848	1	728,760	697,400	697,400	6,056,340
849	1	791,480	760,120	760,120	6,816,460
850	1	854,200	822,840	822,840	7,639,300
851	1	936,320	895,260	895,260	8,534,560
852	1	1,018,440	977,380	977,380	9,511,940
853	1	1,100,560	1,059,500	1,059,500	10,571,440
854	1	1,182,680	1,141,620	1,141,620	11,713,060
855	1	1,264,800	1,223,740	1,223,740	12,936,800
856	1	1,337,740	1,301,270	1,301,270	14,238,070
857	1	1,410,680	1,374,210	1,374,210	15,612,280
858	1	1,483,620	1,447,150	1,447,150	17,059,430
859	1	1,556,560	1,520,090	1,520,090	18,579,520
860	1	1,629,500	1,593,030	1,593,030	20,172,550
861	1	1,724,920	1,677,210	1,677,210	21,849,760
862	1	1,820,340	1,772,630	1,772,630	23,622,390
863	1	1,915,760	1,868,050	1,868,050	25,490,440
864	1	2,011,180	1,963,470	1,963,470	27,453,910
865	1	2,106,600	2,058,890	2,058,890	29,512,800
866	1	2,224,320	2,165,460	2,165,460	31,678,260
867	1	2,342,040	2,283,180	2,283,180	33,961,440
868	1	2,459,760	2,400,900	2,400,900	36,362,340
869	1	2,577,480	2,518,620	2,518,620	38,880,960
870	1	2,695,200	2,636,340	2,636,340	41,517,300
871	1	2,824,140	2,759,670	2,759,670	44,276,970
872	1	2,953,080	2,888,610	2,888,610	47,165,580
873	1	3,082,020	3,017,550	3,017,550	50,183,130
874	1	3,210,960	3,146,490	3,146,490	53,329,620
875	1	3,339,900	3,275,430	3,275,430	56,605,050
876	1	3,499,680	3,419,790	3,419,790	60,024,840
877	1	3,659,460	3,579,570	3,579,570	63,604,410
878	1	3,819,240	3,739,350	3,739,350	67,343,760
879	1	3,979,020	3,899,130	3,899,130	71,242,890
880	1	4,138,800	4,058,910	4,058,910	75,301,800

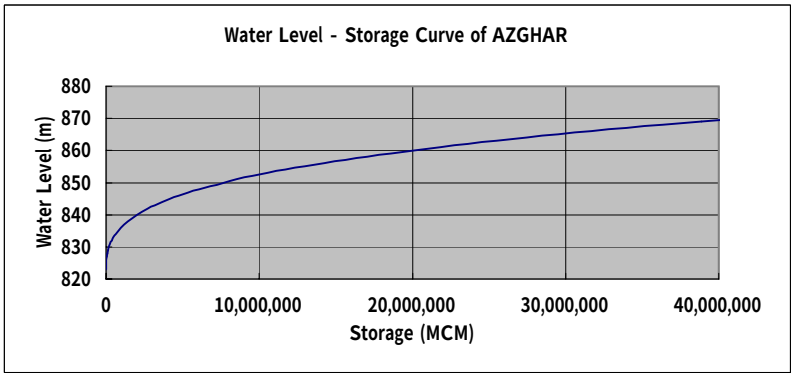


Table XV1.14: Result of Water Balance Study

Normal Water Level	Regulated Volume	Average Deficiency Rate	Frequency of Deficit Year	Maximum Annual Deficit	Average Water Use	Average Evaporation	Average Spillout
EL. m	**Mm^3**	**%**	**%**	**%**	**Mm^3**	**Mm^3**	**Mm^3**
N'fifikh Dam (upstream)							
228	1.2	5.8	15.5	49.8	1.13	0.45	11.74
230	2.5	6.4	17.2	49.8	2.34	0.55	10.43
235	4.3	6.8	13.8	45.1	4.01	0.87	8.45
240	5.5	6.4	15.5	49.4	5.15	1.31	6.87
245	6.4	6.5	19.0	50.0	5.98	1.79	5.54
250	7.1	7.0	19.0	50.0	6.60	2.22	4.45
N'fifikh Dam (downstream)							
13	2.0	2.6	3.4	48.2	1.95	1.06	8.41
15	2.7	7.6	20.7	48.5	2.50	1.21	7.70
20	4.0	8.3	20.7	49.4	3.67	1.64	6.09
25	4.6	7.0	19.0	49.4	4.28	2.14	4.96
30	5.1	6.6	19.0	50.0	4.76	2.56	4.00
35	5.4	6.0	20.7	50.0	5.07	2.90	3.39
Taskourt Dam							
976	8.0	7.3	14.5	40.7	7.41	0.57	36.66
986	19.0	7.2	19.4	47.0	17.63	0.76	26.24
991	22.0	7.2	14.5	50.1	20.42	0.90	23.29
995	24.0	6.7	14.5	46.2	22.40	1.02	21.18
1005	28.0	7.3	14.5	48.2	25.94	1.41	17.19
1020	34.0	6.6	21.0	50.0	31.76	2.02	10.95
1030	37.0	6.2	19.4	50.0	34.71	2.46	7.87
1040	38.5	6.2	19.4	50.0	36.13	2.86	6.42
Timkit Dam							
1245	2.7	8.5	19.4	50.0	2.47	1.60	7.60
1250	3.8	8.5	19.4	50.0	3.48	2.54	5.67
1255	4.0	8.3	19.4	50.0	3.67	3.68	4.34
1260	4.3	9.2	19.4	50.0	3.91	5.22	2.57
Azghar Dam							
850	9.0	8.6	20.0	45.0	8.23	0.81	44.19
852	12.5	6.4	20.5	45.1	11.70	0.91	40.65
854	14.6	5.6	18.2	41.7	13.79	1.02	38.48
860	23.0	7.3	13.6	49.4	21.33	1.40	30.70
865	28.0	7.5	15.9	42.6	25.90	1.81	25.85
870	32.5	7.9	18.2	50.0	29.92	2.29	21.48
875	36.0	8.0	20.5	50.0	33.11	2.82	17.90
880	39.0	9.0	20.5	50.0	35.50	3.33	15.17

Table XV1.15: Water Balance for Alternative Design Period of Sedimentation for Timkit Dam

Normal Water Level	Regulated Volume	Average Deficiency Rate	Frequency of Deficit Year	Maximum Annual Deficit	Average Water Use	Average Evaporation	Average Spillout
EL. m	Mm^3	%	%	%	Mm^3	Mm^3	Mm^3
50 Years							
1250	0.7	9.2	19.4	50.0	0.59	3.06	8.02
1255	2.0	7.1	16.7	50.0	1.86	4.53	5.29
1260	2.2	7.7	19.4	50.0	2.03	6.19	3.45
40 Years							
1250	1.6	8.2	19.4	50.0	1.47	2.95	7.24
1255	2.7	8.3	19.4	50.0	2.48	4.26	4.94
1260	2.7	8.0	19.4	50.0	2.48	5.95	3.24
30 Years							
1245	1.2	6.2	11.1	48.7	1.13	1.74	8.83
1250	2.8	8.1	16.7	50.0	2.57	2.77	6.33
1255	3.3	7.9	19.4	50.0	3.04	3.99	4.66
1260	3.5	8.0	19.4	50.0	3.22	5.56	2.90
20 Years							
1245	2.7	8.5	19.4	50.0	2.47	1.60	7.60
1250	3.8	8.5	19.4	50.0	3.48	2.54	5.67
1255	4.0	8.3	19.4	50.0	3.67	3.68	4.34
1260	4.3	9.2	19.4	50.0	3.91	5.22	2.57

Table XV2.1: Monthly Water Volume Taken at Ait Labzem Weir

Site: AIT LABZEM DIVERSION WEIR (unit: 1000 m3/s)

Year		Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apl	May	Jun	Jul	Aug	Total
1961 /	62	36	2	1,011	2	-	-	-	93	205	-	-	-	1,348
1962 /	63	1,045	682	138	56	25	9	9	73	2,694	666	-	-	5,397
1963 /	64	319	-	-	-	-	-	-	-	-	6	-	-	325
1964 /	65	1,471	-	-	-	-	2,084	170	314	58	204	127	451	4,879
1965 /	66	797	2,843	3,448	2,886	1,380	924	1,246	1,230	1,017	932	509	352	17,565
1966 /	67	638	383	461	336	289	411	412	287	357	4	-	-	3,578
1967 /	68	140	637	2,459	633	525	572	557	847	395	353	289	232	7,637
1968 /	69	274	278	230	292	197	199	88	59	40	45	120	1,654	3,476
1969 /	70	441	73	233	2	20	7	6	9	270	155	8	12	1,236
1970 /	71	37	12	144	6	6	6	6	489	0	-	-	-	705
1971 /	72	15	249	34	-	-	-	-	1,087	11	15	10	10	1,431
1972 /	73	10	14	2,218	189	148	142	108	122	68	186	157	68	3,429
1973 /	74	68	67	331	106	45	17	11	97	33	39	46	21	880
1974 /	75	373	12	0	-	-	-	-	1,076	998	47	2	13	2,521
1975 /	76	18	20	40	107	70	16	8	55	640	290	208	27	1,499
1976 /	77	862	259	170	210	352	63	12	17	15	13	2	0	1,976
1977 /	78	150	47	2	441	8	-	-	-	-	-	-	-	649
1978 /	79	-	70	-	-	277	-	-	-	219	-	-	-	565
1979 /	80	413	1,996	-	-	45	463	1,307	832	274	145	158	100	5,733
1980 /	81	196	242	150	220	108	164	33	17	61	57	57	44	1,350
1981 /	82	2	2	44	42	34	-	-	28	409	193	-	-	753
1982 /	83	-	-	-	-	-	-	-	-	139	-	-	62	201
1983 /	84	38	41	-	-	-	-	-	-	-	-	-	-	78
1984 /	85	-	-	123	-	-	-	-	-	203	-	-	-	326
1985 /	86	464	505	1,784	982	-	-	-	-	-	608	-	389	4,733
1986 /	87	842	2,008	-	-	-	-	322	-	314	-	-	-	3,486
1987 /	88	270	754	676	809	-	-	-	-	88	-	-	-	2,597
1988 /	89	-	1,852	502	-	-	1,141	880	35	0	1,301	312	1,092	7,115
1989 /	90	500	699	2,620	2,833	1,755	1,473	1,016	798	2,374	761	691	764	16,284
1990 /	91	1,504	425	249	531	685	720	273	202	298	2,365	953	1,003	9,207
1991 /	92	663	231	84	469	124	144	89	9	7	164	-	-	1,983
1992 /	93	870	-	-	-	-	-	-	-	-	-	-	-	870
1993 /	94	48	109	3,046	136	534	611	609	732	715	588	508	174	7,808
1994 /	95	175	1,378	282	164	109	136	290	2,075	166	221	98	92	5,186
1995 /	96	89	2,974	983	108	97	401	669	204	192	181	171	161	6,231
1996 /	97	151	142	134	126	118	111	102	91	80	71	63	667	1,855
Mean		359	528	600	325	193	273	228	302	343	267	125	205	3,747

Table XV2.2: Monthly Water Volume Taken at Bour Weir

Site: BOUR DIVERSION WEIR (unit: 1000 m3/s)

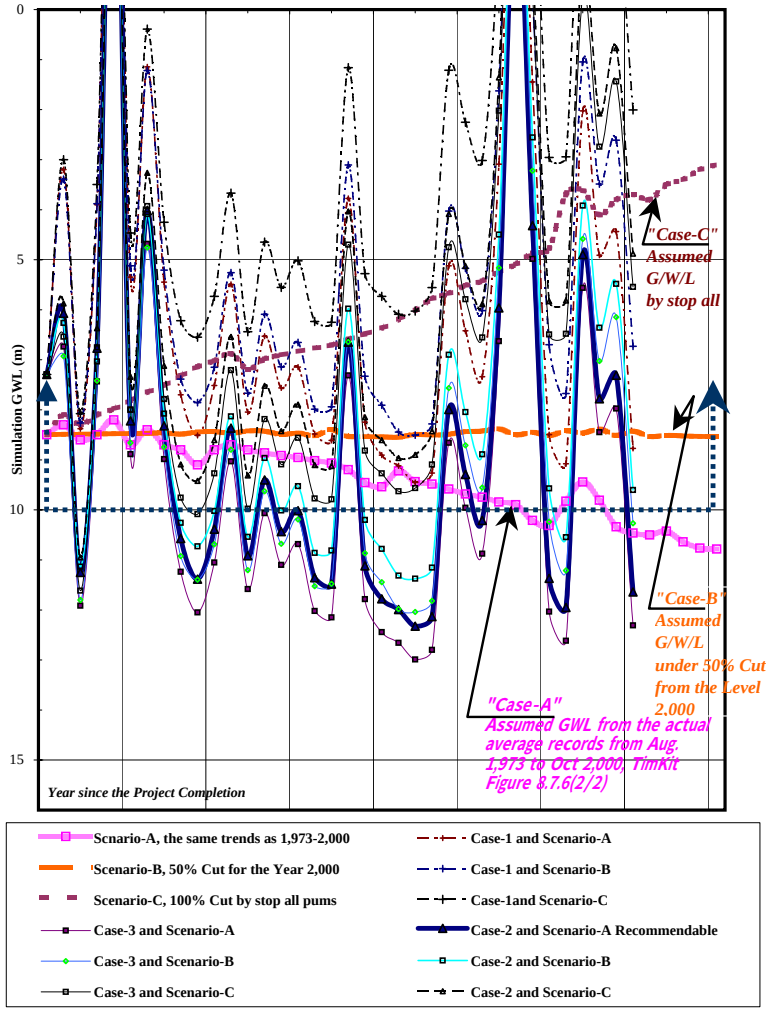
Year		Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apl	May	Jun	Jul	Aug	Total
1961 /	62	158	23	2,045	24	-	-	-	352	719	-	-	-	3,320
1962 /	63	2,076	1,696	503	227	120	56	56	286	2,866	1,675	-	-	9,563
1963 /	64	1,030	-	-	-	-	-	-	-	-	45	-	-	1,074
1964 /	65	2,372	-	-	-	-	2,659	608	1,017	234	714	465	1,327	9,397
1965 /	66	1,833	2,910	3,065	2,922	2,319	1,965	2,232	2,221	2,051	1,972	1,435	1,112	26,035
1966 /	67	1,637	1,183	1,346	1,073	953	1,245	1,246	946	1,124	34	0	0	10,787
1967 /	68	507	1,636	2,793	1,630	1,463	1,539	1,515	1,887	1,209	1,113	951	800	17,044
1968 /	69	913	923	795	961	694	700	334	236	173	191	442	2,470	8,832
1969 /	70	1,307	284	804	27	100	50	43	57	904	558	53	69	4,256
1970 /	71	161	73	520	46	43	43	43	1,398	10	2	2	1	2,341
1971 /	72	81	848	153	-	-	-	-	2,113	68	81	63	63	3,471
1972 /	73	63	78	2,709	670	533	516	402	447	267	660	565	268	7,178
1973 /	74	267	266	1,061	394	190	88	67	366	149	168	192	104	3,312
1974 /	75	1,161	71	5	1	-	-	-	2,103	2,033	197	26	75	5,672
1975 /	76	93	102	174	397	275	85	55	225	1,640	954	728	128	4,855
1976 /	77	1,904	877	607	734	1,110	251	72	90	84	74	25	10	5,838
1977 /	78	543	197	24	1,306	56	0	-	-	0	1	1	-	2,127
1978 /	79	-	274	-	-	920	-	-	-	760	0	-	-	1,954
1979 /	80	1,249	2,624	-	-	190	1,350	2,273	1,871	913	523	569	375	11,937
1980 /	81	691	830	540	761	403	587	150	89	246	232	231	187	4,946
1981 /	82	24	24	187	180	150	-	-	131	1,239	681	-	-	2,616
1982 /	83	-	-	-	-	-	-	-	-	504	-	-	249	753
1983 /	84	165	175	2	-	-	-	-	-	-	-	-	-	341
1984 /	85	-	-	451	-	-	-	-	1	713	-	-	-	1,165
1985 /	86	1,352	1,427	2,532	2,019	-	-	-	-	-	1,595	-	1,197	10,121
1986 /	87	1,882	2,629	-	-	-	-	1,038	-	1,017	-	-	-	6,566
1987 /	88	904	1,784	1,689	1,846	-	-	-	-	334	-	-	-	6,557
1988 /	89	0	2,563	1,422	-	-	2,157	1,923	154	8	2,269	1,013	2,118	13,625
1989 /	90	1,419	1,718	2,844	2,907	2,518	2,373	2,050	1,834	2,764	1,792	1,708	1,796	25,724
1990 /	91	2,390	1,275	849	1,473	1,701	1,744	911	710	976	2,761	1,992	2,038	18,819
1991 /	92	1,672	797	323	1,361	454	521	340	57	48	587	3	-	6,162
1992 /	93	1,912	-	-	-	-	-	-	-	-	-	-	-	1,912
1993 /	94	199	405	2,965	494	1,478	1,598	1,595	1,758	1,737	1,564	1,433	622	15,848
1994 /	95	623	2,317	933	588	405	493	956	2,655	596	766	369	349	11,051
1995 /	96	337	2,946	2,020	403	366	1,223	1,680	716	679	644	609	576	12,200
1996 /	97	544	515	487	460	435	412	383	344	310	278	250	1,677	6,094
Mean		874	930	940	636	469	602	555	668	733	615	365	489	7,875

Table XV2.3: Monthly Water Volume Taken at Chitam Weir

Site: CHITAM DIVERSION WEIR (unit: 1000 m3/s)

Year	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apl	May	Jun	Jul	Aug	Total
1961 / 62	46	15	1,194	16	-	-	-	78	140	-	-	-	1,488
1962 / 63	1,238	764	102	58	39	25	25	67	2,362	742	-	-	5,423
1963 / 64	261	-	-	-	-	-	-	-	-	22	-	-	283
1964 / 65	1,678	-	-	-	-	2,097	118	255	59	138	96	451	4,892
1965 / 66	917	2,409	2,549	2,422	1,598	1,085	1,470	1,454	1,202	1,094	538	306	17,044
1966 / 67	703	351	464	284	226	395	396	223	312	19	0	0	3,371
1967 / 68	102	701	2,274	695	560	619	601	985	369	306	225	161	7,599
1968 / 69	206	212	159	229	133	135	75	59	49	52	92	1,824	3,226
1969 / 70	438	67	162	17	35	24	22	25	202	110	25	28	1,155
1970 / 71	47	29	104	23	22	22	22	507	9	3	3	2	792
1971 / 72	31	177	45	-	-	-	-	1,295	28	31	27	27	1,662
1972 / 73	27	30	2,166	128	106	104	86	93	64	126	111	64	3,106
1973 / 74	64	64	277	85	51	33	28	80	44	48	52	36	862
1974 / 75	336	29	6	2	0	-	0	1,280	1,177	53	16	30	2,928
1975 / 76	34	36	49	85	66	32	25	57	705	226	142	40	1,497
1976 / 77	1,006	189	118	144	304	62	29	33	32	30	16	9	1,971
1977 / 78	108	53	16	437	25	0	0	0	1	1	2	-	643
1978 / 79	-	65	-	-	210	-	-	-	152	1	-	-	429
1979 / 80	398	2,048	-	-	52	467	1,530	964	207	105	112	82	5,962
1980 / 81	133	170	107	153	86	115	44	33	61	58	58	51	1,069
1981 / 82	16	15	51	50	45	-	-	41	391	130	-	-	739
1982 / 83	-	-	-	-	-	-	-	0	102	-	-	61	163
1983 / 84	47	49	3	-	-	-	-	-	-	-	-	-	99
1984 / 85	-	-	93	-	-	-	-	2	138	-	-	-	234
1985 / 86	468	531	1,915	1,158	-	-	-	-	-	660	-	360	5,092
1986 / 87	978	2,055	-	-	-	-	265	-	255	-	-	-	3,552
1987 / 88	202	861	756	934	-	-	-	-	75	-	-	-	2,828
1988 / 89	1	1,960	527	-	-	1,360	1,031	45	8	1,524	253	1,302	8,011
1989 / 90	525	788	2,336	2,406	1,895	1,679	1,201	919	2,238	870	777	874	16,509
1990 / 91	1,705	415	177	568	769	816	206	137	235	2,234	1,121	1,184	9,568
1991 / 92	738	160	73	474	94	104	76	26	23	115	4	-	1,887
1992 / 93	1,017	-	-	-	-	-	-	-	-	-	-	-	1,017
1993 / 94	53	86	2,465	100	573	663	661	832	809	636	536	120	7,533
1994 / 95	120	1,596	218	115	86	100	227	2,092	116	152	81	77	4,979
1995 / 96	76	2,447	1,159	86	80	379	747	139	130	123	118	113	5,596
1996 / 97	108	103	99	95	91	87	83	77	71	66	61	744	1,686
Mean	384	513	546	299	199	289	249	328	327	269	124	221	3,747

Table XV2.4: Simulation of Recharge / Pumping for Timkit Basin



Year since project completion	Floods (Intake) barrages Chtam etc (m^3/s)	Outside GWL: With Pumping, Same Trends the year 2,000 Scenario-A	Outside GWL: With Pumping, 50 % Cut of 2,000 Scenario-B	Outside GWL: Without Pumping (100% cut) Scenario-C	Simulation in the TimKit Irrigation Field: Case-1 No Well, Simulation GWL CASE-1 A	CASE-1 B	CASE-1 C	Case-2 1.1E+06 m^3 by total wells of 7: 30 l/s/well by 4hrs, Well Nos	Yield (m^3/year)	Draw Down (m)	Simulation GWL CASE-2 A	CASE-2 B	CASE-2 C	Case-3 1.4E+06 m^3 by total wells of 7: 30 l/s/well by 5hrs, Well Nos	Yield (m^3/year)	Draw Down (m)	Simulation GWL CASE-3 A	CASE-3 B	CASE-3 C
1	5.060E+05	8.5	8.5	8.5	7.3	7.3	7.3	0	0.0E+00	0.0	7.3	7.3	7.3	0	0.0E+00	0.0	7.3	7.3	7.3
2	2.024E+06	8.3	8.5	8.1	3.2	3.4	3.0	7	1.1E+06	2.9	6.1	6.3	5.9	7	1.4E+06	3.5	6.7	6.9	6.5
3	1.220E+05	8.6	8.5	8.3	8.4	8.3	8.1	7	1.1E+06	2.9	11.2	11.1	10.9	7	1.4E+06	3.5	11.9	11.8	11.6
4	1.830E+06	8.5	8.5	8.1	3.9	3.9	3.5	7	1.1E+06	2.9	6.8	6.8	6.4	7	1.4E+06	3.5	7.4	7.4	7.0
5	6.587E+06	8.2	8.5	8.0	(8.6)	(8.3)	(8.8)	7	1.1E+06	2.9	(5.7)	(5.4)	(5.9)	7	1.4E+06	3.5	(5.1)	(4.8)	(5.3)
6	1.342E+06	8.7	8.5	7.8	5.3	5.1	4.5	7	1.1E+06	2.9	8.2	8.0	7.3	7	1.4E+06	3.5	8.9	8.7	8.0
7	2.864E+06	8.4	8.5	7.6	1.1	1.2	0.4	7	1.1E+06	2.9	4.0	4.1	3.3	7	1.4E+06	3.5	4.7	4.8	3.9
8	1.304E+06	8.7	8.5	7.5	5.4	5.2	4.2	7	1.1E+06	2.9	8.3	8.1	7.1	7	1.4E+06	3.5	9.0	8.7	7.8
9	4.640E+05	8.8	8.5	7.3	7.7	7.4	6.2	7	1.1E+06	2.9	10.6	10.3	9.1	7	1.4E+06	3.5	11.2	10.9	9.8
10	2.640E+05	9.1	8.4	7.1	8.5	7.9	6.5	7	1.1E+06	2.9	11.4	10.7	9.4	7	1.4E+06	3.5	12.1	11.4	10.1
11	5.370E+05	8.8	8.4	7.0	7.5	7.1	5.7	7	1.1E+06	2.9	10.4	10.0	8.6	7	1.4E+06	3.5	11.1	10.7	9.3
12	1.286E+06	8.7	8.5	6.9	5.5	5.3	3.7	7	1.1E+06	2.9	8.4	8.1	6.5	7	1.4E+06	3.5	9.0	8.8	7.2
13	3.300E+05	8.8	8.4	7.2	8.0	7.7	6.4	7	1.1E+06	2.9	10.9	10.5	9.3	7	1.4E+06	3.5	11.6	11.2	10.0
14	9.450E+05	8.9	8.4	7.0	6.5	6.1	4.6	7	1.1E+06	2.9	9.4	9.0	7.5	7	1.4E+06	3.5	10.1	9.6	8.2
15	5.620E+05	8.9	8.5	6.9	7.6	7.1	5.6	7	1.1E+06	2.9	10.4	10.0	8.4	7	1.4E+06	3.5	11.1	10.7	9.1
16	7.410E+05	9.0	8.5	6.8	7.1	6.7	5.0	7	1.1E+06	2.9	10.0	9.5	7.9	7	1.4E+06	3.5	10.7	10.2	8.6
17	2.430E+05	9.0	8.5	6.8	8.5	8.0	6.2	7	1.1E+06	2.9	11.4	10.9	9.1	7	1.4E+06	3.5	12.0	11.5	9.8
18	2.120E+05	9.1	8.4	6.7	8.6	7.9	6.3	7	1.1E+06	2.9	11.5	10.8	9.1	7	1.4E+06	3.5	12.1	11.5	9.8
19	2.150E+06	9.2	8.5	6.6	3.8	3.1	1.2	7	1.1E+06	2.9	6.6	6.0	4.0	7	1.4E+06	3.5	7.3	6.6	4.7
20	5.060E+05	9.5	8.5	6.5	8.2	7.3	5.3	7	1.1E+06	2.9	11.1	10.2	8.1	7	1.4E+06	3.5	11.8	10.9	8.8
21	2.820E+05	9.5	8.5	6.4	8.9	7.9	5.7	7	1.1E+06	2.9	11.8	10.8	8.6	7	1.4E+06	3.5	12.4	11.4	9.3
22	7.500E+04	9.2	8.5	6.2	9.1	8.4	6.1	7	1.1E+06	2.9	12.0	11.3	9.0	7	1.4E+06	3.5	12.7	12.0	9.6
23	2.900E+04	9.4	8.5	6.0	9.5	8.5	6.0	7	1.1E+06	2.9	12.3	11.4	8.9	7	1.4E+06	3.5	13.0	12.0	9.6
24	1.220E+05	9.5	8.5	5.8	9.3	8.3	5.6	7	1.1E+06	2.9	12.1	11.2	8.4	7	1.4E+06	3.5	12.8	11.8	9.1
25	1.775E+06	9.6	8.5	5.7	5.1	4.0	1.2	7	1.1E+06	2.9	8.0	6.9	4.1	7	1.4E+06	3.5	8.7	7.6	4.8
26	1.307E+06	9.7	8.4	5.5	6.4	5.2	2.3	7	1.1E+06	2.9	9.3	8.0	5.1	7	1.4E+06	3.5	10.0	8.7	5.8
27	9.740E+05	9.7	8.4	5.4	7.3	6.0	3.0	7	1.1E+06	2.9	10.2	8.9	5.9	7	1.4E+06	3.5	10.9	9.6	6.6
28	2.668E+06	9.8	8.4	5.2	3.1	1.6	(1.5)	7	1.1E+06	2.9	6.0	4.5	1.4	7	1.4E+06	3.5	6.6	5.2	2.0
29	6.107E+06	9.9	8.5	5.1	(5.7)	(7.1)	(10.5)	7	1.1E+06	2.9	(2.8)	(4.2)	(7.6)	7	1.4E+06	3.5	(2.1)	(3.5)	(6.9)
30	3.453E+06	10.2	8.4	4.9	1.4	(0.3)	(3.9)	7	1.1E+06	2.9	4.3	2.6	(1.0)	7	1.4E+06	3.5	5.0	3.2	(0.4)
31	7.440E+05	10.3	8.5	4.8	8.5	6.7	3.0	7	1.1E+06	2.9	11.4	9.6	5.8	7	1.4E+06	3.5	12.0	10.2	6.5
32	3.260E+05	9.8	8.4	3.7	9.1	7.7	2.9	7	1.1E+06	2.9	12.0	10.5	5.8	7	1.4E+06	3.5	12.6	11.2	6.5
33	2.928E+06	9.4	8.5	3.6	2.0	1.0	(3.8)	7	1.1E+06	2.9	4.9	3.9	(0.9)	7	1.4E+06	3.5	5.6	4.6	(0.3)
34	1.945E+06	9.8	8.4	4.1	4.9	3.5	(0.8)	7	1.1E+06	2.9	7.8	6.4	2.1	7	1.4E+06	3.5	8.4	7.0	2.7
35	2.337E+06	10.3	8.5	3.8	4.4	2.6	(2.1)	7	1.1E+06	2.9	7.3	5.5	0.8	7	1.4E+06	3.5	8.0	6.1	1.4
36	6.960E+05	10.5	8.4	3.7	8.8	6.7	2.0	7	1.1E+06	2.9	11.6	9.6	4.9	7	1.4E+06	3.5	12.3	10.3	5.5
37		10.5	8.5	3.8															
38		10.4	8.5	3.5															
39		10.6	8.5	3.4															
40		10.8	8.5	3.2															
41		10.8	8.5	3.1															

Average	1.405E+06	Evaporation	0.009		Recovery (= pumping/inflow) after the project completion														
Model (ha)	390	6 mm	m/day		CASE-1	0%		CASE-2			80%			CASE-3			98%		
		Width (m)	1,950		Length (m)	2,000		Porosity	0.1		Permeability (cm/s)	0.1		Thickness (m)		8.5	m		

LEGEND

Senario(A,B,C) - Cases(1,2,3)

Scenario-A	Same Trends as 1,973-2,000	Well Nos	Recovery
1	no well (rechrge only)	-	0%
2	recovery by the well number of	7	80%
3	recovery by the well number of	7	98%

Scenario-B	50% Cut from the year 2,000	Well Nos	Recovery
1	no well (rechrge only)	-	0%
2	recovery by the well number of	7	80%
3	recovery by the well number of	7	98%
Scenario-C	100% Cut Without Use		
1	no well (rechrge only)	-	0%
2	recovery by the well number of	7	80%
3	recovery by the well number of	7	98%

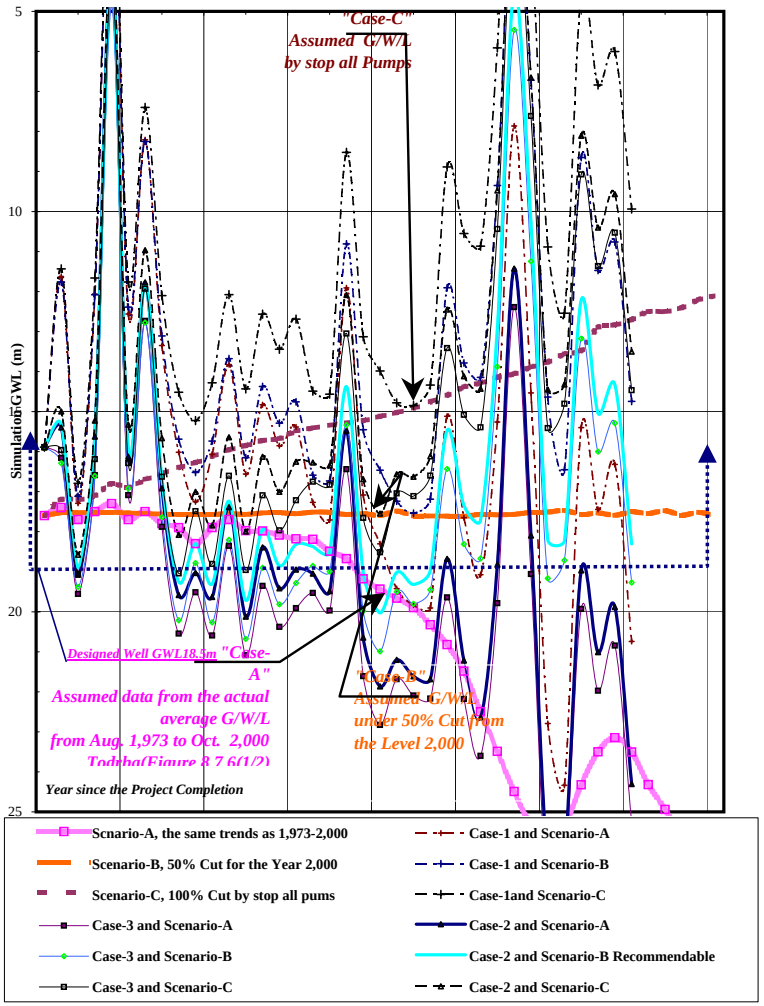
Note

2A

Parameters are set by the Calibration Results

Preferable Senario

Table XV2.5: Simulation of Recharge / Pumping for Todrah Basin



Year since project completion	Floods (Intake) barrages Chtam etc (m^3/s)	Outside GWL With Pumping Same Trends the year 2,000 Scenario-A	Outside GWL With Pumping 50 % Cut of 2,000 Scenario-B	Outside GWL Without Pumping (100% cut) Scenario-C	Simulation in the Todrha Case-1 No Well Simulation GWL CASE-1 A	B	C	Case-2 1.1E+07 m^3 by total wells of 30 30 l/s/well by 9hrs Well Nos	Yield (m^3/year)	Draw Down (m)	Simulation GWL CASE-2 A	B	C	Case-3 1.4E+07 m^3 by total wells of 30 30 l/s/well by 12hrs Well Nos	Yield (m^3/year)	Draw Down (m)	Simulation GWL CASE-3 A	B	C
1	5.651E+06	17.60	17.60	17.60	15.9	15.9	15.9	0	0.0E+00	0.0	15.9	15.9	15.9	0	0.0E+00	0.0	15.9	15.9	15.9
2	1.836E+07	17.40	17.53	17.20	11.6	11.8	11.4	30	1.1E+07	3.6	15.4	15.3	15.0	30	1.4E+07	4.5	16.2	16.3	16.0
3	1.560E+06	17.70	17.52	17.20	17.3	17.1	16.8	30	5.6E+06	1.8	19.1	18.9	18.6	30	7.1E+06	2.3	19.6	19.4	19.1
4	1.734E+07	17.50	17.52	17.10	12.1	12.1	11.7	30	1.1E+07	3.6	15.6	15.6	15.2	30	1.4E+07	4.5	16.6	16.6	16.2
5	5.406E+07	17.30	17.52	16.80	0.1	0.4	(0.4)	30	1.1E+07	3.6	3.7	3.9	3.2	30	1.4E+07	4.5	4.7	4.9	4.2
6	1.639E+07	17.70	17.53	16.90	12.6	12.4	11.8	30	1.1E+07	3.6	16.1	16.0	15.3	30	1.4E+07	4.5	17.1	16.9	16.3
7	2.942E+07	17.50	17.55	16.69	8.2	8.3	7.4	30	1.1E+07	3.6	11.8	11.8	11.0	30	1.4E+07	4.5	12.7	12.8	11.9
8	1.423E+07	17.80	17.56	16.55	13.4	13.1	12.1	30	1.1E+07	3.6	16.9	16.7	15.7	30	1.4E+07	4.5	17.9	17.6	16.6
9	6.184E+06	17.90	17.57	16.40	16.0	15.7	14.5	30	1.1E+07	3.6	19.6	19.3	18.1	30	1.4E+07	4.5	20.5	20.2	19.0
10	3.574E+06	18.30	17.57	16.27	17.2	16.5	15.2	30	5.6E+06	1.8	19.0	18.3	17.0	30	7.1E+06	2.3	19.5	18.8	17.5
11	6.027E+06	17.90	17.57	16.11	16.1	15.7	14.3	30	1.1E+07	3.6	19.6	19.3	17.8	30	1.4E+07	4.5	20.6	20.3	18.8
12	1.243E+07	17.70	17.55	15.95	13.8	13.7	12.1	30	1.1E+07	3.6	17.4	17.2	15.6	30	1.4E+07	4.5	18.4	18.2	16.6
13	4.724E+06	17.97	17.57	15.85	16.6	16.2	14.4	30	1.1E+07	3.6	20.1	19.7	18.0	30	1.4E+07	4.5	21.1	20.7	19.0
14	1.018E+07	17.98	17.53	15.72	14.8	14.4	12.6	30	1.1E+07	3.6	18.4	17.9	16.1	30	1.4E+07	4.5	19.4	18.9	17.1
15	7.289E+06	18.09	17.52	15.68	15.9	15.3	13.4	30	1.1E+07	3.6	19.4	18.9	17.0	30	1.4E+07	4.5	20.4	19.8	18.0
16	9.044E+06	18.18	17.55	15.48	15.4	14.8	12.7	30	1.1E+07	3.6	18.9	18.3	16.3	30	1.4E+07	4.5	19.9	19.3	17.2
17	3.176E+06	18.19	17.51	15.41	17.3	16.6	14.5	30	5.6E+06	1.8	19.0	18.4	16.3	30	7.1E+06	2.3	19.5	18.9	16.8
18	2.736E+06	18.49	17.51	15.35	17.7	16.7	14.6	30	5.6E+06	1.8	19.5	18.5	16.3	30	7.1E+06	2.3	20.0	19.0	16.8
19	2.148E+07	18.67	17.57	15.28	11.9	10.8	8.5	30	1.1E+07	3.6	15.5	14.4	12.1	30	1.4E+07	4.5	16.4	15.3	13.0
20	6.859E+06	19.18	17.55	15.23	17.1	15.5	13.1	30	1.1E+07	3.6	20.6	19.0	16.7	30	1.4E+07	4.5	21.6	20.0	17.7
21	3.826E+06	19.43	17.59	15.12	18.3	16.5	14.0	30	1.1E+07	3.6	21.9	20.0	17.5	30	1.4E+07	4.5	22.8	21.0	18.5
22	1.042E+06	19.66	17.48	15.02	19.4	17.2	14.8	30	5.6E+06	1.8	21.2	19.0	16.6	30	7.1E+06	2.3	21.7	19.5	17.0
23	4.890E+05	19.90	17.60	14.91	19.8	17.5	14.8	30	5.6E+06	1.8	21.6	19.3	16.6	30	7.1E+06	2.3	22.1	19.8	17.1
24	1.603E+06	20.33	17.61	14.76	19.9	17.2	14.3	30	5.6E+06	1.8	21.7	19.0	16.1	30	7.1E+06	2.3	22.2	19.5	16.6
25	1.817E+07	20.82	17.61	14.59	15.1	11.9	8.9	30	1.1E+07	3.6	18.7	15.5	12.4	30	1.4E+07	4.5	19.6	16.4	13.4
26	1.230E+07	21.49	17.62	14.38	17.7	13.8	10.6	30	1.1E+07	3.6	21.2	17.3	14.1	30	1.4E+07	4.5	22.2	18.3	15.1
27	1.101E+07	22.50	17.57	14.29	19.1	14.1	10.9	30	1.1E+07	3.6	22.6	17.7	14.4	30	1.4E+07	4.5	23.6	18.7	15.4
28	2.608E+07	23.49	17.58	14.14	15.3	9.4	5.9	30	1.1E+07	3.6	18.8	12.9	9.5	30	1.4E+07	4.5	19.8	13.9	10.4
29	5.241E+07	24.49	17.57	14.06	7.9	0.9	(2.6)	30	1.1E+07	3.6	11.4	4.5	1.0	30	1.4E+07	4.5	12.4	5.5	2.0
30	3.414E+07	25.33	17.52	13.89	14.5	6.7	3.1	30	1.1E+07	3.6	18.1	10.3	6.7	30	1.4E+07	4.5	19.1	11.2	7.6
31	9.288E+06	25.67	17.51	13.76	22.8	14.6	10.9	30	1.1E+07	3.6	26.4	18.2	14.4	30	1.4E+07	4.5	27.3	19.2	15.4
32	3.473E+06	25.36	17.47	13.56	24.3	16.4	12.5	30	5.6E+06	1.8	26.1	18.2	14.3	30	7.1E+06	2.3	26.6	18.7	14.8
33	2.826E+07	24.33	17.58	13.47	15.4	8.7	4.5	30	1.1E+07	3.6	19.0	12.2	8.1	30	1.4E+07	4.5	19.9	13.2	9.1
34	1.927E+07	23.50	17.53	12.90	17.4	11.5	6.8	30	1.1E+07	3.6	21.0	15.0	10.4	30	1.4E+07	4.5	22.0	16.0	11.4
35	2.169E+07	23.15	17.59	12.83	16.3	10.8	6.0	30	1.1E+07	3.6	19.9	14.3	9.6	30	1.4E+07	4.5	20.8	15.3	10.5
36	8.939E+06	23.50	17.50	12.70	20.7	14.7	9.9	30	1.1E+07	3.6	24.3	18.3	13.5	30	1.4E+07	4.5	25.3	19.3	14.5
37		24.32	17.55	12.50				30						30					
38		24.94	17.47	12.50				30						30					
39		25.67	17.59	12.40				30						30					
40		26.16	17.51	12.20				30						30					
41		26.82	17.61	12.10				30						30					
Average	1.396E+07	Evaporation		0.009	Recovery (= pumping/inflow) after the project completion														
Model (ha)	3,135	6 mm		m/day	CASE-1 0%			CASE-2 80%						CASE-3 102%					
		Width (m)		2,000	Length (m) 15,675			Porosity 0.1			Permeability (cm/s) 0.1			Thickness (m) 18 m					

LEGEND

Senario(A,B,C) - Cases(1,2,3)

Scenario-A	Same Trends as 1,973-2,000	Well Nos	Recovery
1	no well (rechrge only)	-	0%
2	recovery by the well number of	30	80%
3	recovery by the well number of	30	102%

Scenario-B	50% Cut from the year 2,000	Well Nos	Recovery
1	no well (rechrge only)	-	0%
2	recovery by the well number of	30	80%
3	recovery by the well number of	30	102%

Scenario-C	100% Cut Without Use		
1	no well (rechrge only)	-	0%
2	recovery by the well number of	30	80%
3	recovery by the well number of	30	102%

Note

2B

Parameters are set by the Calibration Results

Preferable Senario

Table XV3.1 Annual Average Irrigation Area for Alternative NU1

Year	Rainfall (mm)	Water requirement (m3/ha/yr)	Potential irrigation area (ha)	Possible irrigation area (ha)
1977	234.3	8,267	774	774
1978	426.4	6,242	1,025	1,000
1979	568.0	4,749	1,348	1,000
1980	294.1	7,637	838	838
1981	131.3	9,353	684	684
1982	248.6	8,116	789	789
1983	244.4	8,161	784	784
1984	378.7	6,745	949	949
1985	271.0	7,880	812	812
1986	379.5	6,736	950	950
1987	430.4	6,200	1,032	1,000
1988	320.0	7,364	869	869
1989	420.4	6,305	1,015	1,000
1990	334.0	7,216	887	887
1991	481.5	5,661	1,131	1,000
1992	230.6	8,306	771	771
1993	283.4	7,749	826	826
1994	118.7	9,486	675	675
1995	191.5	8,718	734	734
1996	635.7	4,035	1,586	1,000
1997	231.2	8,300	771	771
1998	162.4	9,025	709	709
1999	256.4	8,034	797	797
			Average	**853**

Table XV3.2 Annual Average Irrigation Area for Alternative ND1

Year	Rainfall (mm)	Water requirement (m3/ha/yr)	Potential irrigation area (ha)	Possible irrigation area (ha)
1977	234.3	572.5	210	210
1978	426.4	437.1	275	260
1979	568.0	337.2	356	260
1980	294.1	530.3	226	226
1981	131.3	645.1	186	186
1982	248.6	562.4	213	213
1983	244.4	565.4	212	212
1984	378.7	470.7	255	255
1985	271.0	546.6	220	220
1986	379.5	470.1	255	255
1987	430.4	434.2	276	260
1988	320.0	512.1	234	234
1989	420.4	441.3	272	260
1990	334.0	502.2	239	239
1991	481.5	398.2	301	260
1992	230.6	575.1	209	209
1993	283.4	537.9	223	223
1994	118.7	654.0	183	183
1995	191.5	602.7	199	199
1996	635.7	289.5	414	260
1997	231.2	574.7	209	209
1998	162.4	623.2	193	193
1999	256.4	556.9	215	215
			Average	**228**

Table XV3.3: Coefficient for Adjustment of Regulated Volume of Taskourt Dam

Regulated volume	Mm^3	8.7		9.6		19.3		28.9		38
Irrigation area	ha	900		1,000		2,000		3,000		4,0
		Perenial	Seasonal and Flood	Perenial	Seasonal and Flood	Perenial	Seasonal and Flood	Perenial	Seasonal and Flood	Perenial
		900	0	900	100	900	1100	900	2100	900
Present net income	Dh/ha	12,420	0	12,420	138	12,420	138	12,420	138	12,420
Future net income	Dh/ha	25,218	0	25,218	25,218	25,218	25,218	25,218	25,218	25,218
Income increasing	Dh/ha	12,798	0	12,798	25,080	12,798	25,080	12,798	25,080	12,798
Total net icmome in the Areas	Dh	11,518,200	0	11,518,200	2,508,000	11,518,200	27,588,000	11,518,200	52,668,000	11,518,200
Total net income	Dh	11,518,200		14,026,200		39,106,200		64,186,200		89,26
Total income per ha	Dh/ha	12,798		14,026		19,553		21,395		22,3
Coefficient		1.000		1.096		1.528		1.672		1.7

Note : The above income is estimated in economic value.

3.6
)00
Seasonal and Flood 3100
138
25,218
25,080
77,748,000
6,200
317
'44

Table XV3.4 Annual Average Irrigation Area for Alternative TA1

Year	Rainfall (mm)	Water requirement (m3/ha/yr)	Potential irrigation area (ha)	Possible irrigation area (ha)
1976	424.9	815.4	4,170	4,170
1977	337.2	906.3	3,751	3,751
1978	385.2	856.6	3,969	3,969
1979	284.7	960.7	3,539	3,539
1980	362.1	880.5	3,861	3,861
1981	205.9	1042.4	3,262	3,262
1982	504.1	733.4	4,636	4,500
1983	138.3	1112.5	3,056	3,056
1984	282.1	963.4	3,529	3,529
1985	360.5	882.2	3,854	3,854
1986	313.2	931.2	3,651	3,651
1987	329.6	914.2	3,719	3,719
1988	459.3	779.8	4,360	4,360
1989	435.0	805.0	4,224	4,224
1990	136.7	1114.1	3,052	3,052
1991	352.2	890.8	3,817	3,817
1992	364.5	878.0	3,872	3,872
1993	258.2	988.2	3,441	3,441
1994	307.7	936.9	3,629	3,629
1995	352.8	890.2	3,820	3,820
1996	553.5	682.2	4,984	4,500
1997	448.6	790.9	4,299	4,299
1998	294.4	950.7	3,576	3,576
1999	588.2	646.2	5,262	4,500
			Average	**3,831**

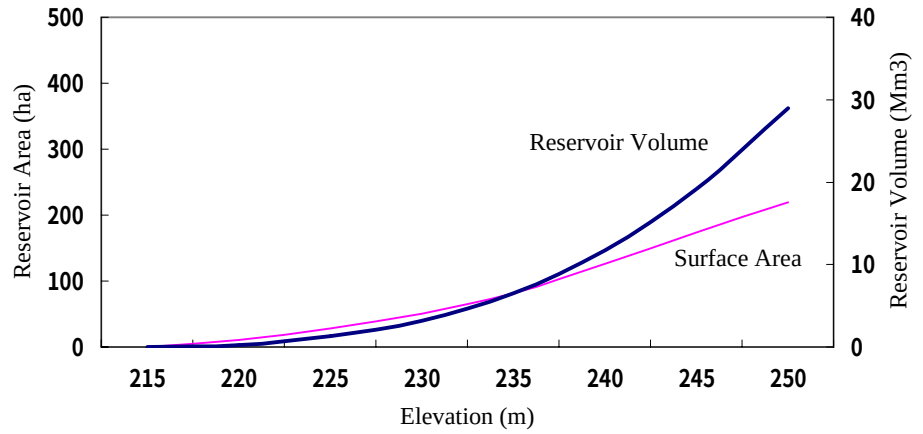
Table XV3.5 Annual Average Volume Released from Timkit Dam

Year	Spill-out															5 Mm^3		10 Mm^3		15 Mm^3		20 Mm^3		25 Mm^3		U 30 M
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Total	Oct-Dec	Jan-Sep	Oct-Mar	Apr-Sep	Oct-Mar	Apr-Sep	Oct-Mar	Apr-Sep	Oct-Mar	Apr-Sep	Oct-Mar	Apr-Sep	Oct-Mar
61	0.00	0.00	0.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.56	0.56	0.00	0.56	0.00	0.56	0.00	0.56	0.00	0.56	0.00	0.56	0.00	0.56
62	0.18	1.14	0.21	0.08	0.00	0.00	0.00	0.00	9.01	0.89	0.00	0.00	11.51	1.43	10.08	1.43	5.00	1.43	10.00	1.43	10.08	1.43	10.08	1.43	10.08	1.43
63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
64	0.51	0.00	0.00	0.00	0.00	4.15	0.00	0.14	0.00	0.00	0.00	0.44	5.24	0.00	5.24	0.00	5.00	0.00	5.24	0.00	5.24	0.00	5.24	0.00	5.24	0.00
65	1.25	12.14	45.32	13.02	2.65	1.34	2.02	1.99	1.64	1.38	0.62	0.39	83.76	70.48	13.28	5.00	5.00	10.00	10.00	15.00	13.28	20.00	13.28	25.00	13.28	30.00
66	0.96	0.60	0.78	0.59	0.42	0.48	0.35	0.18	0.40	0.00	0.00	0.00	4.76	1.97	2.79	1.97	2.79	1.97	2.79	1.97	2.79	1.97	2.79	1.97	2.79	1.97
67	0.00	0.29	7.40	1.13	0.85	0.74	0.61	1.17	0.47	0.34	0.22	0.17	13.40	8.82	4.58	5.00	4.58	8.82	4.58	8.82	4.58	8.82	4.58	8.82	4.58	8.82
68	0.32	0.40	0.37	0.51	0.25	0.13	0.00	0.00	0.00	0.00	0.00	2.46	4.45	1.29	3.16	1.29	3.16	1.29	3.16	1.29	3.16	1.29	3.16	1.29	3.16	1.29
69	0.62	0.03	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.02	0.40	0.62	0.40	0.62	0.40	0.62	0.40	0.62	0.40	0.62	0.40	0.62	0.40
70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
72	0.00	0.00	4.48	0.33	0.16	0.03	0.00	0.00	0.00	0.00	0.00	0.00	5.00	4.81	0.19	4.81	0.19	4.81	0.19	4.81	0.19	4.81	0.19	4.81	0.19	4.81
73	0.00	0.00	0.05	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.23	0.00	0.23	0.00	0.23	0.00	0.23	0.00	0.23	0.00	0.23	0.00	0.23
74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	1.60	0.00	0.00	0.00	1.68	0.00	1.68	0.00	1.68	0.00	1.68	0.00	1.68	0.00	1.68	0.00	1.68	0.00
75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
76	1.07	0.37	0.26	0.36	0.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.60	1.00	1.60	1.00	1.60	1.00	1.60	1.00	1.60	1.00	1.60	1.00	1.60	1.00
77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
79	0.00	2.86	0.00	0.00	0.00	0.40	2.17	1.15	0.25	0.00	0.00	0.00	6.83	2.86	3.97	2.86	3.97	2.86	3.97	2.86	3.97	2.86	3.97	2.86	3.97	2.86
80	0.08	0.34	0.23	0.38	0.09	0.07	0.00	0.00	0.00	0.00	0.00	0.00	1.18	0.95	0.24	0.95	0.24	0.95	0.24	0.95	0.24	0.95	0.24	0.95	0.24	0.95
81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
85	0.00	0.00	2.19	1.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.99	3.99	0.00	3.99	0.00	3.99	0.00	3.99	0.00	3.99	0.00	3.99	0.00	3.99
86	0.98	4.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.79	4.81	0.98	4.81	0.98	4.81	0.98	4.81	0.98	4.81	0.98	4.81	0.98	4.81
87	0.00	0.41	1.16	1.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.02	3.02	0.00	3.02	0.00	3.02	0.00	3.02	0.00	3.02	0.00	3.02	0.00	3.02
88	0.00	2.21	0.85	0.00	0.00	1.56	1.21	0.00	0.00	1.67	0.27	1.82	9.59	3.06	6.54	3.06	5.00	3.06	6.54	3.06	6.54	3.06	6.54	3.06	6.54	3.06
89	0.72	1.17	8.88	12.07	3.79	2.52	1.49	1.08	6.77	1.06	0.95	1.14	41.64	22.11	19.53	5.00	5.00	10.00	10.00	15.00	15.00	20.00	19.53	22.11	19.53	22.11
90	2.84	0.67	0.40	0.95	1.14	0.98	0.10	0.03	0.29	6.45	1.46	1.61	16.92	2.03	14.90	2.03	5.00	2.03	10.00	2.03	14.90	2.03	14.90	2.03	14.90	2.03
91	1.01	0.32	0.11	0.84	0.12	0.04	0.00	0.00	0.00	0.00	0.00	0.00	2.43	1.27	1.16	1.27	1.16	1.27	1.16	1.27	1.16	1.27	1.16	1.27	1.16	1.27
92	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.09	0.00	0.09	0.00	0.09	0.00	0.09	0.00	0.09	0.00	0.09	0.00
93	0.00	0.00	14.27	0.23	0.86	0.80	0.71	0.96	1.05	0.76	0.62	0.07	20.33	14.50	5.83	5.00	5.00	10.00	5.83	14.50	5.83	14.50	5.83	14.50	5.83	14.50
94	0.15	2.65	0.46	0.28	0.09	0.02	0.13	4.74	0.05	0.11	0.00	0.00	8.68	3.39	5.28	3.39	5.00	3.39	5.28	3.39	5.28	3.39	5.28	3.39	5.28	3.39
95	0.00	14.61	1.73	0.18	0.07	0.46	0.82	0.04	0.10	0.04	0.01	0.04	18.08	16.51	1.57	5.00	1.57	10.00	1.57	15.00	1.57	16.51	1.57	16.51	1.57	16.51
96	0.11	0.16	0.20	0.21	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.96	0.56	0.40	0.56	0.40	0.56	0.40	0.56	0.40	0.56	0.40	0.56	0.40	0.56
Average	0.30	1.26	2.51	0.96	0.31	0.38	0.27	0.32	0.60	0.35	0.12	0.23	7.60	4.72	2.88	1.74	1.75	2.40	2.39	2.94	2.75	3.26	2.88	3.46	2.88	3.60
															without Ifegh :	3.49		4.79		5.70		6.14		6.34		6.4
															with Ifegh :	5.96		7.26		8.17		8.61		8.81		8.9

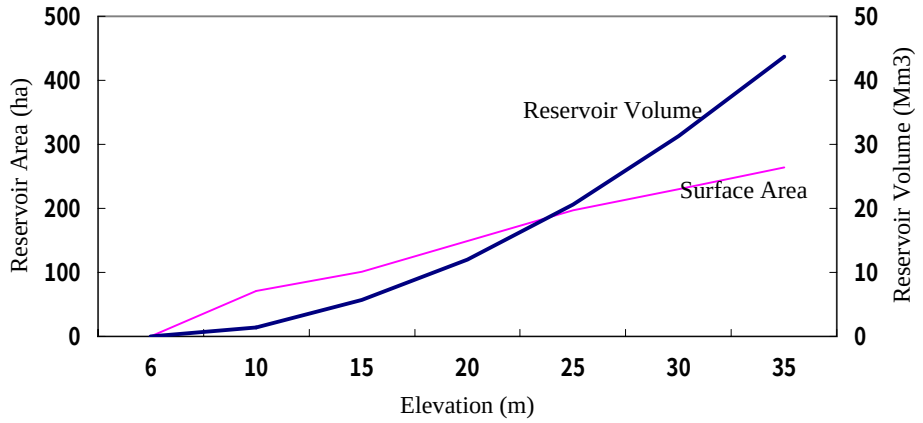
nit : Mm^3
Mm^3
Apr-Sep
0.00
10.08
0.00
5.24
13.28
2.79
4.58
3.16
0.62
0.00
0.00
0.19
0.00
1.68
0.00
1.60
0.00
0.00
3.97
0.24
0.00
0.00
0.00
0.00
0.00
0.98
0.00
6.54
19.53
14.90
1.16
0.09
5.83
5.28
1.57
0.40
2.88
48
95

Figures

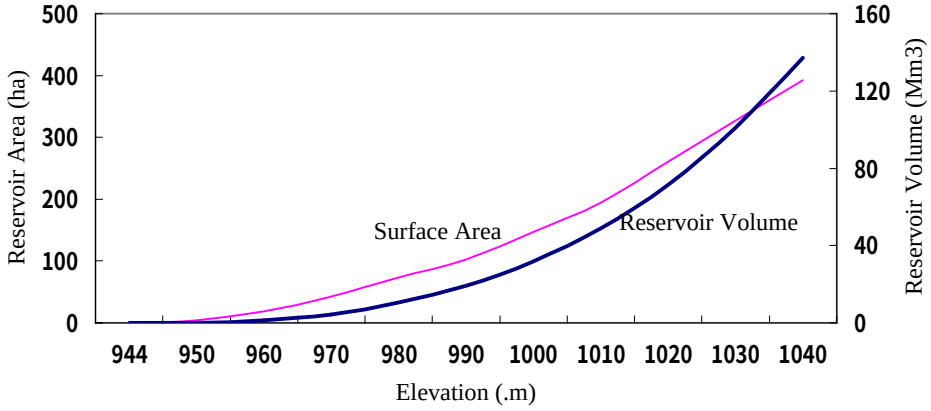
N'fifikh (upstream)



N'fifikh (downstream)

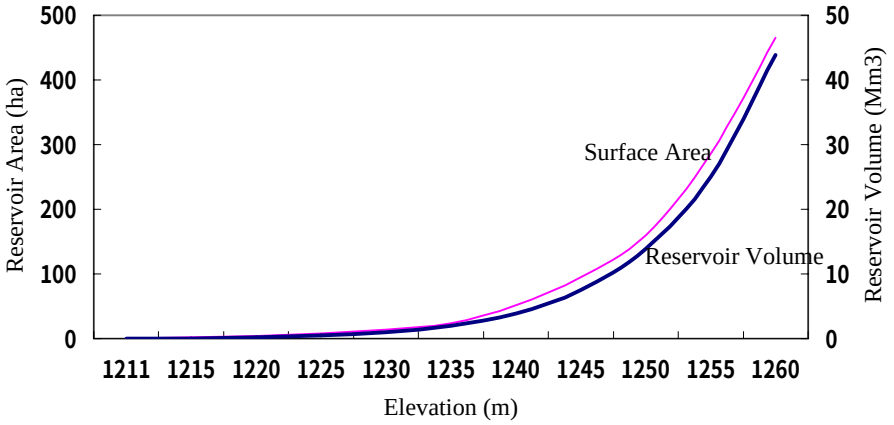


Taskourt

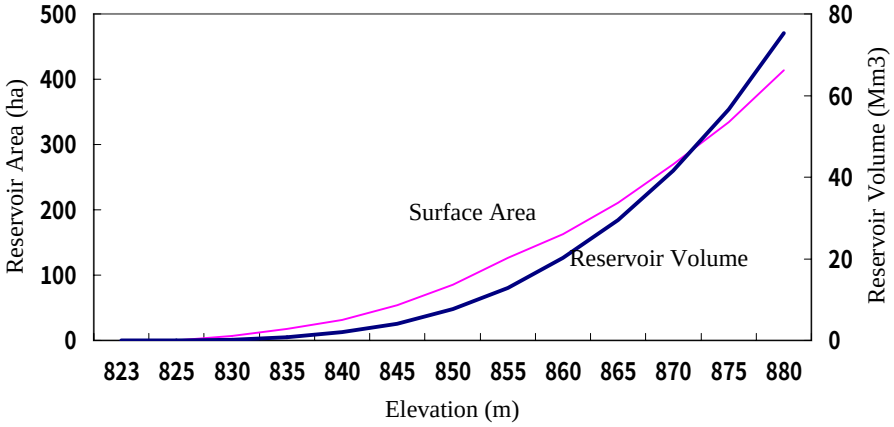


FEASIBILITY STUDY ON WATER RESOURCES DEVELOPMENT IN RURAL AREA JAPAN INTERNATIONAL COOPERATION AGENCY	**Figure XV1.1** **Curves for Elevation - Area/Volume (1/2)**

Timkit

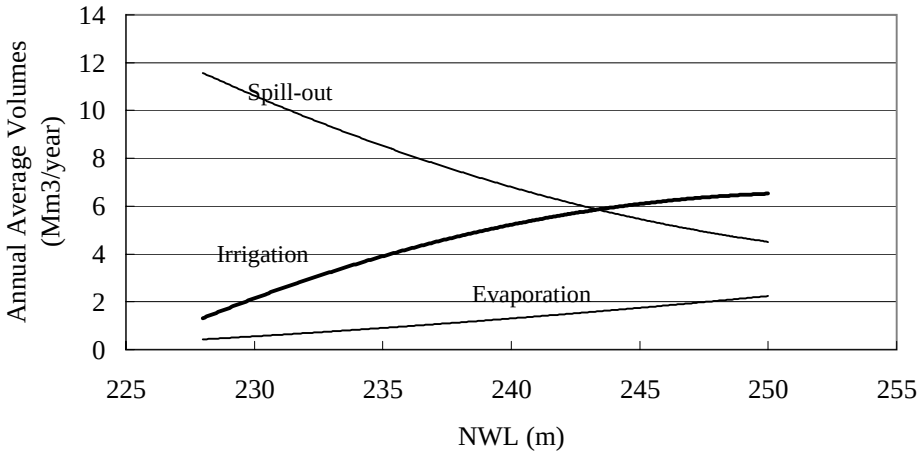


Azghar

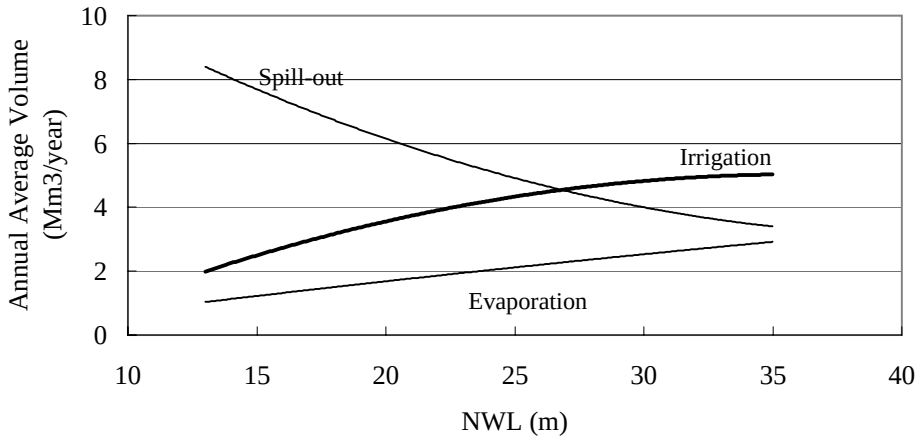


FEASIBILITY STUDY ON WATER RESOURCES DEVELOPMENT IN RURAL AREA JAPAN INTERNATIONAL COOPERATION AGENCY	**Figure XV1.1** **Curves for Elevation - Area/Volume** **(2/2)**

N'fifikh (upstream)



N'fifikh (downstream)



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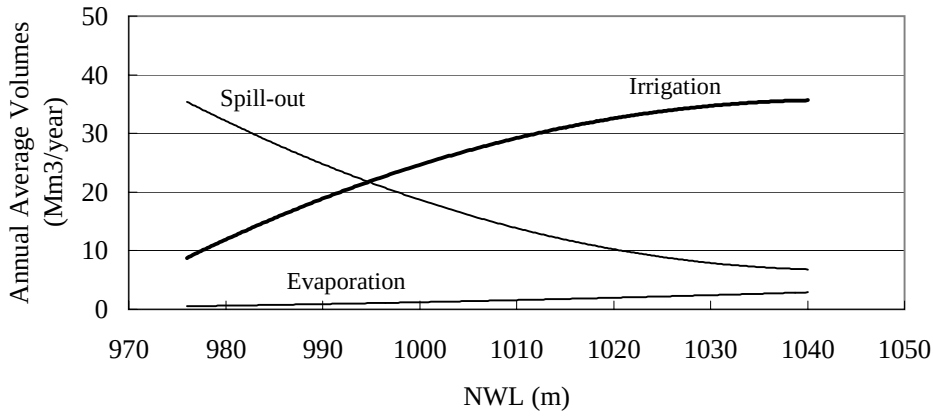
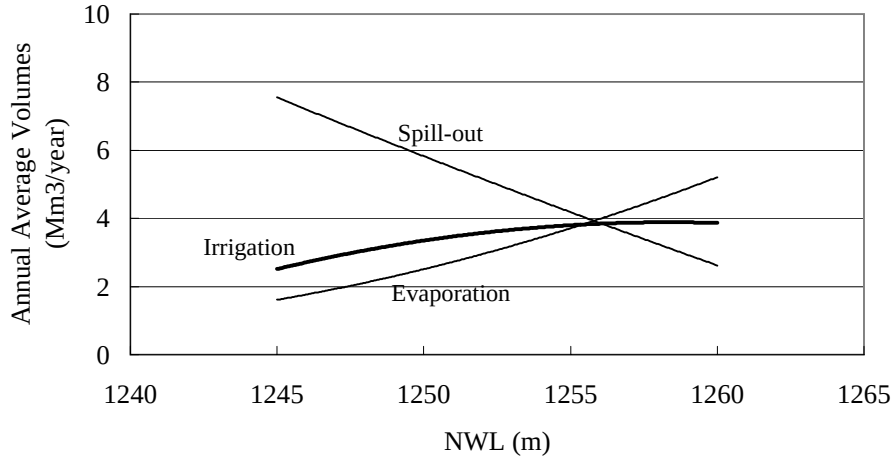
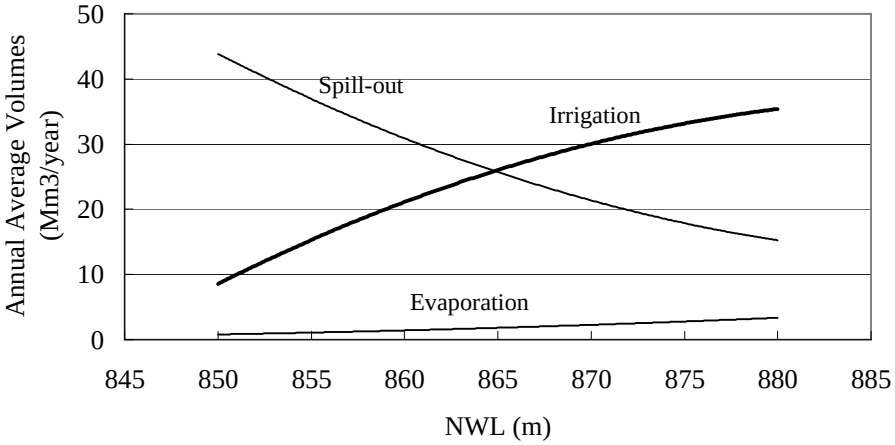


FEASIBILITY STUDY ON WATER RESSOURCES DEVELOPMENT IN RURAL AREA JAPAN INTERNATIONAL COOPERATION AGENCY	**Figure XV1.2 (1/2)** **Curves for NWL-Annual Average Volumes**

Timkit

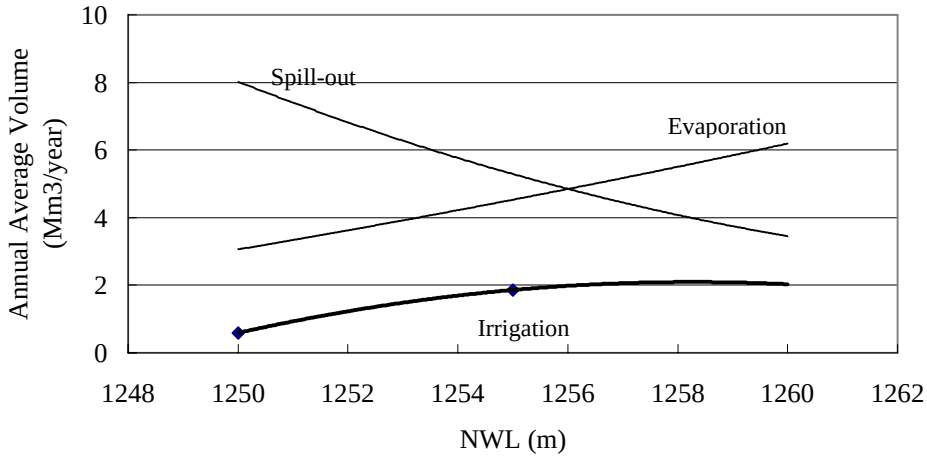


Azghar

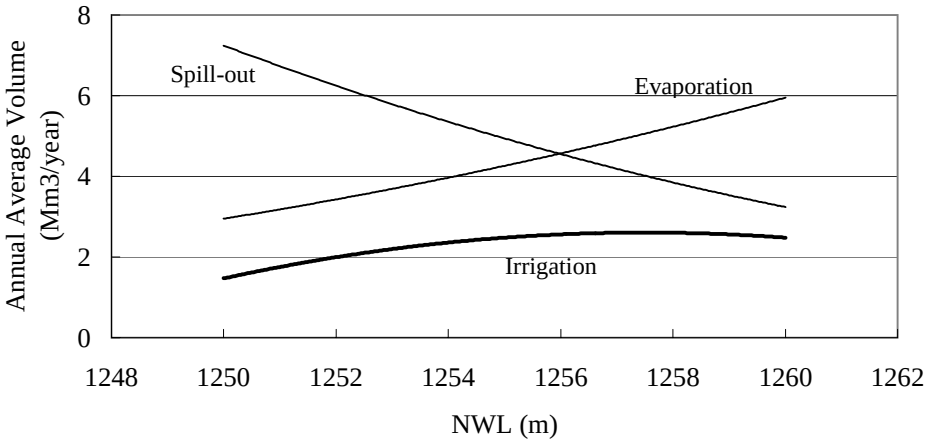


FEASIBILITY STUDY ON WATER RESSOURCES DEVELOPMENT IN RURAL AREA JAPAN INTERNATIONAL COOPERATION AGENCY	**Figure XV1.2 (2/2)** **Curves for NWL-Annual Average Volumes**

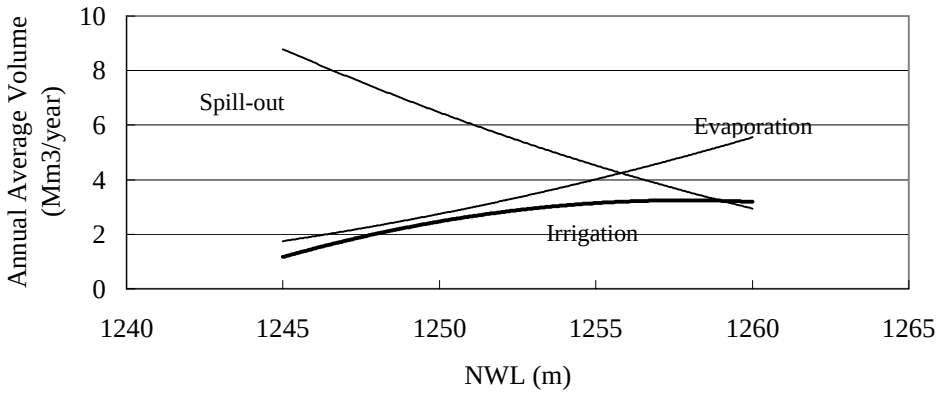
50 Years Sedimentation



40 Years Sedimentation

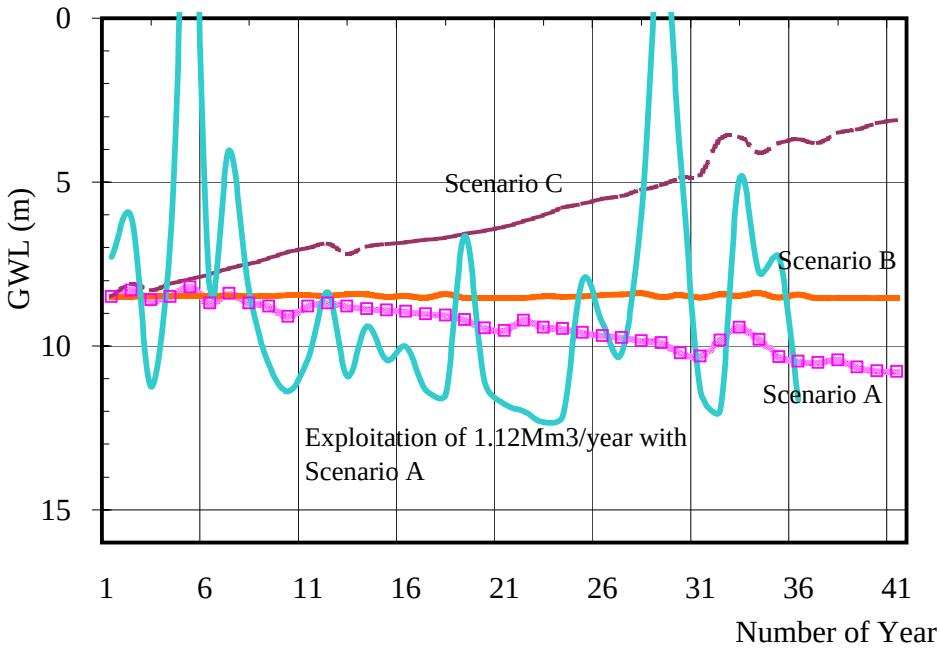


30 Years Sedimentation

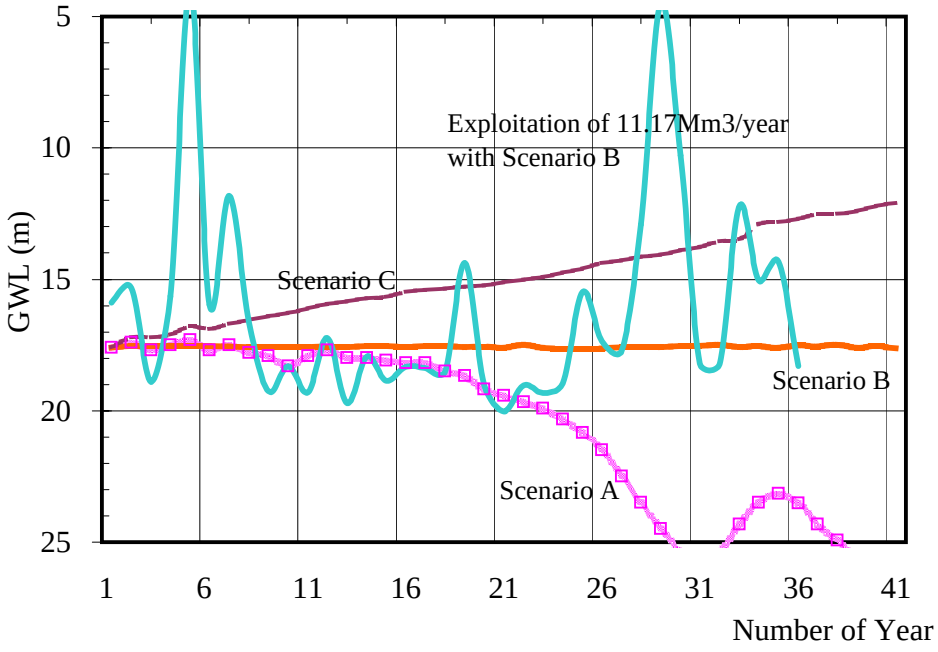


FEASIBILITY STUDY ON WATER RESSOURCES DEVELOPMENT IN RURAL AREA JAPAN INTERNATIONAL COOPERATION AGENCY	**Figure XV1.3** **Curves for Alternative Design Period of Sedimentation for Timkit**

Timkit Basin

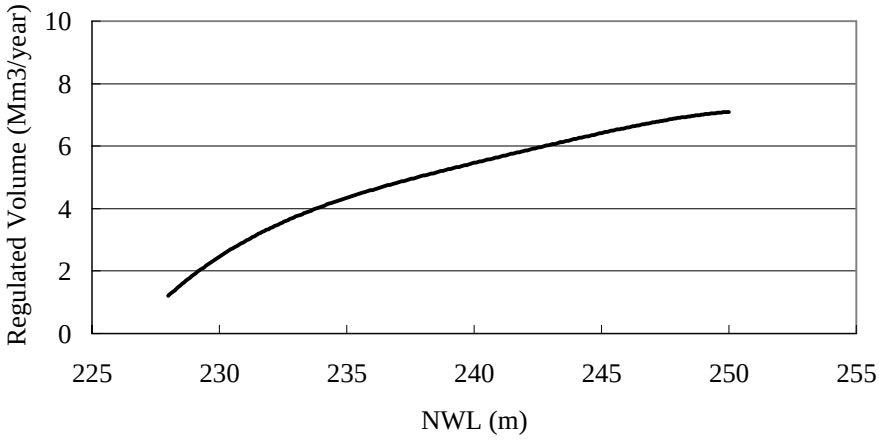


Todrha Basin

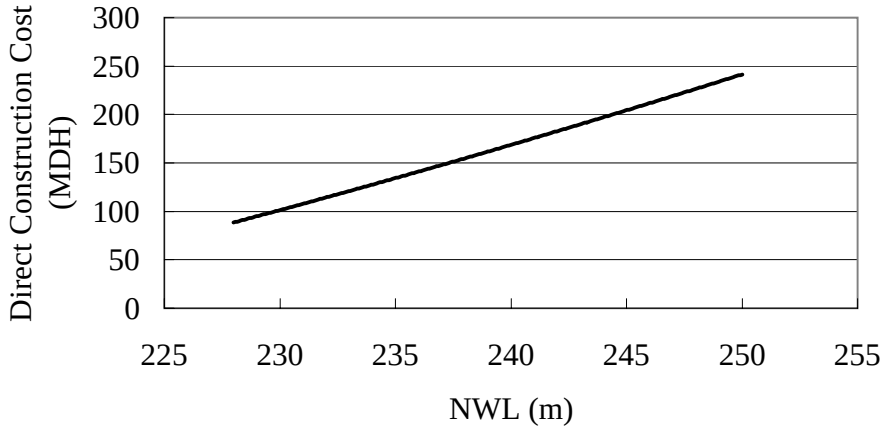


FEASIBILITY STUDY ON WATER RESSOURCES DEVELOPMENT IN RURAL AREA JAPAN INTERNATIONAL COOPERATION AGENCY	**Figure XV2.1** **Simulation of Recharge/Pumping**

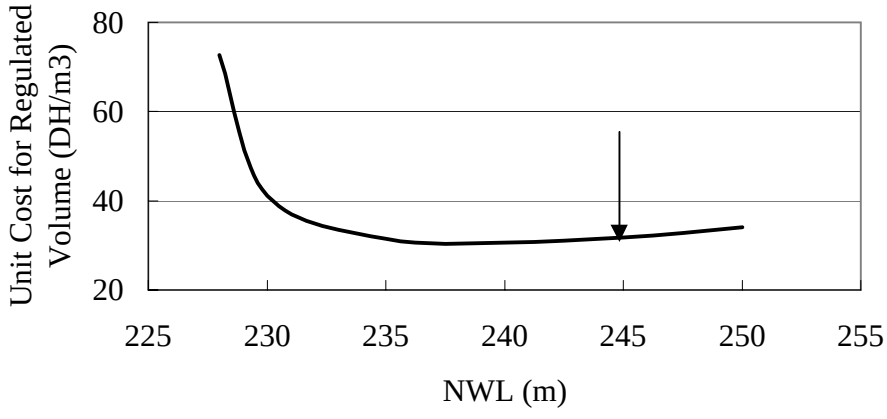
NWL-Regulated Volume



NWL-Direct Construction Cost

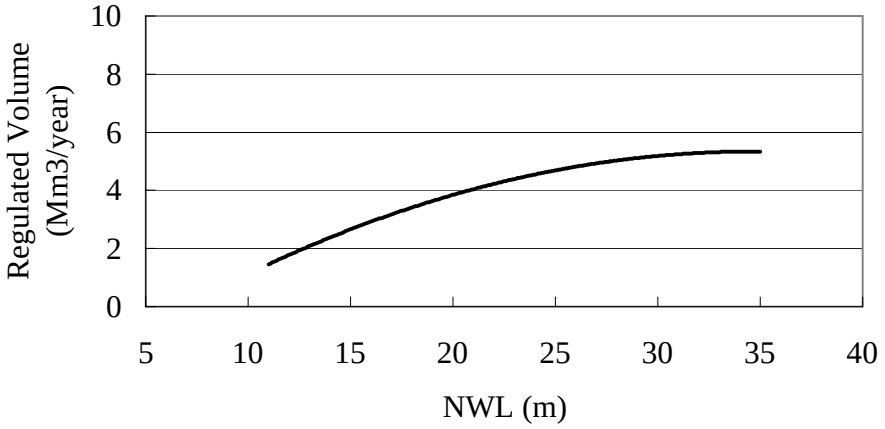


NWL-Unit Cost for Regulated Volume

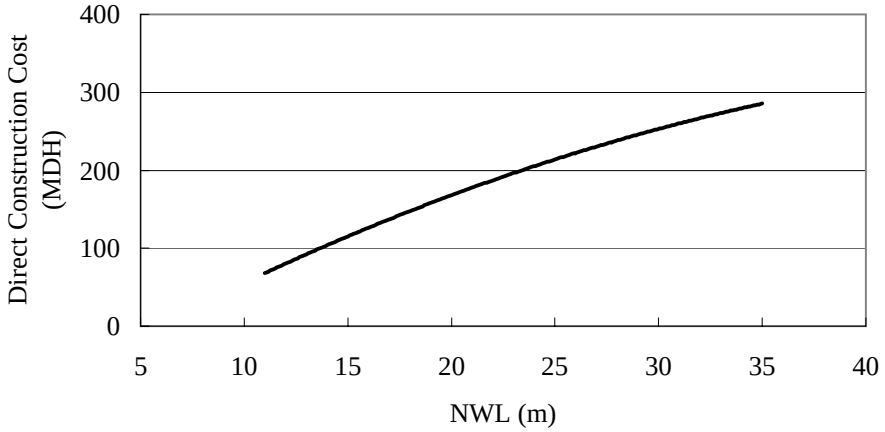


FEASIBILITY STUDY ON WATER RESSOURCES DEVELOPMENT IN RURAL AREA JAPAN INTERNATIONAL COOPERATION AGENCY	**Figure XV3.1** **Optimization of Dam Scale for N'fifikh (upstream)**

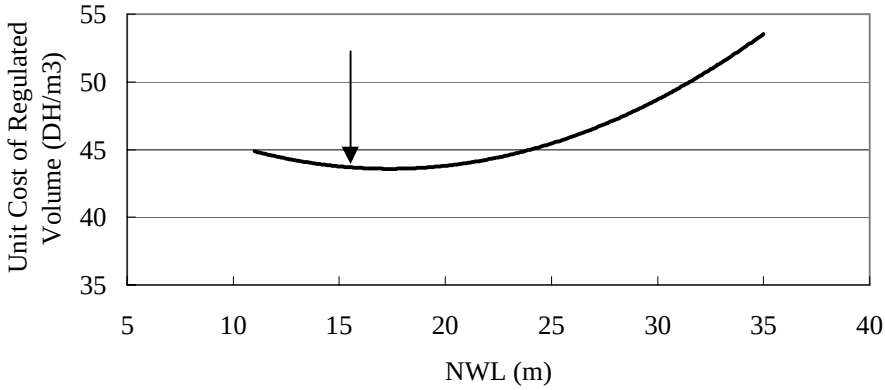
NWL-Regulated Volume



NWL-Direct Construction Cost

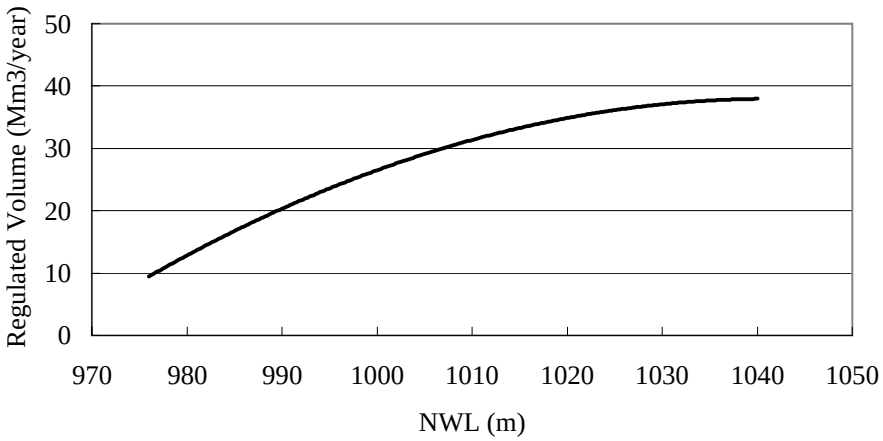


NWL-Unit Cost for Regulated Volume

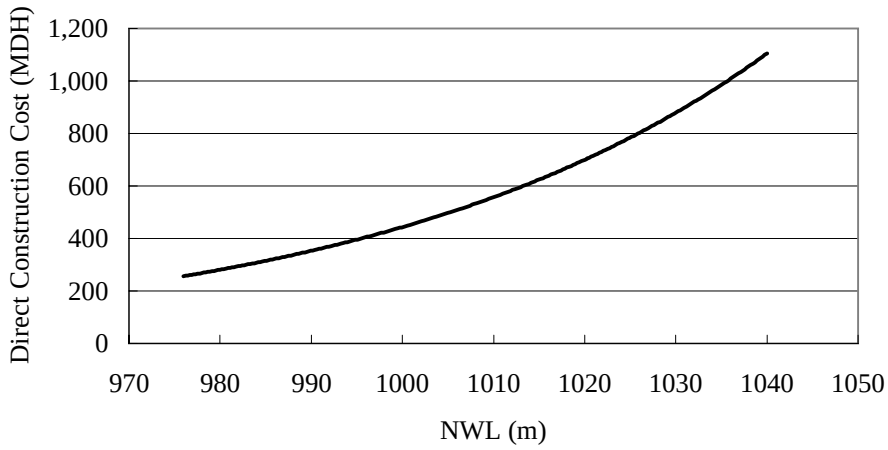


FEASIBILITY STUDY ON WATER RESSOURCES DEVELOPMENT IN RURAL AREA JAPAN INTERNATIONAL COOPERATION AGENCY	**Figure XV3.2** **Optimization of Dam Scale for N'fifikh (downstream)**

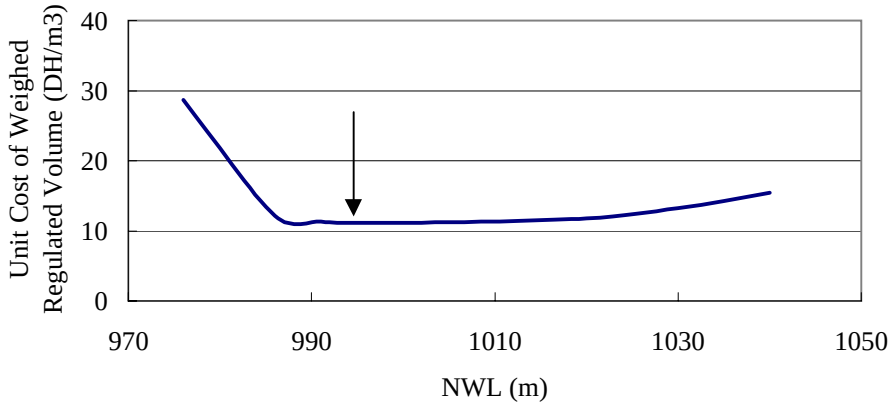
NWL-Regulated Volume



NWL-Direct Construction Cost

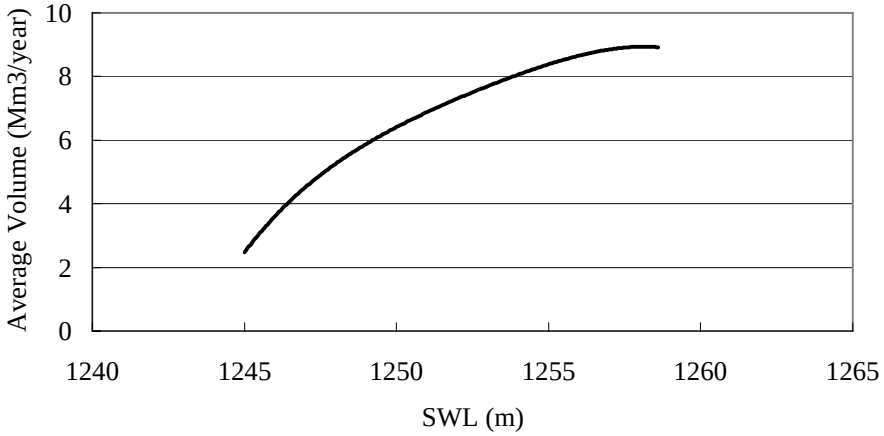


NWL-Unit Cost for Weighed Regulated Volume

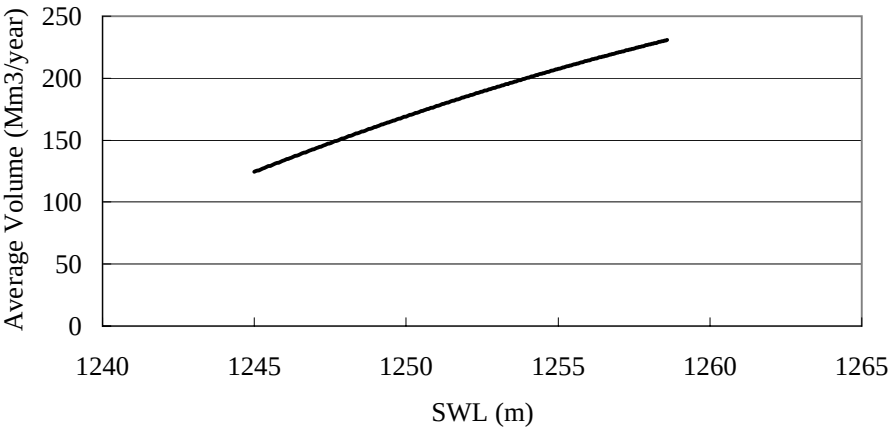


FEASIBILITY STUDY ON WATER RESSOURCES DEVELOPMENT IN RURAL AREA JAPAN INTERNATIONAL COOPERATION AGENCY	**Figure XV3.3** **Optimization of Dam Scale for Taskourt**

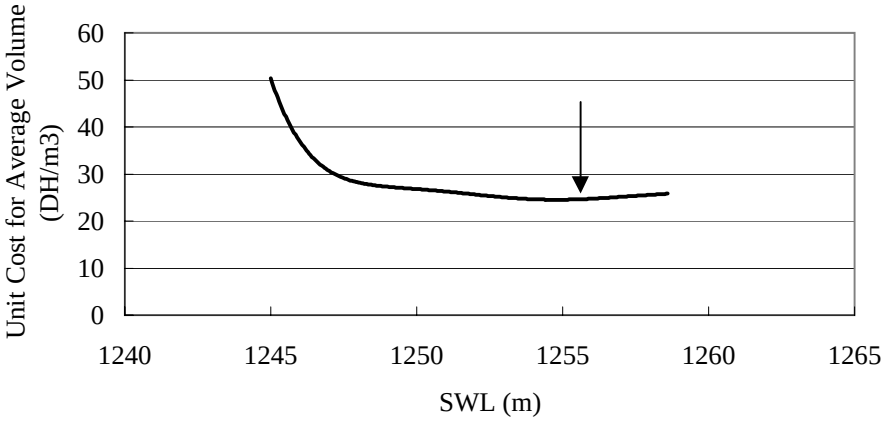
SWL-Average Volume



SWL-Direct Construction Cost

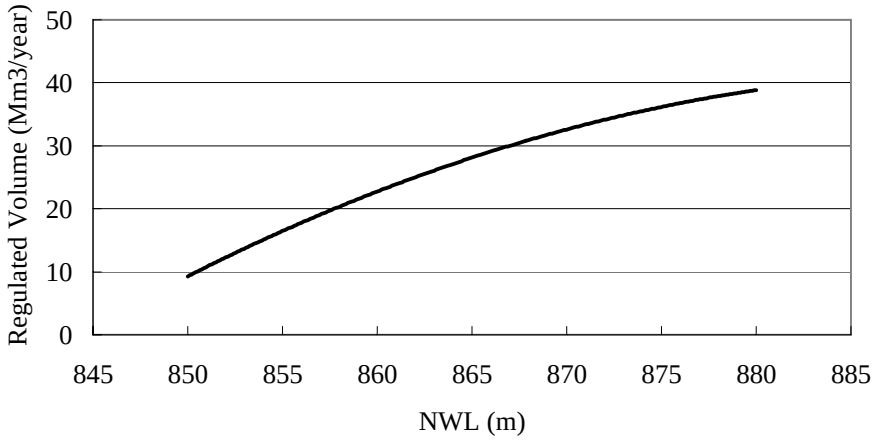


SWL-Unit Cost for Average Volume

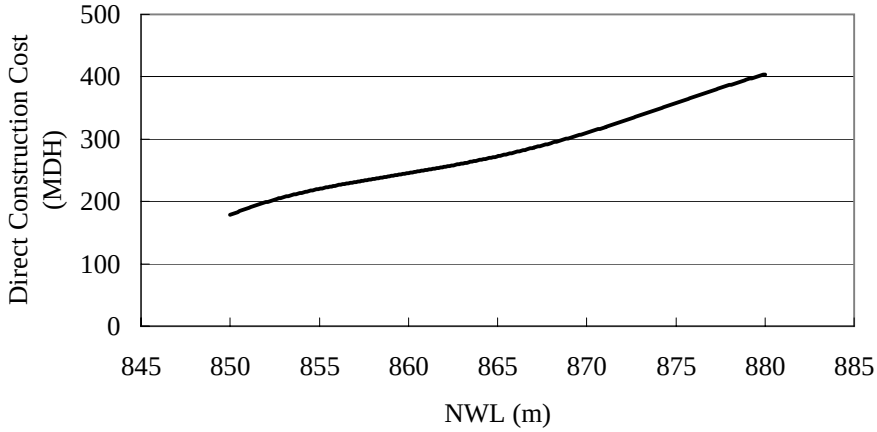


FEASIBILITY STUDY ON WATER RESSOURCES DEVELOPMENT IN RURAL AREA JAPAN INTERNATIONAL COOPERATION AGENCY	**Figure XV3.4** **Optimization of Dam Scale for Timkit**

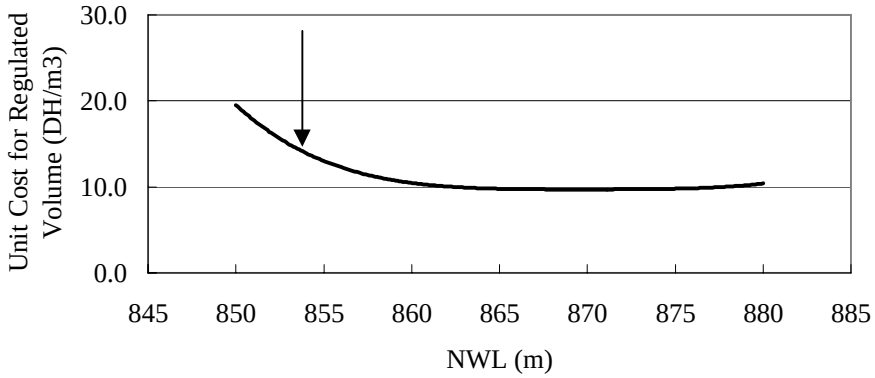
NWL-Regulated Volume



NWL-Direct Construction Cost



NWL-Unit Cost for Regulated Volume



FEASIBILITY STUDY ON WATER RESSOURCES DEVELOPMENT IN RURAL AREA JAPAN INTERNATIONAL COOPERATION AGENCY	**Figure XV3.5** **Optimization of Dam Scale for Azghar**